NORTH DAKOTA DEPARTMENT OF HEALTH
Environmental Health Section

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July 20, 1999

FILE

Ms. Bernadette Gonzalez
U.S. EPA, Region VIII
One Denver Place
999 18TH Street, Suite 500
Denver, CO 80202-2405

Re: FY 98-'99 PPA, Air Quality Media Workplan, Monitoring, Item C (Network Review)

Dear Ms. Gonzalez:

Enclosed are two copies of the referenced review. Please note that our plans for network modification are either vague or not addressed. Because we do not have a clear understanding of the impact of recent court rulings and the impact of the regional haze rule, it is not practical for us to consider any serious network changes beyond what has been agreed to in the $PM_{2.5}$ monitoring plan and what is required to accommodate the speciation special study/national trends site in Fargo.

If you have any questions about the attached Network Review, please call me at 701-328-5188 or by e-mail at dharman@state.nd.us.

Sincerely,

Daniel E. Harman

Daniel E. Harman
Manager
Air Quality Monitoring
Div. of Environmental Engineering

DEH:csc
Enc:

NORTH DAKOTA DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL ENGINEERING

AMBIENT AIR QUALITY MONITORING
ANNUAL NETWORK REVIEW
1998

July 1999

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1.0 INTRODUCTION

The North Dakota Department of Health, Division of Environmental Engineering, has the primary responsibility of protecting the health and welfare of North Dakotans from the detrimental effects of air pollution. Toward that end, the Division of Environmental Engineering ensures that the ambient air quality in North Dakota is maintained in accordance with the levels established by the State and Federal Ambient Air Quality Standards (AAQS) and the Prevention of Significant Deterioration of Air Quality (PSD) Rules. To carry out this responsibility, the Division of Environmental Engineering operates and maintains a network of ambient air quality monitors and requires five major industrial pollution sources to conduct source specific ambient air quality monitoring.

To evaluate the effectiveness of the State's air quality monitoring effort, the U.S. Environmental Protection Agency (EPA) requires the Division of Environmental Engineering to conduct an annual review of the State's ambient air quality monitoring (AAQM) network. EPA's requirements, as set forth in 40 CFR 58.20, are to (1) determine if the system meets the monitoring objectives defined in 40 CFR 58, Appendix D, and (2) identify network modifications such as termination or relocation of unnecessary sites or establishment of new sites which are necessary. 40 CFR 58.25 requires the State to annually develop and implement a schedule to modify the AAQM network to eliminate any unnecessary sites or correct any inadequacies indicated as a result of the annual review required by 40 CFR 58.20(d). This document and subsequent revisions satisfy these annual requirements.

1.1 Network Review Process

The locations of sites in a monitoring program are established to meet certain objectives. The May 10, 1979, Federal Register (40 CFR 58), "Air Quality Monitoring, Data Reporting, and Surveillance Provisions," as amended, has specified a minimum of four basic monitoring objectives. These objectives are as follows:

1. To determine the highest <u>pollutant concentrations</u> expected to occur in an area covered by the network.

2. To determine representative concentrations in areas of high <u>population density</u>.

3. To determine the impact on ambient pollution levels by a <u>significant source</u> or class of sources.

4. To determine the general/background concentration levels.

The link between basic monitoring objectives and the physical location of a particular monitoring site involves the concept of spatial scale of representativeness. This spatial scale is determined by the physical dimensions of the air parcel nearest a monitoring site throughout which actual pollutant concentrations are reasonably similar. The goal in locating sites is to match the spatial scale represented by the sample of monitored air with a spatial scale most appropriate for the monitoring objective. Spatial scales of representativeness, as specified by EPA, are described as follows:

Microscale - dimensions ranging from several meters up to about 100 meters.

Middle Scale - areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 km.

Neighborhood Scale - city areas of relatively uniform land use with dimensions of 0.5 to 4.0 km.

Urban Scale - overall, city-wide dimensions on the order of 4.0 to 50.0 km. (Usually requires more than one site for definition.)

Regional Scale - rural areas of reasonably homogeneous geography covering from 50 km to hundreds of km.

The relationships between monitoring objectives and spatial scales of representativeness, as specified by EPA, are as follows:

Monitoring Objective	Appropriate Siting Scales
Highest Concentration	Micro, middle, neighborhood
Population Exposure	Neighborhood, urban
Source Impact	Micro, middle, neighborhood
General/Background	Urban, regional

Recommended scales of representativeness appropriate to the criteria pollutants monitored in North Dakota are shown below:

Criteria Pollutant	Spatial Scales
Inhalable Particulate (PM_{10})	micro, middle, neighborhood, urban, regional
Sulfur Dioxide (SO_2)	middle, neighborhood, urban, regional
Ozone (O_3)	middle, neighborhood, urban, regional
Nitrogen Dioxide (NO_2)	middle, neighborhood, urban
Carbon Monoxide (CO)	micro, middle, neighborhood

Using this physical basis to locate sites allows for an objective approach, ensures compatibility among sites, and provides a common basis for data interpretation and application. The annual review process involves an examination of existing sites to evaluate their monitoring objectives and spatial scale with sites deleted, added, or modified accordingly. Further details on network design can be found in 40 CFR 58, Appendix D.

1.2 General Monitoring Needs

As can be gathered from the prior discussion, each air pollutant has certain characteristics which must be considered when establishing a monitoring site. These characteristics may result from 1) variations in the number and types of sources and emissions in question; 2) reactivity of a particular pollutant with other constituents in the air; 3) local site influences such as terrain and land use; and 4) climatology. The State AAQM network is designed to monitor air quality data for three basic conditions: 1) background monitoring; 2) population exposure; and 3) highest concentration. The industrial AAQM network sites are designed to monitor air quality data for source specific highest concentration impacts on a neighborhood scale.

The primary function of the department operated continuous sites is to collect background data to determine if and when there is any change in background concentrations. Beulah, Fargo Residential, and Fargo NW are exceptions to this primary function. Beulah is population exposure because of the major sources in the vicinity. Fargo Residential and Fargo NW are also population orientated because Fargo is a major population center with PSD sources in the Fargo-Moorhead area. The data from these sites will be used as input to dispersion models to evaluate permits-to-construct and permits-to-operate for projects located in or near population centers in the eastern part of the state. PM_{10} sites, except for Sharon, are population exposure sites: Sharon collects background data for the eastern part of the state.

Background sites are chosen to determine concentrations of air contaminants in areas remote from urban sources and generally are sited using the regional spatial scale. This is true for NO_2 despite the fact that the regional spatial scale is not normally used for NO_2 monitoring. Once general locations are established, all monitoring sites are established in accordance with the specific probe siting criteria specified in 40 CFR 58, Appendix E.

The PM_{10} network, with the exception of Fargo, was terminated on December 31, 1998. With the workload created by the $PM_{2.5}$ network it was necessary to terminate as many PM_{10}

samplers as possible. As additional $PM_{2.5}$ and speciation samplers are added to the network, the location of the PM_{10} samplers will be reviewed.

The TRNP-NU site was terminated at the National Park Service's request and moved to TRNP-SU, back to the Painted Canyon site. The data collected will be used to supplement the data collected by the NPS.

Since all industrial AAQM network sites are source specific, all the pollutants at industry sites are source oriented on a neighborhood scale. Industrial sites are selected using dispersion modeling results and meteorological data. These sites are the most likely locations to have elevated ambient concentrations. The data collected at the industry-operated sites is included in the data summaries for comparison but not included in any discussion of the State ambient monitoring network needs or analysis. Each industry network is an entity unto itself and does not influence the placement of State operated sites.

A second site was established North of the AMOCO refinery to better address the emissions from the refinery.

The Short Creek - SPM site was initiated at the request of the Governor to monitor the influence of the Boundary Dam Power Plant on North Dakota. A PM10 sampler was install at startup. Continuous SO_2 and NO_X analyzers and MET will be installed as soon as a shelter is available. An FRM PM2.5 sampler will be added next year.

The Fort Berthold Indian Reservation operates an ambient air quality monitoring network. Since the department has influence on neither the operation nor maintenance of the network, the data collected are included only to indicate the presence of the sites and reflects the data sent to the department. The validity of the data is not certified by inclusion.

1.3 Monitoring Objectives

The monitoring objectives of the Department are to track those pollutants that are judged to have the potential for violating either State or Federal Ambient Air Quality Standards and to ensure that those pollutants do not cause significant deterioration of our existing air quality. To accomplish these objectives, the Department operated 15 AAQM sites around the State. Eleven were SLAMS/NAMS sites, and four were special purpose monitoring (SPM) sites. There were three industries reporting ambient air quality data to this Department. Table 1 lists each site's type and the parameters monitored. Figure 1 shows the approximate site locations. For the industry networks, each network is represented by a single circle whether there is a single site or multiple sites.

The numbers in the Site Name/Company column in Table 1 and in the '#' column in Tables 2, 5, 7, 9, and 12 correspond to the numbers on the figures. The numbers in the circles correspond to the monitoring site monitoring that pollutant and the squares correspond to the major sources for that particular pollutant.

TABLE 1

AAQM Network Description

Site Name AQS Site #	Type Station	Parameter Monitored[1]	Operating Schedule	Monitoring Objective[2]	Spatial Scale[2]	Date Site Began
1 Beulah Residential 380570001	SLAMS	PM_{10} SO_2, NO_2, O_3, MET	6th Day cont.	Population Exposure Population Exposure	Neighborhood Neighborhood	12/95 04/80
2 Bismarck Residential 380150003	SLAMS	PM_{10} $PM_{2.5}$ $PM_{2.5}$	6th Day 6th Day 3rd Day	Population Exposure SSI + SA-231F Population Exposure	Urban Urban Urban	07/95 06/97 12/98
3 Dickinson Residential 380890002	SLAMS	PM_{10}	6th Day	Population Exposure	Urban	07/89
4 Dunn Center 380250003	SLAMS	SO_2, MET	cont.	General Background	Regional	10/79
5 Fargo Residential 380171003	SLAMS	PM_{10} PM_{10} SO_2, NO_2, O_3, MET	6th Day 6th Day cont.	Population Exposure Collocated SSI Population Exposure	Urban N/A Urban	08/95 08/95
6 Fargo NW 380171004	SAMS	PM_{10} PM_{10} $PM_{2.5}$ $PM_{2.5}$ SO_2, NO_2, O_3, MET	6th Day 6th Day 3rd day 3rd Day cont.	Population Exposure Collocated SSI Population Exposure Collocated Population Exposure	Urban N/A Urban N/A Urban	05/98 12/98 05/98
7 Grand Forks North 380350004	SLAMS	PM_{10} $PM_{2.5}$	6th Day 3rd Day	Population Exposure Population Exposure	Urban Urban	07/89 12/98
8 Hannover 380650002	SLAMS	SO_2, NO_2, O_3, MET	cont.	General Background	Regional	10/84
9 Mandan Refinery - SPM 380590002	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	12/95
10 Mandan Refinery NW - SPM 380590003	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	09/98
11 Sharon 380910001	SLAMS	SO_2, NO_X O_3, MET PM_{10}	cont. 6th Day	General Background	Regional	07/94
12 Short Creek - SPM 380130002	SPM	PM_{10}	6th Day	Source Impact	Regional	09/98
13 TRNP - NU 380530003	SLAMS	SO_2, O_3, H_2S, MET	cont.	General Background	Regional	02/80
14 TRNP - SU 380070002	SPM	SO_2, O_3 MET	cont.	General Background	Regional	07/95
15 Williston Residential 381050002	SLAMS	PM_{10}	6th Day	Population Exposure	Urban	08/95
Company	**Site Name** AQS Site #					
16 Amerada Hess Corporation	TIOGA #1 381050103 TIOGA #2 381050104 TIOGA #3 381050105	SO_2 H_2S, MET SO_2	cont. cont. cont.	Source Impact Source Impact Source Impact	Urban Urban Urban	07/87 07/87 11/87
17 Dakota Gasification Company	DGC #12 380570102 DGC #14 380570118 DGC #16 380570123 DGC #17 380570124	SO_2, NO_2, MET SO_2 SO_2 SO_2, NO_2	cont. cont. cont. cont.	Source Impact Source Impact Source Impact Source Impact	Urban Urban Urban Urban	01/80 01/89 10/95 10/95
18 Bear Paw Energy, Inc.	MGP #3 380530104 MGP #5 380530111	SO_2, MET SO_2, MET	cont. cont.	Source Impact Source Impact	Urban Urban	11/94 05/94

1. MET refers to meteorological and indicates wind speed and wind direction monitoring equipment.
2. Not applicable to MET.

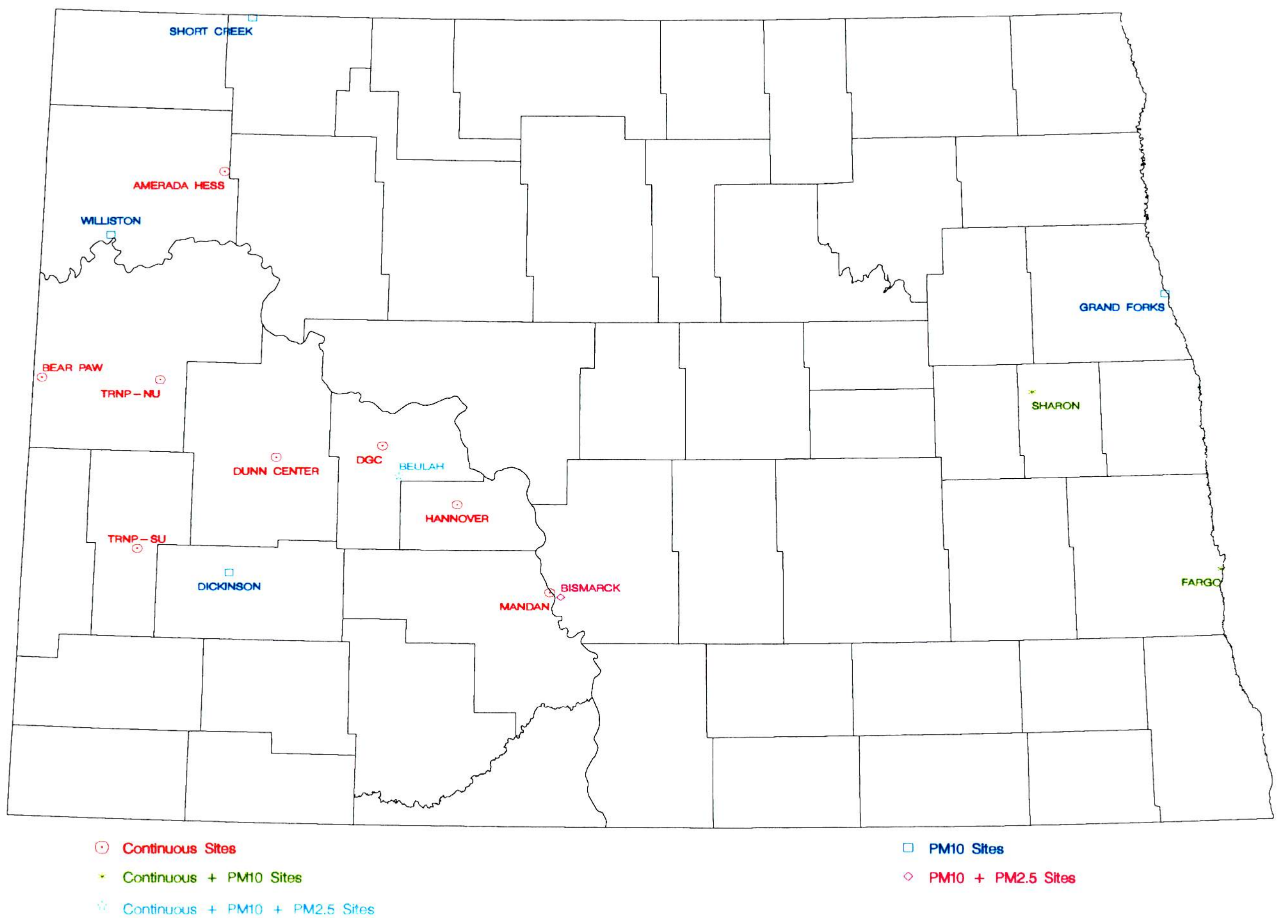

Figure 1 North Dakota Ambient Air Quality Monitoring Sites

2.0 AMBIENT AIR MONITORING NETWORK COVERAGE

The State of North Dakota is attainment for all criteria pollutants. As such, there are no "problem areas" in the general sense of the term. However, there are areas of concern where the Department has established monitoring sites to track the emissions of specific pollutants from area sources. Also, three major sources maintained monitoring networks in the vicinity of their plants (see Table 1 and Figure 1).

2.1 Sulfur Dioxide

Energy development in the west and west-central portions of North Dakota has produced a number of sources of sulfur dioxide (SO_2). These sources include coal-fired steam-powered electrical generating facilities, a coal gasification plant, natural gas processing plants, an oil refinery, and flaring at oil/gas well sites. As a result, SO_2 is one of the Department's major concerns in regard to ambient air quality monitoring.

2.1.1 Point Sources

The major SO_2 point sources (>100 TPY) are listed in Table 2 along with their emissions from the emissions inventories reported to the department. Figure 2 shows the approximate locations of these facilities (the numbers correspond to the respective positions in the site and source tables).

2.1.2 Other Sources

The western part of the State has a number of potential SO_2 sources associated with the development of oil and gas. These sources include individual oil/gas wells, oil storage facilities, and compressor stations. Emissions from such sources can create two problems. First, these sources may directly emit significant amounts of hydrogen sulfide (H_2S) to the ambient air (see Section 2.7). Second, flaring the H_2S from these sources can create significant concentrations of SO_2 in the ambient air. The primary counties for these sources in western North Dakota are outlined in green on Figure 2.

TABLE 2

Major SO_2 Sources
(>100 TPY)

1998

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
1	Basin Electric: Leland Olds Station	Mercer	Stanton	52,272	24.33	380570001
2	Great River Energy: Coal Creek	Mc Lean	Underwood	47,055	21.90	380550017
3	Minnkota Power Coop: M R Young #2	Oliver	Center	20,246	9.42	380650020
3	Minnkota Power Coop: M R Young #1	Oliver	Center	20,039	9.33	380650001
4	Otter Tail Power Company: Coyote	Mercer	Beulah	18,364	8.55	380570012
5	Dakota Gasification Company	Mercer	Beulah	17,354	8.08	380570013
6	Basin Electric: Avs 1&2	Mercer	Beulah	16,020	7.46	380570011
7	Great River Energy: Stanton 1	Mercer	Stanton	7,522	3.50	380570004
8	Amoco Oil Co: Mandan Refinery	Morton	Mandan	6,394	2.98	380590003
9	Montana Dakota Utilities: Heskett 1 & 2	Morton	Mandan	2,554	1.19	380590001
7	Great River Energy: Stanton 10	Mercer	Stanton	1,269	0.59	380570007
10	Bear Paw Energy, Inc.: Grasslands Plant	Mc Kenzie	–	1,189	0.55	380530023
11	Amerada Hess Corp: Tioga Gas Plant	Williams	Tioga	1,150	0.54	381050004
12	American Crystal Sugar: Drayton Plant	Pembina	Drayton	738	0.34	380670003
13	Univ. Of North Dakota Heating Plant	Grand Forks	Grand Forks	625	0.29	380350003
14	Bear Paw Energy - Lignite Gas Plant	Burke	Lignite	561	0.26	380130071
15	American Crystal Sugar: Hillsboro Plant	Traill	Hillsboro	433	0.20	380970019
16	Petro-Hunt, Llc	Billings	Killdeer	409	0.19	380070002
17	Minn-Dak Farmers Cooperative	Richland	Wahpeton	265	0.12	380770026
18	Cargill Corn Milling - Wahpeton Facility	Richland	Wahpeton	205	0.10	380770110
19	North Dakota State University	Cass	Fargo	195	0.09	380170005

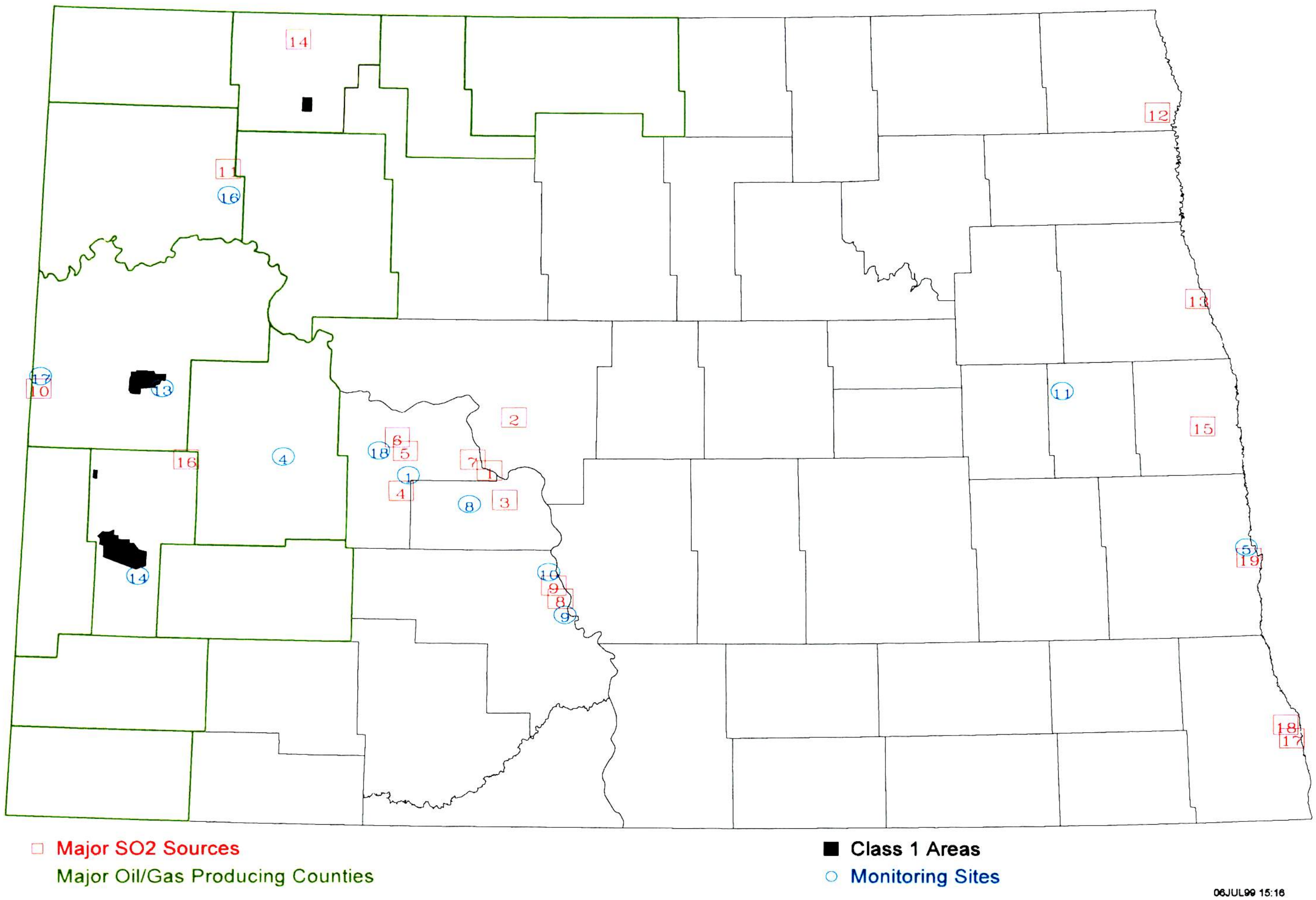

Figure 2 Major Sulfur Dioxide Sources

2.1.3 Monitoring Network

The SO_2 monitoring sites are shown on Figure 2. As can be seen, these monitoring sites are concentrated in the vicinity of the oil and gas development in the west and the coal-fired steam electrical generating plants in the central part of the State. Table 3 shows the 1998 annual SO_2 data summaries; Table 4 shows the 5-minute data summary. There were no exceedances of either State or Federal SO_2 standards.

2.1.4 Network Analysis

The nine largest SO_2 sources in the state are within 45 miles of both the Beulah and Hannover sites. This makes these two sites very important in tracking the impact of these nine sources on the ambient air . In Beulah, many homes and businesses use coal as a heat source during the heating season. This local influence could be as much an influence on the data as the major sources in the vicinity. One would expect that as these large sources came on line, beginning in 1980, a noticeable change would be seen on the ambient air quality. This has not been the case. There have been possible short term influences, but no significant long term impact by these nine sources combined. Figures 3, 4, 5, and 6, present a 19 year view of the percentage of data greater than the minimum detectable value (MDV), 1-hour maximums, 3-hour maximums, and 24-hour maximums, for the state operated sites. Because the industry sites are sited specifically for maximum expected concentrations (primarily as predicted by dispersion models and secondarily in a downwind direction), the industry sites are not reviewed for particular long term trends.

The best long term indicator of the change in the amount of SO_2 in the ambient air is seen by reviewing the percentages of data less than the MDV. Figure 3 presents this data for the active state sites from 1980 through 1998. To calculate valid annual statistics, at least 75% of the data must be greater than the MDV. Therefore, the annual mean is not a valid indicator and, consequently, not addressed.

TABLE 3

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Sulfur Dioxide (PPB)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1 - HOUR 1ST MM/DD/HH	MAXIMA 1 - HOUR 2ND MM/DD/HH	MAXIMA 3 - HOUR 1ST MM/DD/HH	MAXIMA 3 - HOUR 2ND MM/DD/HH	MAXIMA 24 - HOUR 1ST MM/DD	MAXIMA 24 - HOUR 2ND MM/DD	ARITH MEAN	1HR #>273	24HR #>99	% >MDV
Amerada Hess - Tioga #1	1998	JAN-DEC	8026	26 12/19/16	25 06/27/03	20 12/19/14	16 12/19/17	7 12/19	6 01/21	1.4			13.2
Amerada Hess - Tioga #3	1998	JAN-DEC	8628	59 01/15/23	49 11/14/06	39 10/06/14	38 04/17/11	16 10/06	13 09/20	2.1			18.8
Bear Paw - MGP #3	1998	JAN-DEC	7808	123 09/03/14	62 09/03/16	76 09/03/14	34 09/03/17	15 09/03	4 12/30	1.3			8.9
Bear Paw - MGP #5	1998	JAN-DEC	7181	141 09/01/10	132 09/01/11	120 09/01/11	70 09/01/14	30 09/01	13 08/21	1.6			12.6
Beulah	1998	JAN-DEC	8345	178 03/08/11	163 10/09/13	134 10/09/14	76 03/08/11	25 10/09	17 02/26	2.4			33.1
DGC #12	1998	JAN-DEC	8677	66 01/08/18	61 10/25/18	50 02/02/11	39 01/08/14	17 01/08	13 11/06	3.1			55.1
DGC #14	1998	JAN-DEC	8633	212 03/30/14	165 03/30/12	169 03/30/14	77 09/28/11	38 03/30	15 12/07	2.3			25.0
DGC #16	1998	JAN-DEC	8698	81 04/03/09	68 05/17/12	53 04/03/11	49 05/17/14	27 09/08	15 05/17	4.5			81.1
DGC #17	1998	JAN-DEC	8626	186 02/15/11	126 02/15/12	100 02/15/14	81 02/15/11	34 02/15	18 08/17	4.7			77.6
Dunn Center	1998	JAN-DEC	8262	31 03/04/06	25 04/02/15	22 04/02/17	21 03/04/08	6 04/02	5 12/31	1.3			10.3
Fargo NW	1998	MAY-DEC	4851	8 12/29/05	5 12/25/08	4 12/28/08	4 12/30/08	2 11/20	2 12/30	1.1			4.5
Fargo Residential	1998	JAN-MAY	3144	23 01/01/05	20 02/03/12	14 02/26/05	12 02/26/02	6 02/26	4 04/25	1.8			36.4
Hannover	1998	JAN-DEC	8624	121 09/03/12	115 04/15/08	62 09/03/14	55 07/29/11	16 09/03	14 10/13	2.5			25.8
Mandan Refinery - SPM	1998	JAN-DEC	8360	241 02/28/01	228 02/28/02	224 02/28/02	202 02/28/05	143 02/28	116 02/27	5.8		2	29.9
Mandan Refinery NW - SPM	1998	SEP-DEC	2323	113 11/24/05	87 10/03/07	62 11/24/08	61 10/03/08	29 10/03	15 11/24	3.2			40.9
Sharon	1998	JAN-DEC	7396	36 01/14/10	15 03/07/11	16 01/14/11	15 03/07/14	10 01/12	10 01/13	1.5			18.8
TRNP - NU	1998	JAN-JUN	4301	23 04/02/18	19 04/02/17	15 04/02/20	12 01/20/20	6 01/20	5 04/02	1.3			14.8
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3658	12 12/31/22	11 08/29/07	10 12/30/20	10 12/31/23	4 09/06	4 12/30	1.2			7.7
White Shield	1998	JAN-DEC	8595	53 10/07/21	42 01/21/08	35 01/21/08	31 01/21/11	11 01/21	8 10/13	1.8			23.8

The maximum 1-hour concentration is 241 ppb at Mandan Refinery - SPM on 02/28/01
The maximum 3-hour concentration is 224 ppb at Mandan Refinery - SPM on 02/28/02
The maximum 24-hour concentration is 143 ppb at Mandan Refinery - SPM on 02/28

* The air quality standards are:
STATE Standards -
1) 273 ppb maximum 1-hour average concentration.
2) 99 ppb maximum 24-hour average concentration.
3) 23 ppb maximum annual arithmetic mean concentration.

FEDERAL Standards -
1) 500 ppb maximum 3-hour concentration not to be exceeded more than once per year.
2) 140 ppb maximum 24-hour concentration not to be exceeded more than once per year.
3) 30 ppb annual arithmetic mean.

TABLE 4

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : SO 5-Minute Averages (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	5 - MINUTE MAXIMA 1ST	DATE MM/DD/HH	2ND	DATE MM/DD/HH	3RD	DATE MM/DD/HH	# HOURS >600	% >MDV
Bear Paw - MGP #3	1998	JAN-DEC	7106	199	09/03/14	164	09/03/13	143	06/26/10	0	15.5
Bear Paw - MGP #5	1998	JAN-DEC	7181	288	09/01/14	270	09/01/11	264	09/01/09	0	23.7
Beulah	1998	JAN-DEC	8345	241	10/09/10	228	10/09/13	221	10/09/11	0	44.4
Dunn Center	1998	JAN-DEC	8262	52	03/04/06	44	03/04/05	42	03/30/09	0	15.2
Fargo NW	1998	MAY-DEC	4851	8	12/29/05	5	12/29/08	5	12/28/05	0	4.5
Fargo Residential	1998	JAN-MAY	3144	23	01/01/05	20	02/01/12	19	02/03/11	0	36.4
Hannover	1998	JAN-DEC	8624	203	07/29/10	195	04/29/08	163	09/03/12	0	35.5
Mandan Refinery - SPM	1998	JAN-DEC	8360	295	02/28/01	289	02/28/02	281	02/28/00	0	40.6
Mandan Refinery NW - SPM	1998	SEP-DEC	2323	197	10/01/09	194	11/01/05	146	12/29/23	0	55.5
Sharon	1998	JAN-DEC	7396	36	01/14/10	15	03/14/11	15	03/07/12	0	18.8
TRNP - NU	1998	JAN-JUN	4301	25	04/02/16	25	04/02/17	24	04/02/18	0	21.5
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3661	12	12/31/22	11	08/31/07	11	12/30/18	0	7.6

The maximum 5-minute concentration is 295 ppb at Mandan Refinery - SPM on 02/28/01

* No Standard is currently in effect.

Beginning in 1980, major events are easily traceable. In 1980, the oil industry was expanding. In 1981, MDU's Coyote Power Station began operation. In 1982 the oil industry in western North Dakota hit its peak activity. 1983, 1984, and 1985 were startup years for Basin Electric's Antelope Valley Unit #1, the synthetic natural gas plant (aka, Dakota Gasification Company), and Antelope Valley Unit #2, respectively. From 1987 through 1993, for the Beulah and Hannover sites, there has been a steady increasing trend in the percentage of data greater than the MDV. However, Hannover has shown a decrease the last four years while Beulah continued to increase until 1997. In contrast, the Dunn Center and TRNP - NU sites have remained consistently between 5% and 10% since 1988.

The same patterns seen in Figure 3 are discernable in the 1-hour, 3-hour, and 24-hour maximum concentration graphs (see Figures 4, 5, and 6, respectively). As can be seen from the graphs, the Mandan Refinery - SPM site exceeded the state and nearly the Federal 24-hour standard (see Figure 6): The 24-hour average was 143 ppb.

Because the newer sites (Fargo Residential, Fargo NW, Mandan Refinery - SPM, Mandan Refinery NW - SPM, Sharon, and TRNP - SU) have a limited amount of data, no attempt is made to evaluate the results.

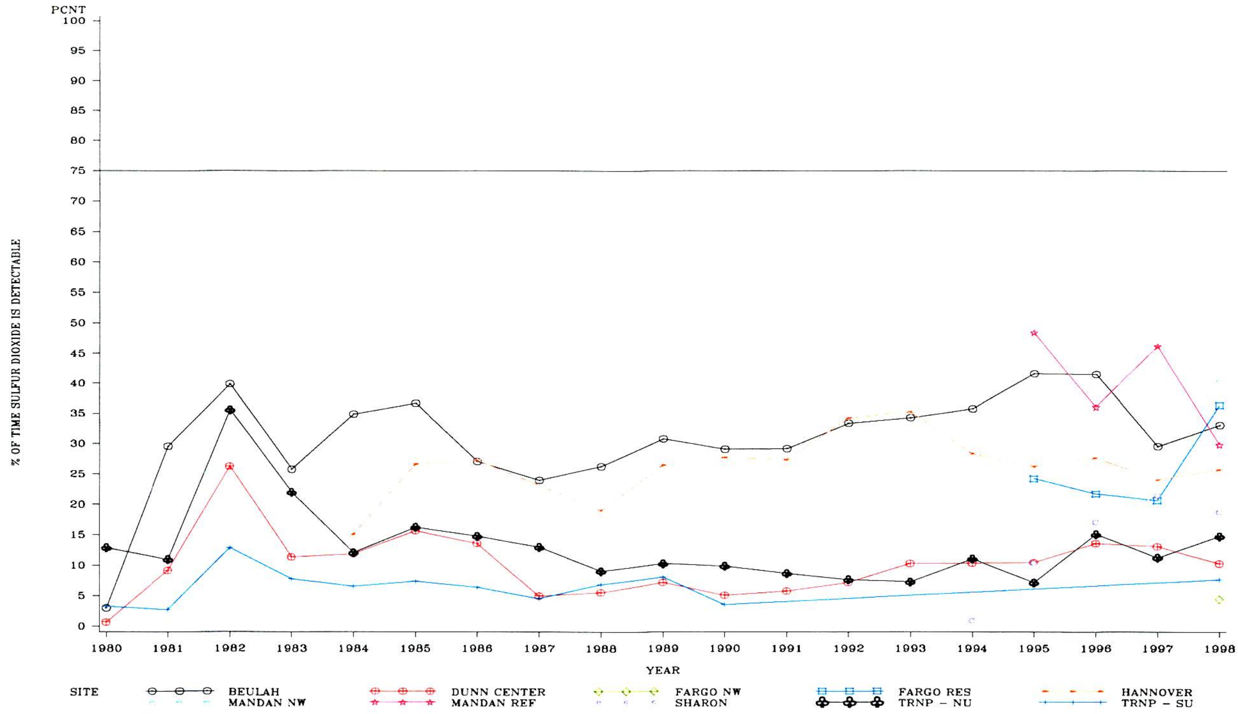

Figure 3 Percentage of Time SO_2 Detectable

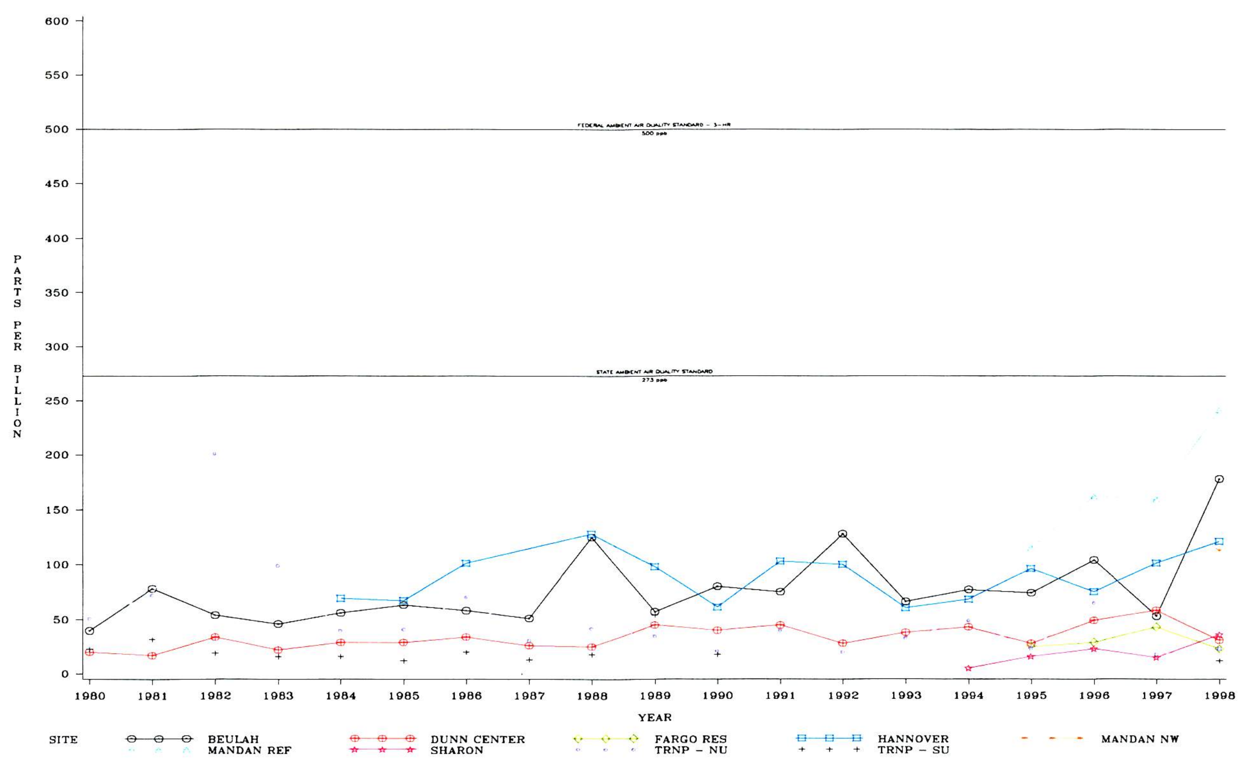

Figure 4 SO_2 Maximum 1-Hour Concentrations

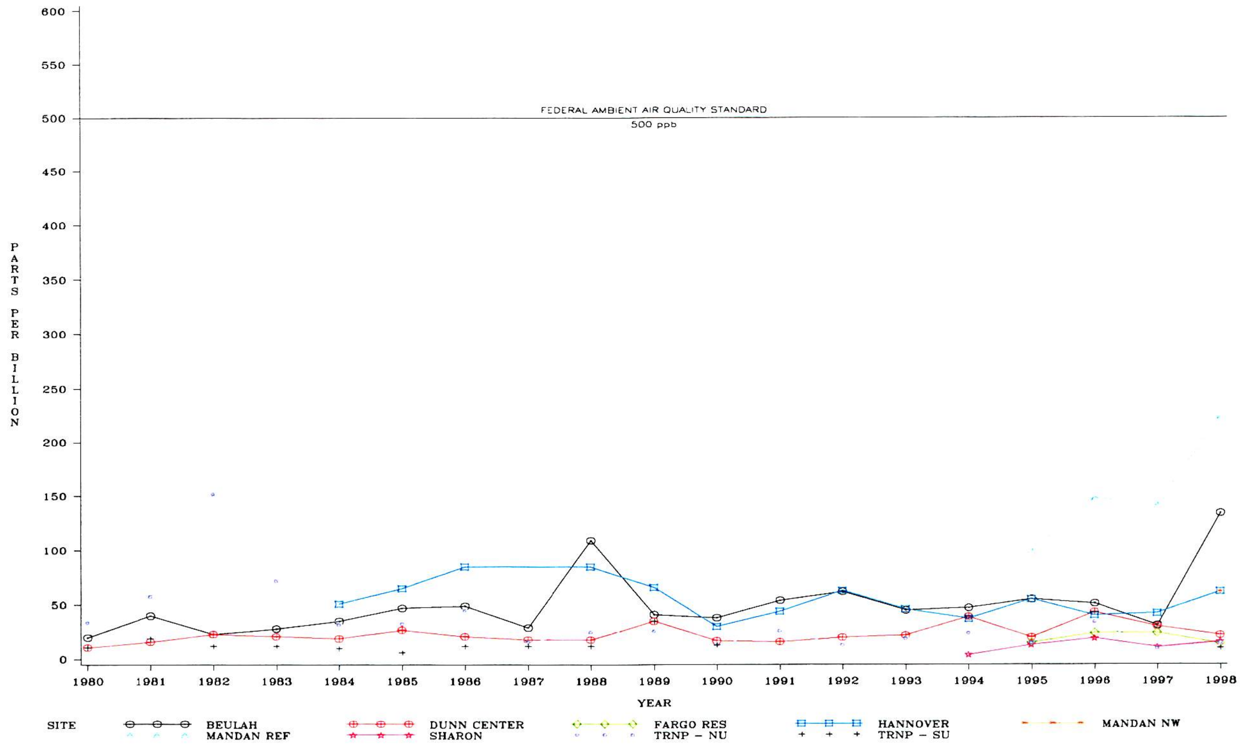

Figure 5 SO_2 Maximum 3-Hour Concentrations

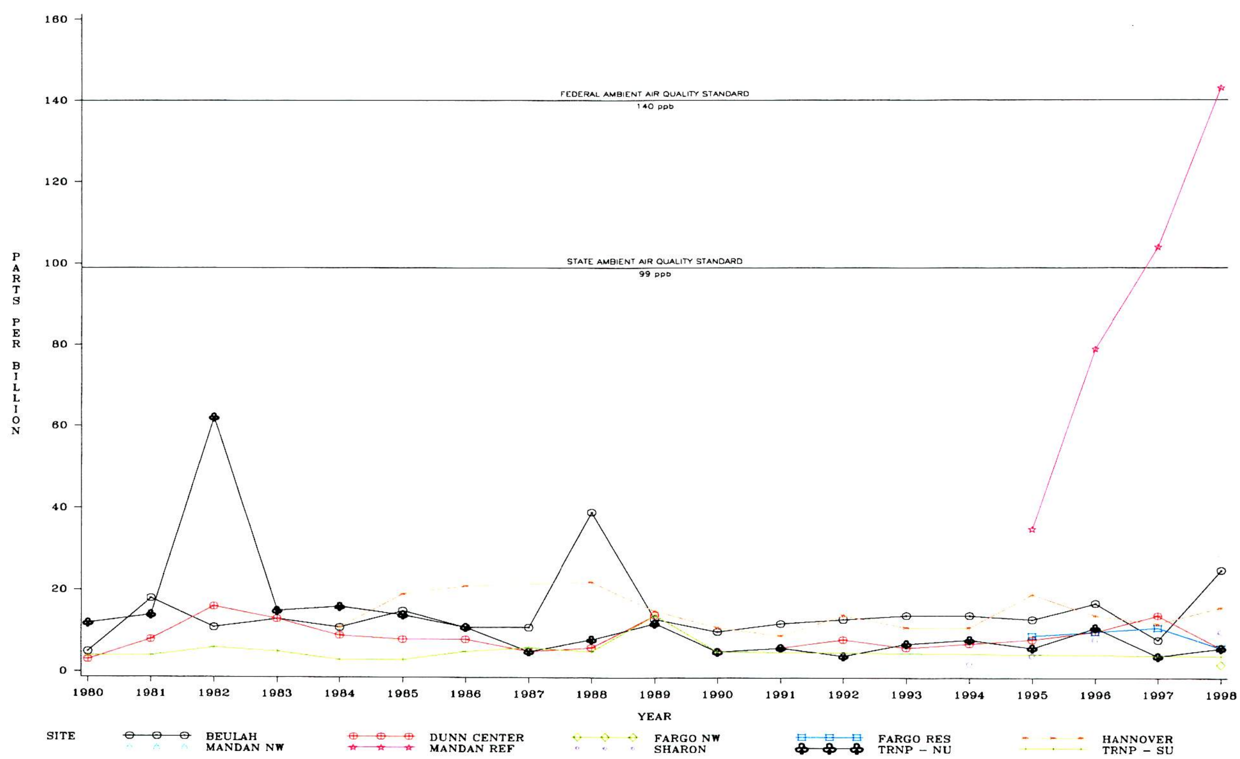

Figure 6 SO_2 Maximum 24-Hour Concentrations

2.2 Oxides of Nitrogen

Oxides of Nitrogen (NO_x) is the term used to represent both nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is formed when NO is oxidized in the ambient air. There are no ambient air quality standards for NO.

2.2.1 Point Sources

The major NO_x stationary point sources (>100 TPY) are listed in Table 5 along with their emissions as calculated from the most recent emission inventories reported to the department. Figure 7 shows the approximate locations of these facilities (the numbers correspond to the respective positions in the site and source tables). The larger NO_x point sources in North Dakota are associated with coal-fired steam-powered electrical generating plants in the west-central portion of the State and large internal combustion compressor engines in the natural gas fields in the western part of the State.

2.2.2 Area Sources

Another source of NO_X is automobile emissions. North Dakota has no significant urbanized areas with regard to oxides of nitrogen; the entire population of the State is less than the 1,000,000 population figure that EPA specifies in the NO_2 requirement for NAMS monitoring.

2.2.3 Monitoring Network

The Department currently operates six $NO/NO_2/NO_x$ analyzers. These are located at Beulah, Dunn Center, Fargo, Hannover, and Sharon. The Dakota Gasification Company (DGC) network also operated analyzers at sites DGC #12 and DGC #17. Table 6 shows the 1998 NO_2 data summaries. The measured NO_2 values are quite low, particularly the annual means. From Figure 7 it can be seen that $NO/NO_2/NO_x$ analyzers, except for Dunn Center and Sharon, are well placed with respect to the major NO_x sources: Dunn Center and Sharon are background sites.

TABLE 5

Major NO_x Sources
(> 100 TPY)

1998

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
1	Great River Energy: Coal Creek	Mc Lean	Underwood	21,303	20.88	380550017
2	Minnkota Power Coop: My Young #2	Oliver	Center	15,438	15.13	380650020
3	Basin Electric: Avs 1&2	Mercer	Beulah	14,193	13.91	380570011
4	Basin Electric: Leland Olds Station	Mercer	Stanton	13,859	13.58	380570001
5	Otter Tail Power Company: Coyote	Mercer	Beulah	12,947	12.69	380570012
2	Minnkota Power Coop: Mr Young #1	Oliver	Center	8,641	8.47	380650001
6	Dakota Gasification Company	Mercer	Beulah	3,450	3.38	380570013
7	Great River Energy: Stanton 1	Mercer	Stanton	3,338	3.27	380570004
8	Amerada Hess Corp: Tioga Gas Plant	Williams	Tioga	2,153	2.11	381050004
9	Amoco Oil Co: Mandan Refinery	Morton	Mandan	1,243	1.22	380590003
10	Montana Dakota Utilities: Heskett 1 & 2	Morton	Mandan	1,031	1.01	380590001
7	Great River Energy: Stanton 10	Mercer	Stanton	757	0.74	380570007
11	Minn-Dak Farmers Cooperative	Richland	Wahpeton	639	0.63	380770026
12	American Crystal Sugar: Drayton Plant	Pembina	Drayton	556	0.54	380670003
13	American Crystal Sugar: Hillsboro Plant	Traill	Hillsboro	465	0.46	380970019
14	Cavalier Air Station	Pembina	Cavalier	322	0.32	380670005
15	Univ. Of North Dakota Heating Plant	Grand Forks	Grand Forks	234	0.23	380350003
16	Bear Paw Energy - Lignite Gas Plant	Burke	Lignite	196	0.19	380130071
17	Amerada Hess: Antelope #2	Mc Kenzie	–	168	0.16	380530045
18	Bear Paw Energy, Inc.: Alexander	Mc Kenzie	Alexander	166	0.16	380530024
19	Bear Paw Energy, Inc.: Boxcar Butte	Mc Kenzie	–	155	0.15	380530018
20	Northern Border Pipeline: Cs #4	Mc Kenzie	Arnegard	140	0.14	380530014
21	Bear Paw Energy, Inc.: Tree Top	Billings	Fairfield	136	0.13	380070019
22	Continental Resources Inc	Bowman	–	105	0.10	380110010
23	Amerada Hess: Cherry Creek	Mc Kenzie	–	105	0.10	380530005

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
24	Bear Paw Energy, Inc.: Demicks Lake	Mc Kenzie	–	104	0.10	380530040
25	North Dakota State University	Cass	Fargo	102	0.10	380170005
26	Amerada Hess: Antelope #1	Mc Kenzie	–	101	0.10	380530044

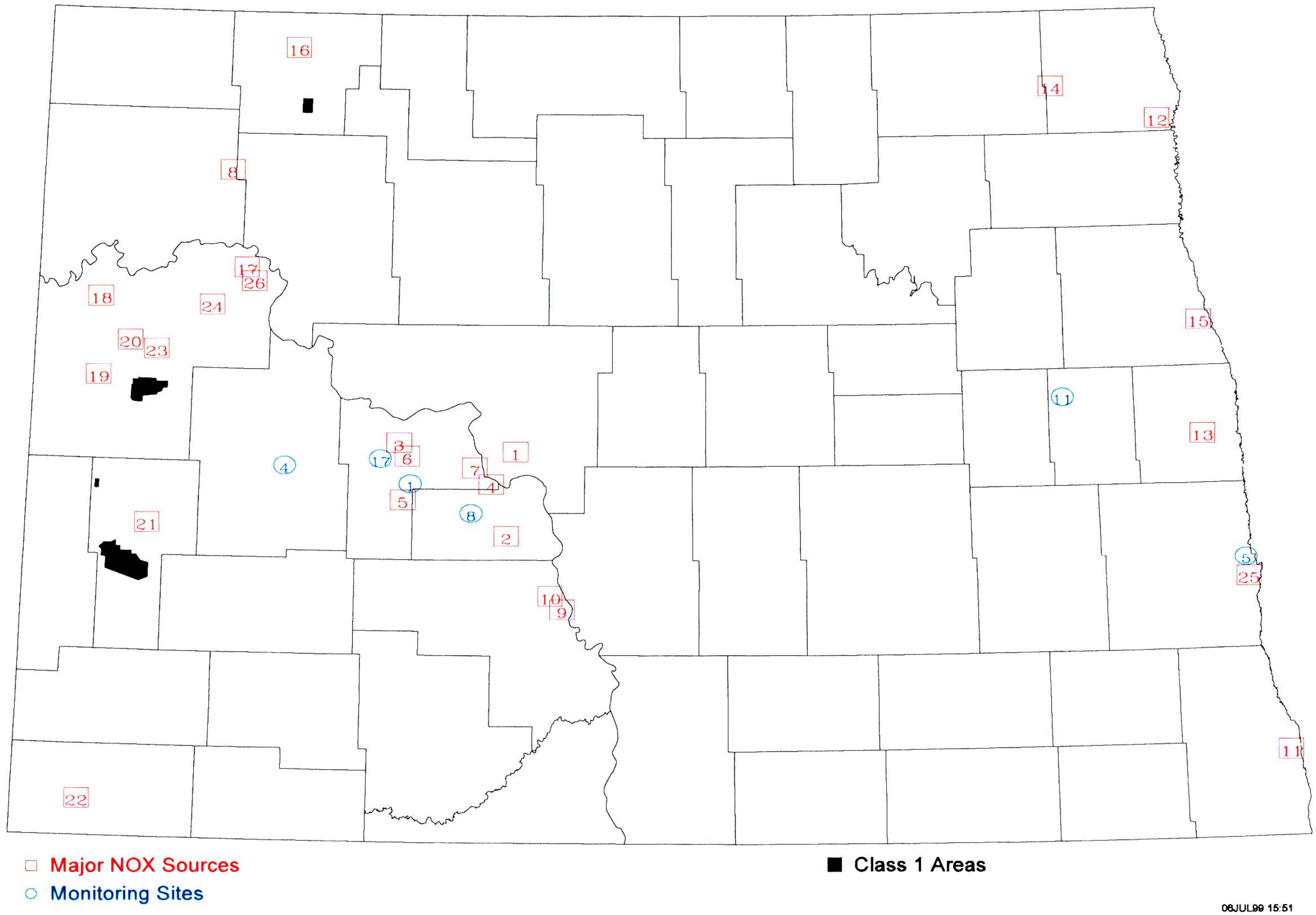

Figure 7 Major Nitrogen Dioxide Sources

TABLE 6

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Nitrogen Dioxide (PPB)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1 - HOUR 1ST MM/DD/HH	2ND MM/DD/HH	ARITH MEAN	% >MDV
Beulah	1998	JAN-DEC	8701	37 10/09/18	36 10/09/19	4.3	79.8
DGC #12	1998	JAN-DEC	8291	65 10/27/13	52 11/14/01	4.8	99.7
DGC #17	1998	JAN-DEC	8472	181 09/03/22	170 09/03/23	4.8	94.9
Dunn Center	1998	DEC-DEC	408	6 12/30/07	5 12/28/04	1.3	19.1
Fargo NW	1998	MAY-DEC	5327	44 05/26/23	44 09/03/20	6.5	81.7
Fargo Residential	1998	JAN-MAY	3136	58 04/22/20	55 04/22/21	8.1	80.9
Hannover	1998	JAN-DEC	8563	39 08/20/23	36 01/21/03	2.5	56.8
Sharon	1998	JAN-DEC	8705	16 01/14/20	16 01/14/21	1.7	36.8

The maximum 1-hour concentration is 181 ppb at DGC #17 on 09/03/22

* The air quality standards are:
STATE - 53 ppb maximum annual arithmetic mean.

FEDERAL - 53 ppb annual arithmetic mean.

2.2.4 Network Analysis

Ten of the eleven largest NO_2 sources in the state are within 45 miles of the Beulah and Hannover monitoring sites. Figures 8 and 9 show the trends for the state operated sites for the last 19 years. Since the industry operated sites are placed for maximum concentrations, trends are not considered.

With the exception of Beulah in 1981, the percentage of data greater than the MDV, shown in Figure 8, was reasonably stable until 1993. The significant increase in the percentage of detectable concentrations is contrary to the quantity of NO_2 emitted. In 1992 these nine sources emitted 119,213 tons; in 1993, 103,673 tons; in 1994, 97,583 tons; in 1995, 96,098 tons; in 1997, 108,676 tons; and , in 1998, 102,047 tons,. A possible explanation for Hannover is the analyzer was changed in March 1992 from a Meloy 8101C to a TECO 42. However, the analyzer change did not produce a discreet jump: the increase was seen at both the Beulah and Hannover sites. A possible conclusion is the increase in detectable NO_2 concentrations is real and not the result of equipment changes. Another possibility, and more likely, is a change in the wind flow patterns. As Hannover began a decline in 1995, Sharon began to increase. Beulah and Fargo Res are the only State sites with more then 75% of the possible values greater then the MDV.

If the 1-hour maximum concentrations had followed a pattern similar to the one shown in Figure 8, the equipment change could have accounted for the increase in the percentage of data greater than the MDV. However, the 1-hour maximums, shown in Figure 9, have shown an overall decrease. Since Dunn Center, Fargo Res, Fargo NW, and Sharon are relatively new sites, no valid trending is possible.

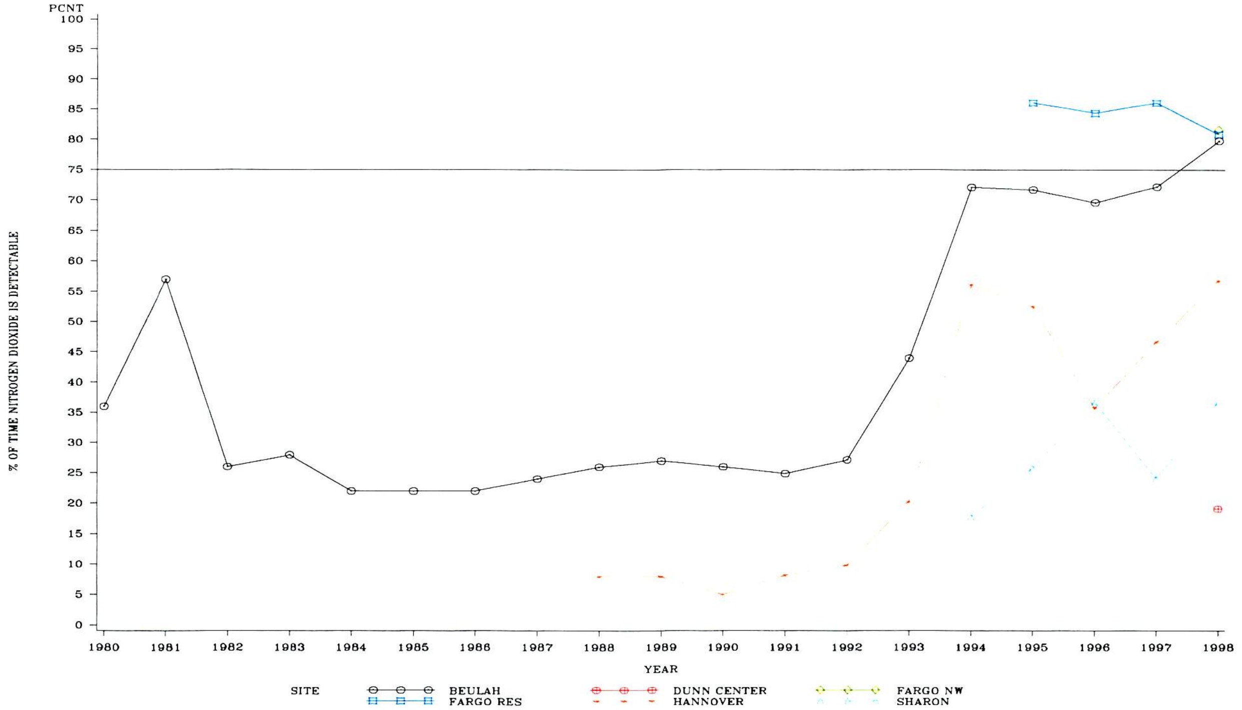

Figure 8 Percentage of Time NO_2 Detectable

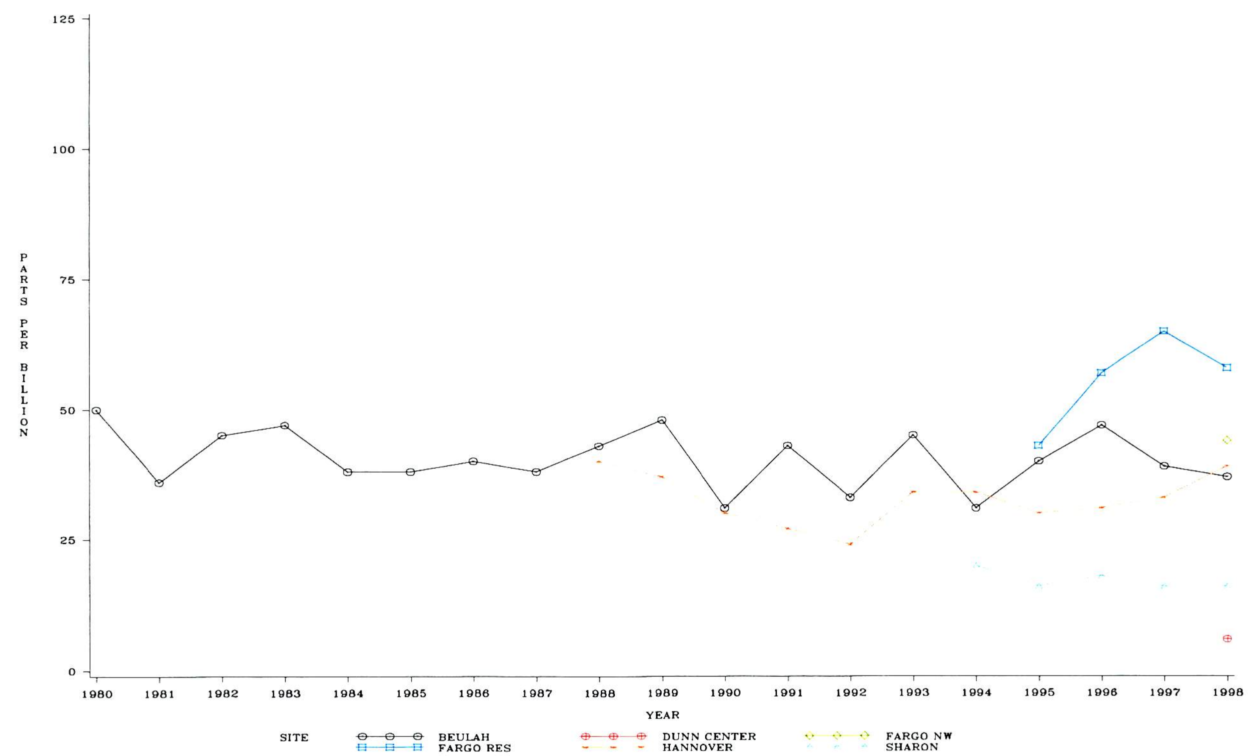

Figure 9 NO_2 Maximum 1-Hour Concentrations

2.3 Ozone

Unlike most other pollutants, ozone (O_3) is not emitted directly into the atmosphere but results from a complex photochemical reaction between volatile organic compounds (VOC), oxides of nitrogen (NO_x), and solar radiation. Both VOC and NO_x are emitted directly into the atmosphere from sources within the State. Since solar radiation is a major factor in O_3 production, O_3 concentrations are known to peak in summer months. 40 CFR 58 defines the O_3 monitoring season for North Dakota as May 1 through September 30. However, at TRNP - NU the O_3 analyzers are operated from April 1 through September 30 to collect two full quarters of data. The O_3 analyzers at the other sites collect data year round for use in dispersion modeling.

2.3.1 Point Sources

The major stationary point sources (> 100 TPY) of VOC, as calculated from the most recent emission inventories reported to the department, are listed in Table 7. Figure 10 shows the approximate locations of these facilities.

2.3.2 Area Sources

Point sources contribute only part of the total VOC and NO_x emissions. The remaining emissions are attributed to mobile sources in urban areas. The EPA has specified a design criteria for selecting NAMS locations for O_3 as any urbanized area having a population of more than 200,000. North Dakota has no urbanized areas large enough to warrant monitoring for ozone.

2.3.3 Monitoring Network

The state currently has six continuous ozone analyzers in operation. These are at Beulah, Dunn Center, Fargo, Hannover, Sharon, and Theodore Roosevelt National Park. The analyzer at TRNP - NU was terminated on June 30 and moved to TRNP - SU (Painted Canyon). Table 8 presents 1998 1-hour and 8-hour data summaries. The most interesting aspect of the data is the similarity between the 1-hour and 8-hour averages. The greatest difference between any two pairs is four parts per billion. This indicates the O_3 concentrations are reasonably uniform across the State for both the 1-hour and 8-hour averages. Also, this indicates the ozone is unrelated to the major sources. Figure 11 shows the maximum 1-hour average by month for 1998.

TABLE 7

Major VOC Sources
(> 100 TPY)

1998

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
1	Otter Tail Power Company: Coyote	Mercer	Beulah	1,299	39.28	380570012
2	Dakota Gasification Company	Mercer	Beulah	407	12.31	380570013
3	Basin Electric: Avs 1&2	Mercer	Beulah	306	9.25	380570011
4	Kaneb Pipe Line Operating Partnership,Lp	Stutsman	Jameston	305	9.22	380930037
5	Cargill, Inc.	Cass	West Fargo	282	8.53	380170066
6	Basin Electric: Leland Olds Station	Mercer	Stanton	170	5.14	380570001
7	Great River Energy: Coal Creek	Mc Lean	Underwood	143	4.32	380550017
8	Amoco Oil Co: Mandan Refinery	Morton	Mandan	143	4.32	380590003
9	Minnkota Power Coop: My Young #2	Oliver	Center	140	4.23	380650020
10	Hood Flexible Packaging	Grand Forks	Grand Forks	112	3.39	380350052

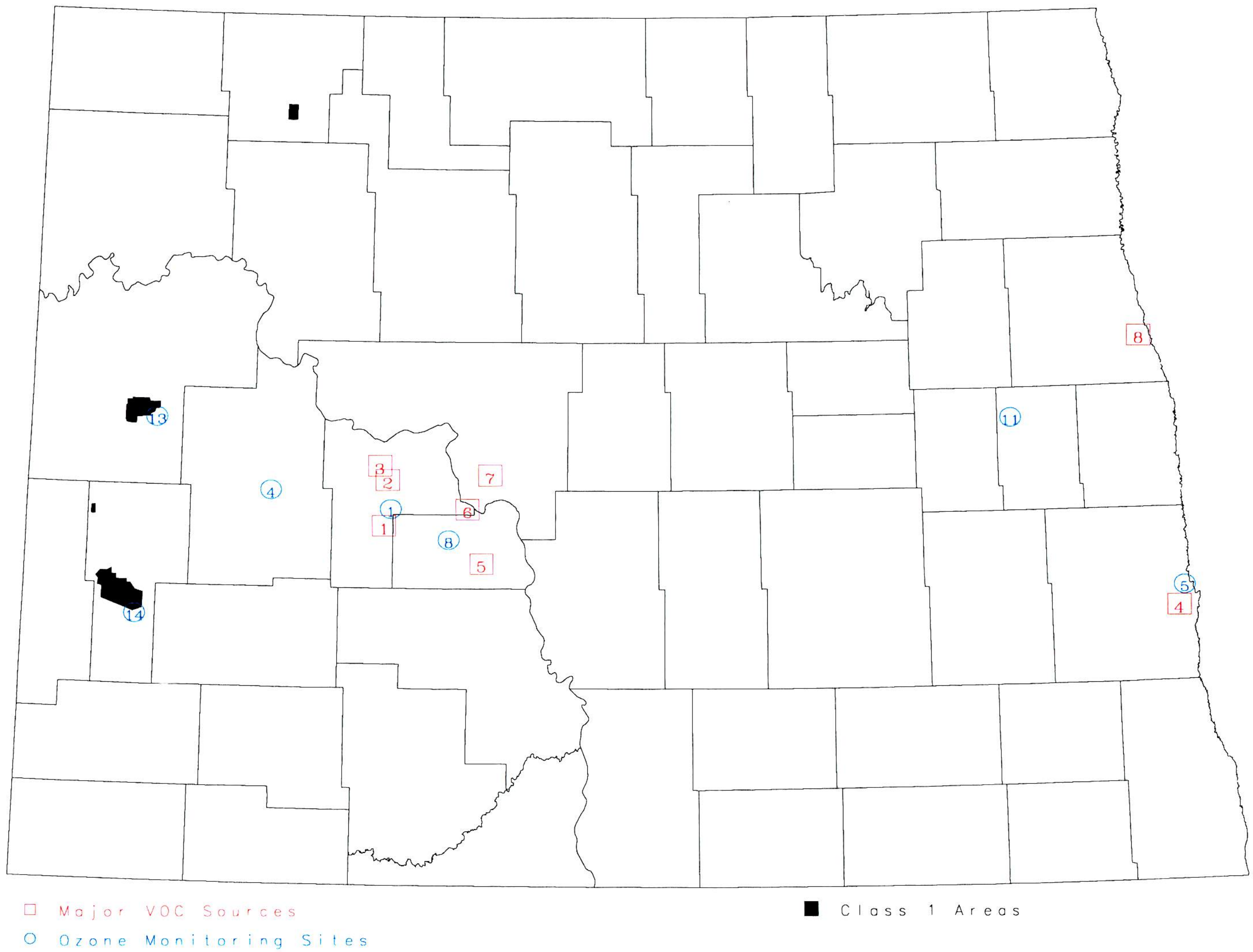

Figure 10 Major VOC Sources

TABLE 8

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Ozone (PPB)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	M A X I M A 1 - HOUR 1ST MM/DD/HH	1 - HOUR 2ND MM/DD/HH	1 - HOUR 3RD MM/DD/HH	8 - HOUR 1ST MM/DD/HH	8 - HOUR 2ND MM/DD/HH	8 - HOUR 3RD MM/DD/HH	1HR #>120	8HR #>80
Beulah	1998	JAN-DEC	7961	71 08/09/16	69 08/05/16	69 08/09/15	64 08/09/10	62 08/09/11	62 08/09/12		
Dunn Center	1998	DEC-DEC	412	40 12/18/17	39 12/18/15	39 12/18/16	38 12/18/15	36 12/18/14	36 12/18/13		
Fargo NW	1998	MAY-DEC	5515	86 05/17/17	84 05/17/16	77 05/17/15	73 05/17/10	66 05/17/11	66 05/17/09		
Fargo Residential	1998	JAN-MAY	3145	67 04/23/15	67 04/29/12	67 04/23/14	66 04/30/09	58 04/30/10	58 04/29/10		
Hannover	1998	JAN-DEC	8326	67 05/17/15	67 08/09/16	66 04/22/16	63 04/22/11	61 04/22/10	61 04/22/09		
Sharon	1998	JAN-DEC	8716	75 05/17/18	72 05/17/16	72 05/17/17	66 05/17/11	63 05/17/10	63 05/17/12		
TRNP - NU	1998	APR-JUN	1249	69 06/26/16	67 04/21/15	67 04/21/16	66 04/21/09	63 04/22/09	63 04/22/08		
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3232	61 09/09/15	60 09/01/16	60 09/01/15	57 09/09/09	54 09/09/08	54 09/01/09		

The maximum 1-hour concentration is 86 ppb at Fargo NW on 05/17/17
The maximum 8-hour concentration is 73 ppb at Fargo NW on 05/17/10

* The air quality standards for ozone are:
STATE - 120 ppb not to be exceeded more than once per year.

FEDERAL Standards -
1) 120 ppb maximum 1-hour concentration with no more than one expected exceedance per year.
2) Fourth highest daily maximum 8-hour averages for a 3-year period not to exceed 80 ppb.

The two sites, Beulah and Hannover, in the vicinity of the major VOC sources are not significantly different from the TRNP-NU or TRNP-SU sites which are in a Class 1 area. However, the VOCs from the oil fields may have some effect on the O_3 levels at these sites.

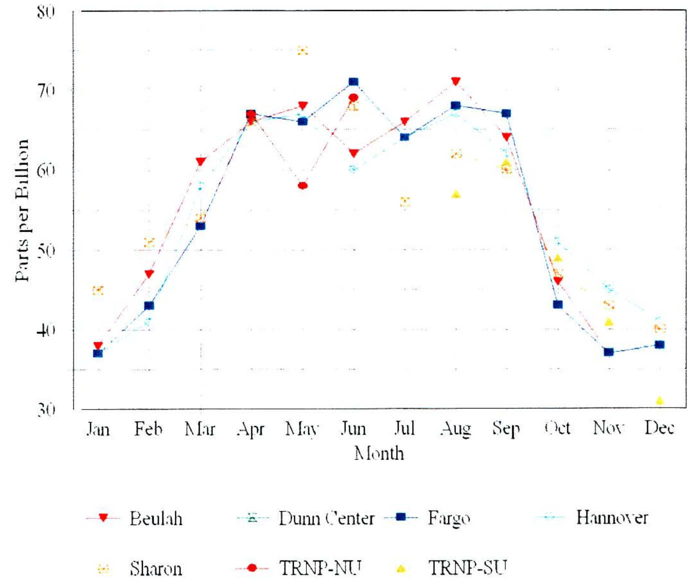

Figure 11 Monthly Maximum Ozone Concentrations

2.3.4 Network Analysis

Only one of the five state ozone monitoring sites is in an area not significantly influenced by VOC sources (see Figure 10). Beulah and Hannover are within 45 miles of eight of the ten major VOC sources in the state. TRNP- NU and TRNP-SU are located in a Class I area surrounded by oil fields. Fargo Residential is located in Fargo and influenced by city traffic. Dunn Center and Sharon are located in a rural area surrounded by crop land. With this diversity of site locations and influences, it would be expected to see a diversity of ozone concentrations. On the contrary, Figure 12 shows a significant similarity among the maximum 1-hour concentrations. Since 1980, there have been only two hours of data collect higher than 80 ppb and neither of these exceeded 100 ppb.

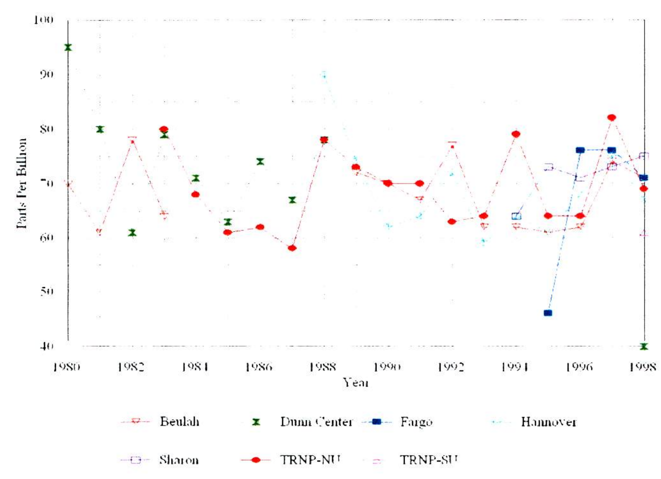

Figure 12. Annual Maximum Ozone Concentrations

2.4 Inhalable Particulates

The inhalable particulate standards are designed to protect against those particulates that can be inhaled deep into the lungs and cause respiratory problems. The major designation for inhalable particulates is PM. Within this designation are two subgroups: PM_{10} and $PM_{2.5}$. The PM_{10} particulates have an aerodynamic diameter less than or equal to a nominal 10 microns and are designated as PM_{10}. The $PM_{2.5}$ particulates have an aerodynamic diameter less than or equal to a nominal 2.5 microns and are designated as $PM_{2.5}$.

2.4.1 Sources

The major PM_{10} point sources (>100 TPY) are listed in Table 9 along with their emissions as calculated from the most recent emissions inventories reported to the department. Figure 13 shows the approximate locations of these facilities (the numbers correspond to the respective positions in the site and source tables). Most of these sources are large coal-fired facilities, and the PM_{10} particles are part of the boiler stack emissions; However, some of the emissions are the result of processing operations. Not included in this table are sources of fugitive dust such as coal mines, gravel pits, agricultural fields, and unpaved roads

2.4.2 Monitoring Network

The State operates seven PM_{10} samplers at six sites, two non-FRM PM2.5, and seven FRM $PM_{2.5}$ samplers; the Fargo site has collocated PM_{10} samplers. Since PM_{10} and smaller particles are of concern mainly because of their effects on people, monitoring efforts are concentrated in the state's population centers. Table 10 shows the inhalable PM_{10} particulate data summary, Table 11 shows the non-FRM $PM_{2.5}$ particulate data summary, and Table 12 shows the FRM $PM_{2.5}$ particulate data summary.

The non-FRM $PM_{2.5}$ samplers are a Graseby Andersen Model 231-F $PM_{2.5}$ impactor used on a PM_{10} sampler at the Bismarck and Beulah sites to collect non-FRM data. The Beulah sampler was terminated on December 31. The Bismarck sampler is planned to operate until December 31, 1999.

R&P single-day samplers were installed at Beulah and Sharon. And, R&P sequential samplers were installed at Bismarck, Fargo, and Grand Forks. Duplicate samplers were co-located at Beulah and Fargo. The official start date for the FRM samplers was December 13. However, the only samplers that ran without a problem were the single-day samplers. It appears the sequential samplers were not adequately tested for cold weather.

TABLE 9

Major PM_{10} Sources
(> 100 TPY)

1998

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
1	Dakota Gasification Company	Mercer	Beulah	1,366	23.42	380570013
2	Great River Energy: Coal Creek	Mc Lean	Underwood	1,360	23.32	380550017
3	Basin Electric: Avs 1&2	Mercer	Beulah	694	11.90	380570011
4	Basin Electric: Leland Olds Station	Mercer	Stanton	617	10.58	380570001
5	Otter Tail Power Company: Coyote	Mercer	Beulah	569	9.75	380570012
6	Amoco Oil Co: Mandan Refinery	Morton	Mandan	416	7.13	380590003
7	American Crystal Sugar: Drayton Plant	Pembina	Drayton	200	3.43	380670003
8	American Crystal Sugar: Hillsboro Plant	Traill	Hillsboro	194	3.33	380970019
9	Minn-Dak Farmers Cooperative	Richland	Wahpeton	180	3.09	380770026
10	Montana Dakota Utilities: Heskett 1 & 2	Morton	Mandan	119	2.04	380590001
11	Minnkota Power Coop: M R Young #1	Oliver	Center	118	2.02	380650001

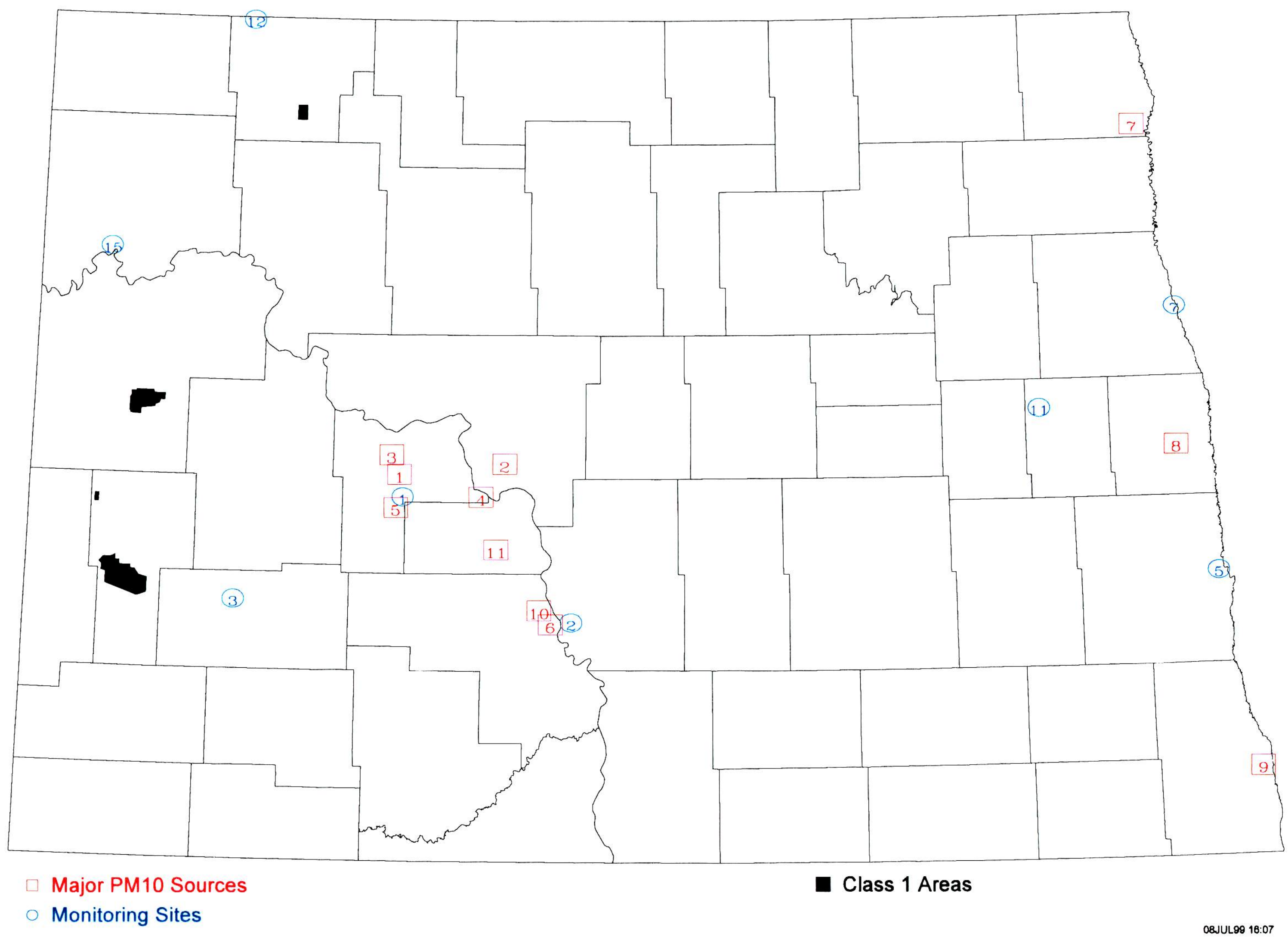

Figure 13 Major PM_{10} Sources

TABLE 10

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Inhalable PM_{10} Particulates (µg/m^3)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 24 - HOUR 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN	#>150	AM>50	% >MDV
Beulah	1998	JAN-DEC	59	2.0	45.2 09/02	28.1 08/03	26.2 04/23	12.4			96.6
Bismarck Residential	1998	JAN-DEC	61	4.1	52.8 09/02	32.2 08/03	29.9 11/25	16.4			100.0
Dickinson Residential	1998	JAN-DEC	59	1.8	59.1 09/02	39.9 09/08	27.4 08/27	12.8			91.5
Fargo NW	1998	MAY-DEC	36	3.2	52.0 09/02	47.4 07/28	44.4 08/09	18.9			97.2
Fargo Residential	1998	JAN-MAY	22	3.0	51.2 04/29	43.4 04/23	29.2 05/05	16.4			90.9
Grand Forks - North	1998	JAN-DEC	55	4.6	81.6 08/09	81.0 05/05	70.1 08/03	28.6			100.0
Sharon	1998	JAN-DEC	59	0.8	52.9 04/23	48.2 04/29	46.4 08/09	15.1			83.0
Short Creek - SPM	1998	SEP-DEC	20	2.7	38.0 09/08	21.2 09/14	16.2 10/20	10.1			85.0
Williston Residential	1998	JAN-JUN	27	3.8	47.6 04/23	44.8 04/29	28.1 05/05	14.5			96.3

The maximum 24-hour concentration is 81.6 µg/m^3 at Grand Forks - North on 08/09

* The STATE and FEDERAL air quality standards are:
1) 150 µg/m^3 maximum averaged over a 24-hour period with no more than one expected exceedance per year.
2) 50 µg/m^3 expected annual arithmetic mean.

TABLE 11

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Inhalable NON-FRM $PM_{2.5}$ Particulates (µg/m^3)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 24 - HOUR 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN	% >MDV
Beulah	1998	JAN-DEC	58	3.0	37.3 09/02	22.5 08/03	18.4 08/09	9.8	94.8
Bismarck Residential	1998	JAN-DEC	61	3.3	40.5 09/02	26.2 08/03	21.9 09/08	12.6	98.3

The maximum 24-hour concentration is 40.5 µg/m^3 at Bismarck Residential on 09/02

* No standard is in effect.

TABLE 12

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : FRM $PM_{2.5}$ Particulates (µg/m³)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	MAXIMA 2ND MM/DD	MAXIMA 3RD MM/DD	ARITH MEAN	#>150	AM>50	% >MDV
Beulah - North	1998	DEC-DEC	4	2.3	6.6 12/31	6.5 12/25	3.7 12/19	4.8			100.0
Sharon	1998	DEC-DEC	4	0.1	10.0 12/13	5.3 12/19	4.9 12/25	5.3			75.0

The maximum 24-hour concentration is 10.0 µg/m³ at Sharon on 12/13

* The ambient air quality standards are:
FEDERAL Standards -
1) 24-hour: 3-year average of 98th percentiles not to exceed 65 µg/m³.
2) Annual: 3-year average not to exceed 15µg/m³.

2.4.3 Network Analysis

All sites, with the exception of Sharon, are population oriented urban scale sites: Sharon is a background regional scale site. Each site is located within the city limits of the respective cities. The population of the cities range from 119 (Sharon) to over 100,00 in the Fargo, ND-Moorhead, MN area. With this population range, it would be expected to see a wide range in both 24-hour and annual averages as well as a stratification following city population. Figures 14 and 15 show this is not the case. Figure 14 shows that Fargo maximums are about midrange while Bismarck, the third largest city, ranges from the highest ('87, '92, '93) to the lowest maximum ('97).

The annual means do demonstrate some stratification. Dickinson, Sharon and Williston are lower than Bismarck, Grand Forks, and Fargo. This stratification could be for two reasons. First, Dickinson, Sharon, and Williston are in predominantly farmland areas. Second, the reason for the higher average concentrations in Bismarck, Grand Forks, and Fargo is primarily due to anthropogenic activities like furnaces, gasoline engines, and fine dust particles from roadway surfaces. To help resolve this question, a PM_{10} sampler was added to the Beulah site which is a small city (pop. 3363) with three major sources within 10 miles. Also, many of the houses in town use coal for either primary or supplemental heat. If elevated concentrations are found in Beulah, it would be a good indication that combustion sources are the dominant source for fine particulates. Based on two years of data, combustion sources do not appear to be the major source of fine particulates. However, North Dakota has had three exceptional events since 1987, and all three have been associated with higher than normal winds. Since the PM_{10} sampler heads are not efficient at rejecting particulates larger than 10 microns in aerodynamic diameter, these events were most likely caused by loading the filters with oversized particles.

Figures 16 through 19 present the Beulah and Bismark PM_{10}, non-FRM $PM_{2.5}$, and PM_{10}/non-FRM $PM_{2.5}$ ratios. In Figures 17 and 19, ratios greater than 100% were set to 100%. Most of these occurrences are when the concentrations are less than 10 $\mu g/m^3$. The dark line in these graphs represent the average percentage difference. It is interesting the ratio averages are within 2% of each other.

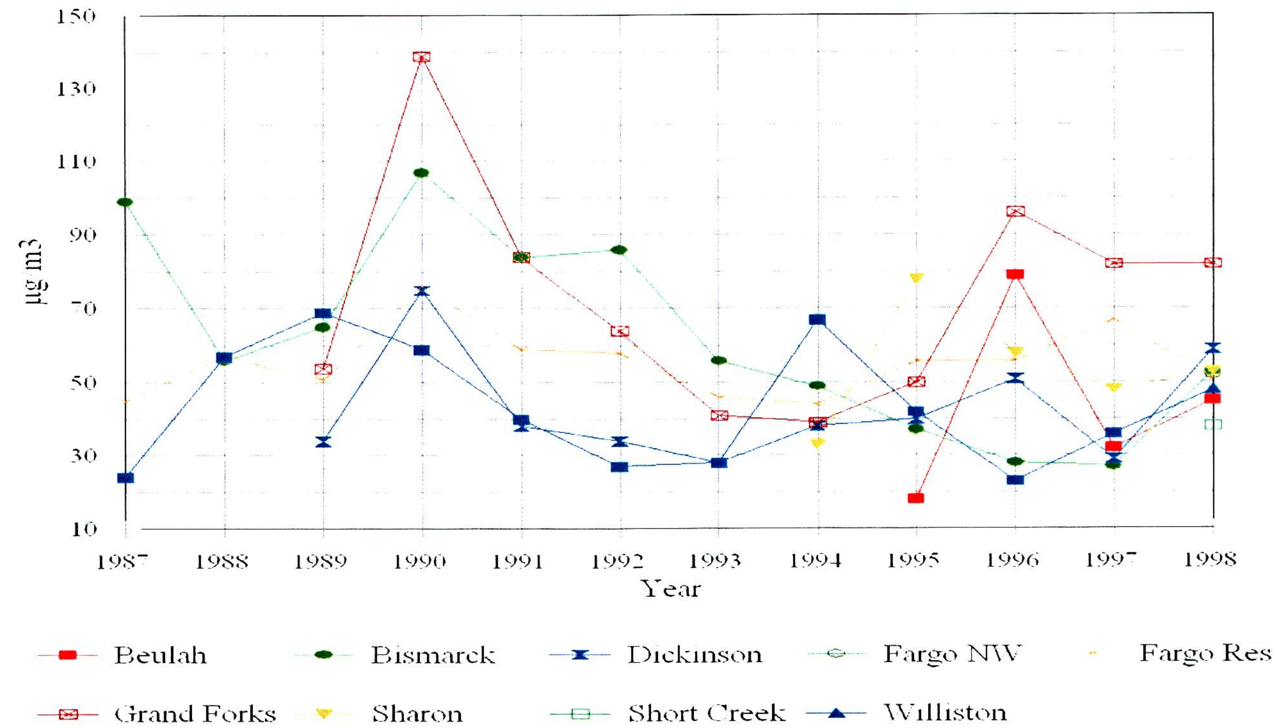

Figure 14 PM$_{10}$ Maximum Concentrations

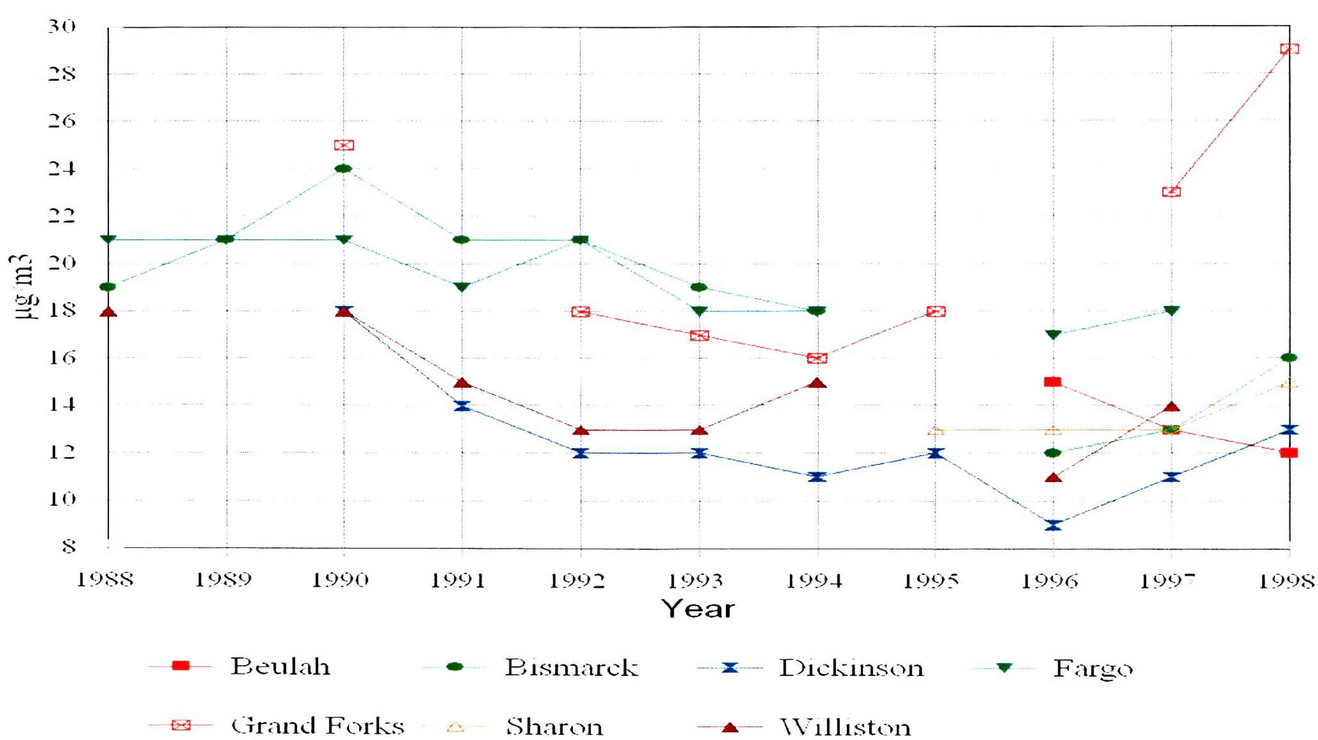

Figure 15 PM$_{10}$ Annual Means

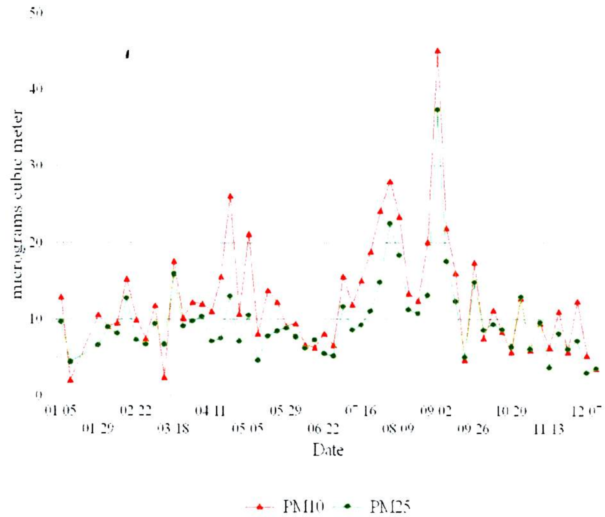

Figure 16 Beulah PM $_{10}$ and $PM_{2.5}$ Data

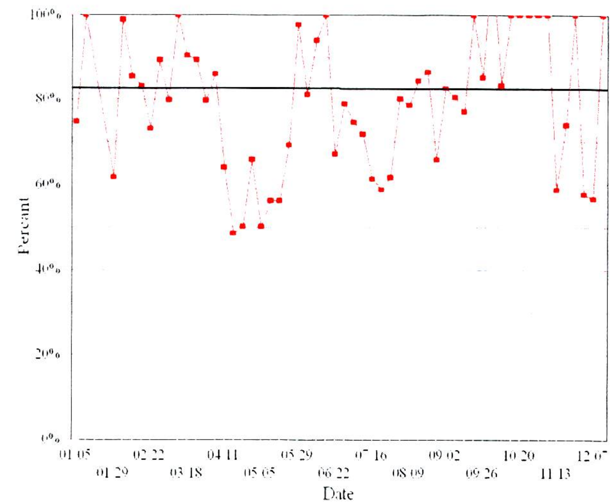

Figure 17 Beulah PM Ratio

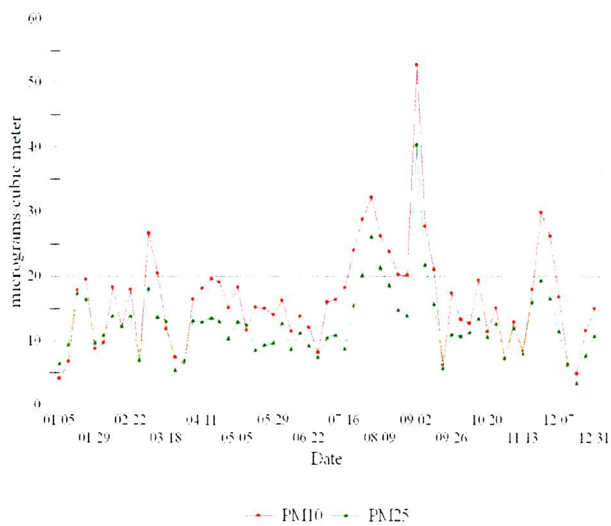

Figure 18 Bismarck PM_{10} and $PM_{2.5}$ Data

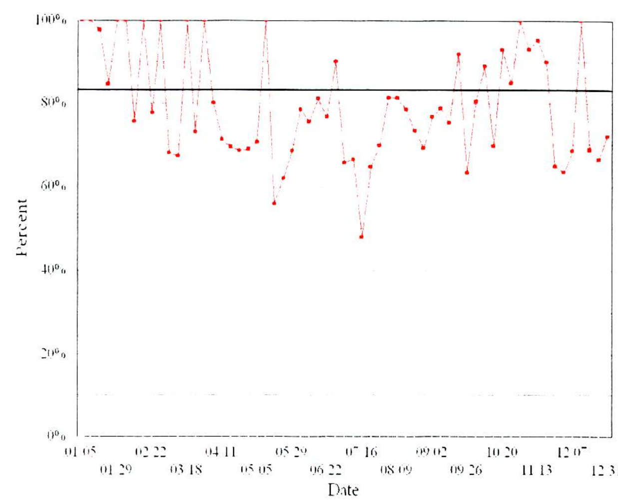

Figure 19 Bismarck PM Data

2.4.4 $PM_{2.5}$ Network

The basic monitoring plan for the $PM_{2.5}$ network was submitted in letter form on July 10, 1998. A total of 12 sites were planned be established in 1998 and 1999 to satisfy the new PM monitoring requirement: eight sites in 1998 and four in 1999. The following is the detailed description of the sites and equipment to be added in 1998 for the 1999 calendar year.

Of the eight sites planned for startup for 1998, five were actually started: Beulah, Bismarck, Fargo, Sharon, and Short Creek. Due to major problems with the filter change mechanism in the sequential samplers at Bismarck, Fargo, and Grand Forks, no valid data was collected during 1998. The Short Creek site was started but the sampler did not have the EPA-required FRM designation sticker so the data collected could not be used. Also, the filters used were nylon instead of the required Teflon. Unfortunately, it was not discovered that nylon filters could not be used for mass measurements until after several months of data was collected.

The sites planned for startup and placed on hold were TRNP-SU and Dickinson. The IMPROVE sampler scheduled for TRNP-SU was delayed until 1999, therefore the FRM sampler was not installed. When the NPS installs the IMPROVE sampler, the FRM will be started. Dickinson has been placed on hold until further notice. The sampler planned for Dickinson was used for the Short Creek site.

The new site planned is Dunn Center. This site is the western background/long range transport site. This site could serve as the downwind transport site for Montana. The data collected will be compare to only the annual standard.

2.4.5 Speciation Network

The Department currently has plans for three speciation sites: Fargo, Bismarck, and Bottineau. However, the Department has concluded that the current speciation samplers are not ready for field use. Therefore, the only speciation sampling site that will be set up is Fargo until after the samplers are field tested and the Department has the opportunity to review the operation characteristics of each sampler make available. Also, the actual location of the other sites is subject to further review after the sulfate and nitrate modeling results are available. The results may indicate better locations than those currently selected.

2.5 Carbon Monoxide

Many large urban areas in the United States have problems attaining the NAAQS for carbon monoxide (CO) where the primary source of CO is automobiles. North Dakota does not have sufficient population with the corresponding traffic congestion and geographical/meteorological conditions to create significant CO emission problems. However, there are several stationary sources in the State that emit more than 100 TPY of CO.

2.5.1 Sources

The major stationary CO sources (>100 TPY) are listed in Table 13 along with their emissions as calculated from the most recent emissions inventories reported to the department. Figure 20 shows the approximate locations of these facilities (the numbers correspond to the respective positions in the site and source tables). Most of these sources are the same sources that are the major emitters of SO_2 and NO_x. However, the corresponding levels of CO from these sources are considerably lower.

2.5.2 Monitoring Network

Carbon monoxide monitoring in North Dakota was terminated March 31, 1994, after 5 years of operation. The conclusion drawn from the data was that North Dakota did not have a CO problem. A summary report of the data collected at the West Acres Shopping Mall was drafted for the Fargo-Moorhead Council of Governments for use in their traffic planning program.

TABLE 13

Major CO Sources
(> 100 TPY)

1998

#	FACILITY NAME	COUNTY	CITY	POLLUTANT EMISSIONS	PERCENT OF TOTAL EMISSIONS	FACILITY ID
1	Dakota Gasification Company	Mercer	Beulah	2,189	19.82	380570013
2	Great River Energy: Coal Creek	Mc Lean	Underwood	1,777	16.09	380550017
3	Basin Electric: Avs 1&2	Mercer	Beulah	1,436	13.00	380570011
4	Minn-Dak Farmers Cooperative	Richland	Wahpeton	1,054	9.54	380770026
5	Basin Electric: Leland Olds Station	Mercer	Stanton	902	8.17	380570001
6	Minnkota Power Coop: My Young #2	Oliver	Center	639	5.79	380650020
7	Otter Tail Power Company: Coyote	Mercer	Beulah	587	5.32	380570012
6	Minnkota Power Coop: Mr Young #1	Oliver	Center	399	3.61	380650001
8	American Crystal Sugar: Drayton Plant	Pembina	Drayton	378	3.42	380670003
9	Amoco Oil Co: Mandan Refinery	Morton	Mandan	321	2.91	380590003
10	American Crystal Sugar: Hillsboro Plant	Traill	Hillsboro	308	2.79	380970019
11	Amerada Hess Corp: Tioga Gas Plant	Williams	Tioga	285	2.58	381050004
12	Montana Dakota Utilities: Heskett 1 & 2	Morton	Mandan	172	1.56	380590001
13	Univ. Of North Dakota Heating Plant	Grand Forks	Grand Forks	134	1.21	380350003
14	Cavalier Air Station	Pembina	Cavalier	129	1.17	380670005
15	Bear Paw Energy, Inc.: Alexander	Mc Kenzie	Alexander	123	1.11	380530024
16	Bear Paw Energy, Inc.: Tree Top	Billings	Fairfield	108	0.98	380070019
17	Continental Resources Inc	Bowman	–	103	0.93	380110010

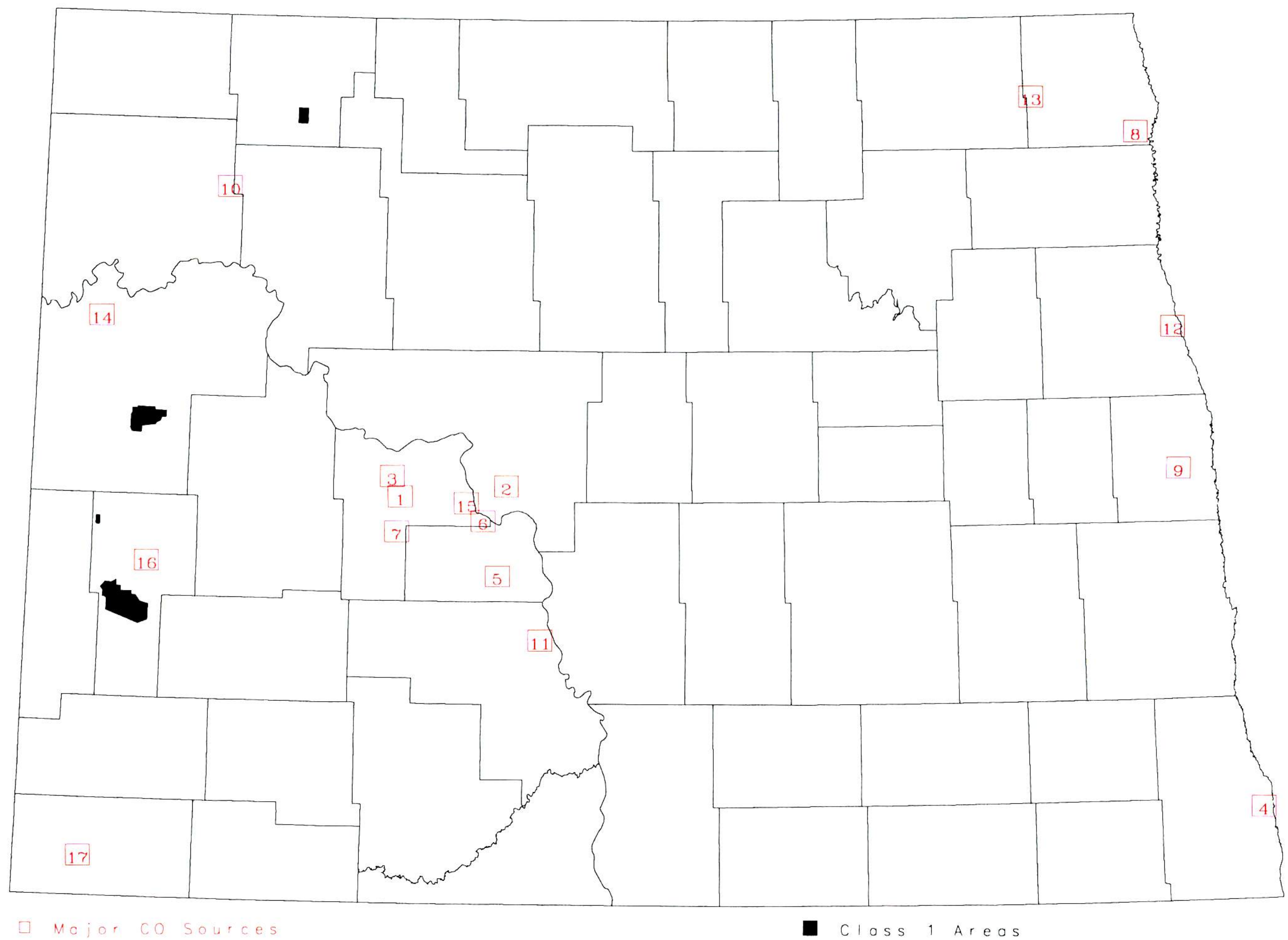

Figure 20 Major CO Sources

2.6 Lead

Through prior sampling efforts, the Department has determined that the State has low lead concentrations (38.6% of the standard) and no significant lead sources. This determination, coupled with the Federal requirement for a NAMS network only in urbanized areas with populations greater than 500,000, resulted in terminating the lead monitoring program effective December 31, 1983. Along with the low monitored concentrations, lead has been completely removed from gasoline since lead monitoring began in 1979.

2.7 Hydrogen Sulfide

Although no Federal Ambient Air Quality Standard exists for hydrogen sulfide (H_2S), the State of North Dakota has developed H_2S standards.

2.7.1 Sources

H_2S emissions of concern stems almost totally from the oil and gas operations in the western part of the State; principally from the green outlined area on Figure 2. Flares and treater stacks associated with oil/gas wells, oil storage tanks, compressor stations, pipeline risers, and natural gas processing plants are potential sources of H_2S emissions.

2.7.2 Monitoring Network

The only state-operated site was at TRNP-NU, which was terminated on June 30 at the request of the NPS. There is only one industry-operated site remaining, which is in the Amerada Hess -Tioga network. Table 14 shows the 1998 H_2S data summaries.

TABLE 14

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Hydrogen Sulfide (PPB)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1 - HOUR 1ST MM/DD/HH	1 - HOUR 2ND MM/DD/HH	24 - HOUR 1ST MM/DD	24 - HOUR 2ND MM/DD	3 - MONTH 1ST MM	3 - MONTH 2ND MM	ARITH MEAN	1HR #>200	24HR #>100	% MDV
Amerada Hess - Tioga #2	1998	JAN-DEC	8335	140 04/12/09	119 04/12/19	35 04/12	17 04/16	3 04	3 06	2.0			19.7
TRNP - NU	1998	JAN-JUN	4309	21 04/02/06	18 04/02/07	4 04/02	3 01/07	2 01	1 06	1.1			6.8

The maximum 1-hour concentration is 140 ppb at Amerada Hess - Tioga #2 on 04/12/09
the maximum 24-hour concentration is 35 ppb at Amerada Hess - Tioga #2 on 04/12
The maximum 3-month concentration is 3 ppb at Amerada Hess - Tioga #2 on 04

* The State air quality standards are:
1) 10 ppm maximum instantaneous (ceiling) concentration not to be exceeded.
2) 200 ppb maximum 1-hour average concentration not to be exceeded more than once per month.
3) 100 ppb maximum 24-hour average concentration not to be exceeded more than once per year.
4) 20 ppb maximum arithmetic mean concentration averaged over three consecutive months.

2.8 Inhalable Particulate Sulfates

Sulfates are any of a group of compounds that contain the sulfate ($SO_4^=$) ion. Sulfates are generally found as a fine particulate with an aerometric diameter of 2.5 microns or less ($PM_{2.5}$). Due to changes to the network, Fargo will be the only site with PM_{10} samplers , therefore, this analysis will not be included in future network reviews.

2.8.1 Sources

Most sulfates are a secondary particulate, not directly emitted from a source, but created by oxidation of SO_2. Sulfur dioxide can be transformed to $SO_4^=$ by several atmospheric chemical reactions. These various reactions involve water vapor, ozone, hydrocarbons, peroxides or free radicals. Sulfates can be directly emitted from application of fertilizers and some industrial sources. Atmospheric sulfates usually exist as sulfuric acid or ammonium sulfate.

2.8.2 Monitoring Network

The State operates seven PM_{10} and two non-FRM $PM_{2.5}$ samplers at nine sites; the Fargo site has collocated samplers; The sampler at Williston was moved to Short Creek - SPM and the samplers at Fargo Residential were moved to Fargo NW. Since sulfates have health effects such as decreased lung function in exercising adolescent asthmatics, efforts are concentrated in the state's population centers. Also, fine particulate sulfate is efficient at scattering light: thus a factor in visibility degradation. Even at concentrations as low as 3 $\mu g/m^3$, sulfate will affect visibility. Tables 15 and 16 show the inhalable particulate sulfate data summaries with Tables 17 and 18 showing the ratios of sulfates to total mass for each sample.

2.8.3 Network Analysis

All sites, with the exception of Sharon and Short Creek - SPM, are population oriented urban scale sites: Sharon is a background regional scale site and Short Creek - SPM is a source impact site. Each site, except Short Creek - SPM, is located within the city limits of the respective cities; Short Creek - SPM is in the Short Creek Wildlife Management Area seven miles North of Columbus. The population of the cities range from 119 (Sharon) to over 100,000 in the Fargo-Moorhead, MN area. The pattern seen in both averaging periods for the four highest concentrations for the PM_{10} and $PM_{2.5}$ samples closely follows the proximity of major sources/high-sulfur fuel usage sources. For the PM_{10} sulfates, all sites met the 75% data recovery criteria for calculating unbiased statistics for the period monitored. For the $PM_{2.5}$ sulfates, both sites met the 75% data recovery for calculating statistics. The samplers at Beulah are within eight miles of three major point sources and within 32 miles of eight major point sources. Also, many homes in Beulah use coal as either primary or supplemental heat during the heating season.

Ratios were calculated for data pairs only when both samples were greater than the minimum detectable for the analysis method. The ratios for the 24-hour PM_{10} sulfates to PM_{10} total mass range from 1.5% to 70.7%. The averages for all samples collected range from to 7.9% to 18.7%. The highest 24-hour average was at Bismarck and highest annual average ratio for sites collecting at least 75% of possible samples for the full year is at Williston. The non-FRM $PM_{2.5}$ sulfates to non-FRM $PM_{2.5}$ total mass appears to reflect the proximity to major sources. The Bismarck site is within seven miles, East-southeast of two major SO_2 point sources. A factor that is not considered is the effect of the combinations of chemical reactions that may occur in the sulfate formation process. Because the necessary information to quantify the speed of transformation from SO_2 to $SO_4^=$ is not available, this process is not addressed.

From the data available, the most surprising information is the average sulfate concentrations for the Beulah and Bismarck PM_{10} and non-FRM $PM_{2.5}$ samplers are similar. With that similarity, one would expect the ratios for the $PM_{2.5}$ samplers to be much higher: However, the ratios are very similar.

Table 15

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : PM[illegible] Sulfate (µg/m3)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	MAXIMA 2ND MM/DD	MAXIMA 3RD MM/DD	ARITH MEAN	#>15.	AM>5.	% >MDV
Beulah	1998	JAN-DEC	59	0.2	9.6 08/03	5.3 03/18	5.0 09/26	1.9			94.9
Bismarck Residential	1998	JAN-DEC	61	0.3	12.1 08/03	6.0 02/10	5.9 03/06	2.1			96.7
Dickinson Residential	1998	JAN-DEC	59	0.3	6.4 08/03	5.0 03/18	3.4 01/17	1.6			94.9
Fargo NW	1998	MAY-DEC	36	0.4	9.2 08/03	3.7 08/09	3.0 06/10	1.4			91.6
Fargo Residential	1998	JAN-MAY	22	0.7	5.0 02/22	4.1 01/23	3.3 02/16	2.4			100.0
Grand Forks - North	1998	JAN-DEC	55	0.2	6.8 08/09	5.3 03/24	3.7 02/10	1.6			89.0
Sharon	1998	JAN-DEC	59	0.5	6.8 08/03	3.8 01/23	3.1 08/21	1.6			100.0
Short Creek - SPM	1998	SEP-DEC	20	0.3	3.0 11/19	1.7 09/08	1.7 10/26	0.9			80.0
Williston Residential	1998	JAN-JUN	27	0.4	6.7 03/18	4.2 01/23	4.1 01/17	2.1			96.3

The maximum 24-hour concentration is 12.1 µg/m^3 at Bismarck Residential on 08/03

* No standard is currently in effect.

Table 16

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : NON-FRM PM[illegible] Sulfate (µg/m3)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	MAXIMA 2ND MM/DD	MAXIMA 3RD MM/DD	ARITH MEAN	#>15.	AM>5.	% >MDV
Beulah	1998	JAN-DEC	58	0.3	9.0 08/03	4.9 03/18	4.4 01/23	1.9			98.2
Bismarck Residential	1998	JAN-DEC	61	0.3	11.8 08/03	5.3 03/06	4.9 01/17	2.0			98.3

The maximum 24-hour concentration is 11.8 µg/m^3 at Bismarck Residential on 08/03

* No standard is currently in effect.

Table 17

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : PM_{10} Sulfate/PM_{10} Total Mass Ratio (PERCENTAGE)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M A X I M A 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN
Beulah	1998	JAN-DEC	54	3.7	35.8 03/12	34.4 02/10	34.3 03/24	16.6
Bismarck Residential	1998	JAN-DEC	59	2.3	70.7 01/05	51.5 01/11	44.6 03/24	15.3
Dickinson Residential	1998	JAN-DEC	52	3.0	57.6 01/23	44.6 02/16	38.3 11/19	16.0
Fargo NW	1998	MAY-DEC	32	1.5	31.4 08/03	19.0 12/19	16.2 12/31	8.3
Fargo Residential	1998	JAN-MAY	20	4.1	37.3 01/05	31.7 01/17	30.9 02/22	18.5
Grand Forks - North	1998	JAN-DEC	49	1.1	24.4 01/11	24.2 03/30	24.1 03/24	7.9
Sharon	1998	JAN-DEC	49	1.6	59.6 03/24	47.3 02/22	44.6 03/18	16.4
Short Creek - SPM	1998	SEP-DEC	14	3.1	26.5 11/19	21.3 12/31	16.9 10/14	11.6
Williston Residential	1998	JAN-JUN	25	2.9	45.6 03/18	35.6 01/11	34.9 02/04	18.7

The maximum 24-hour ratio is 70.7 percent at Bismarck Residential on 01/C5

* No standard is currently in effect.

Table 18

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : NON-FRM $PM_{2.5}$ Sulfate/NON-FRM $PM_{2.5}$ Total Mass Ratio (PERCENTAGE)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M A X I M A 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN
Beulah	1998	JAN-DEC	54	5.4	40.0 08/03	38.6 01/11	37.0 05/11	19.9
Bismarck Residential	1998	JAN-DEC	59	3.0	45.0 08/03	44.2 04/29	42.6 03/24	16.7

The maximum 24-hour ratio is 45.0 percent at Bismarck Residential on 08/03

* No standard is currently in effect.

3.0 SUMMARY AND CONCLUSIONS

The North Dakota Ambient Air Quality Monitoring Network is designed to monitor those air pollutants which demonstrate the greatest potential for deteriorating the air quality of North Dakota. Due to a greater number of pollution producing sources in the western part of the State (primarily associated with the energy producing industries) the greatest percentage of the network is located in the western part of the State.

3.1 Sulfur Dioxide (SO_2)

Neither the State nor Federal standards were not exceeded at any monitoring site. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 1-hour - 241 ppb (88.5%); 3-hour - 224 ppb (44.8%); 24-hour - 143 ppb (144%); annual (partial year) - 3.2 ppb (13.9%); annual (full year) - 5.8 ppb (25.2%).

There is no SO_2 5-minute standard currently in effect. The maximum 5-minute average was 295 ppb.

3.2 Nitrogen Dioxide (NO_2)

Neither the State nor Federal standards were exceeded at any of the monitoring sites. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: annual (partial year) - 8.1 ppb (15.3%); annual (full year) - 4.8 ppb (9.1%).

3.3 Ozone (O_3)

Neither the State nor Federal standard was exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 1-hour - 86 ppb (71.1%); 8-hour - 73 ppb (91.3%).

3.4 Inhalable Particulates

Neither the State nor Federal PM_{10} standards were exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable PM_{10} standard are as follows: 24-hour - 81.6 $\mu g/m^3$ (54.4%); annual - 28.6 $\mu g/m^3$ (57.2%).

Neither the State nor Federal $PM_{2.5}$ standards were exceeded during the year. The maximum concentrations and maximum concentrations expressed as a percentage of the standard are as follows: 24-hour non-FRM - 40.5 $\mu g/m^3$ (62.3%); 24-hour FRM - 10.0 $\mu g/m^3$ (15.4%); annual non-FRM - 12.6 $\mu g/m^3$ (84.0%); annual FRM - 5.3 $\mu g/m^3$ (35.3%). Not included in this report are the data comparing the non-FRM to the FRM data. The data, based on 7 months of test data, indicates the FRM data averages 60% of the non-FRM SA-231F adaptor. Using this correction factor, the non-FRM annual average equates to an FRM average of 7.6 $\mu g/m^3$.

3.5 Carbon Monoxide (CO)

No monitoring was conducted.

3.6 Lead

No monitoring was conducted.

3.7 Hydrogen Sulfide

There were no exceedances of any of the standards. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 1-hour - 140 ppb (70.0%); 24-hour - 35 ppb (35%); 3-month - 3 ppb (15.0%).

3.8 Inhalable Particulate Sulfates

There are no inhalable particulate sulfate standards. The maximum PM_{10} 24-hour and annual concentrations are 12.1 $\mu g/m^3$ and 2.4 $\mu g/m^3$, respectively The maximum $PM_{2.5}$ 24-hour and annual concentrations are 11.8 $\mu g/m^3$ and 2.0 $\mu g/m^3$, respectively.