



June 28, 2016

Monica Morales, Acting Director
Air Program, Mail Code 8P-AR
U.S. EPA, Region 8
1595 Wynkoop Street
Denver, CO 80305

Re: 2016 North Dakota Ambient Air Monitoring Network Plan and Monitoring for the 1-Hour SO₂ Data Requirements Rule

Dear Ms. Morales:

The Code of Federal Regulations Title 40 Part 58 states that "(Agencies) shall adopt and submit to the Regional Administrator an annual monitoring network plan". This plan identifies monitoring stations and monitors that make up an air quality surveillance network under authority of the State. Additionally, the plan outlines any proposed changes or modifications to the network.

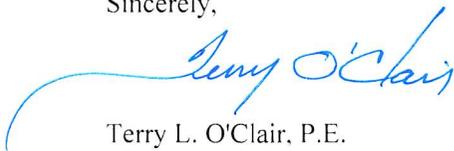
The Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO₂) Primary National Ambient Air Quality Standard (NAAQS) final rule (40 CFR Part 51) states that "...by July 1, 2016, the air agency must ... include information in the Annual Monitoring Network Plan that specifies the monitoring to be conducted to address the requirements of this rule."

Please find attached the 2016 ambient air monitoring network plan for the State of North Dakota. The plan provides information on the selection of monitoring to characterize air quality in the vicinity of the Hess Tioga Gas Plant in accordance with the Data Requirements Rule.

A thirty day public comment period is required on the network plan. In order to meet the submittal deadline specified in the Data Requirements Rule, the comment period will be held concurrently with the initial period of EPA review. It will begin on July 1, 2016 and conclude on August 1, 2016. Any comments received will be addressed in a future addendum to this plan.

If you have any questions concerning the materials provided or require additional information or clarification, please contact Charles Hyatt of my staff at (701)328-5188.

Sincerely,



Terry L. O'Clair, P.E.
Director
Division of Air Quality

TLO/CRH:csc
Enc:

Annual Report

North Dakota Ambient Air Quality Monitoring Program

Network Plan with Data Summary

2016



NORTH DAKOTA
DEPARTMENT *of* HEALTH

Annual Report

North Dakota Ambient Monitoring Network Plan With Data Summary 2016

Jack Dalrymple
Governor

Terry L. Dwelle, M.D.
State Health Officer

L. David Glatt
Environmental Health Section Chief



North Dakota Department of Health
Division of Air Quality
Air Quality Monitoring Branch
918 E. Divide Ave.
Bismarck, N.D. 58501-1947

CONTENTS

LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
ACRONYMS AND ABBREVIATIONS	viii
1.1 Site Selection.....	2
1.1.1 Monitoring Objectives	2
1.1.2 Spatial Scale.....	2
1.2 General Monitoring Needs.....	4
1.3 Monitoring Objectives.....	5
2.0 AMBIENT AIR MONITORING NETWORK COVERAGE	7
2.1 Carbon Monoxide.....	7
2.1.1 Point Sources	9
2.1.2 Monitoring Network.....	9
2.1.3 Network Changes.....	9
2.2 Lead.....	10
2.2.1 Network Changes.....	10
2.3 Oxides of Nitrogen	11
2.3.1 Point Sources	11
2.3.2 Area Sources	13
2.3.3 Monitoring Network.....	13
2.3.4 Network Analysis	13
2.3.5 Network Changes.....	15
2.4 Ozone	16
2.4.1 Point Sources	17
2.4.2 Area Sources	19
2.4.3 Monitoring Network.....	19
2.4.4 Network Analysis	19
2.4.5 Network Changes.....	21
2.5 Particle Pollution.....	21
2.5.1 Point Sources	22
2.5.2 Monitoring Network.....	22
2.5.3 PM ₁₀ Network Analysis	25
2.5.4 PM _{2.5} Network Analysis.....	25
2.5.5 Speciation Network	25
2.5.6 Network Changes.....	26
2.6 Sulfur Dioxide	26
2.6.1 Point Sources	27
2.6.2 Other Sources	27
2.6.3 Monitoring Network.....	27
2.6.4 Network Analysis	30
2.6.5 Network Changes.....	31
2.7 Hydrogen Sulfide.....	31
2.7.1 Point Sources	32
2.7.2 Monitoring Network.....	32
2.7.3 Network Changes.....	32
2.8 Ammonia	32
2.8.1 Point Sources	33

2.8.2	Monitoring Network.....	33
2.8.3	Network Analysis.....	33
2.8.4	Network Changes.....	33
2.9	Air Toxics.....	34
2.9.1	Point Sources.....	34
2.9.2	Monitoring Network.....	34
2.9.3	Network Changes.....	35
3.0	NETWORK SITE CHANGES.....	36
3.1	NCore (Bismarck/Fargo).....	36
3.2	Dunn Center/Lake Ilo.....	36
3.3	Ryder (Minot).....	36
3.4	Peak 1-Hour SO ₂ Characterization for the Tioga Area.....	37
4.0	SUMMARY AND CONCLUSIONS.....	38
4.1	• Carbon Monoxide (CO).....	38
4.2	• Lead.....	38
4.3	• Nitrogen Dioxide (NO ₂).....	38
4.4	• Ozone (O ₃).....	39
4.5	• Particulate Matter (PM ₁₀ , PM _{2.5}).....	39
4.6	• Sulfur Dioxide (SO ₂).....	39
4.7	• Hydrogen Sulfide (H ₂ S).....	40
4.8	• Ammonia (NH ₃).....	40
4.9	• Air Toxics (HAP).....	40
Appendix A	Air Quality Personnel Organizational Chart.....	A-1
Appendix B	Ambient Air Quality Standards.....	B-1
Appendix C	AAQM Site Descriptions.....	C-1
	Site Name: Beulah – North.....	C-3
	Site Name: Dunn Center.....	C-9
	Site Name: Fargo NW.....	C-12
	Site Name: Lostwood NWR.....	C-18
	Site Name: Painted Canyon (TRNP – SU).....	C-21
	Site Name: TRNP-NU.....	C-24
	Site Name: Williston.....	C-27
Appendix D	Wind and Pollution Roses.....	D-1
	Site Name: Beulah – North.....	D-3
	Site Name: Bismarck Residential.....	D-7
	Site Name: Dunn Center.....	D-10
	Site Name: Fargo NW.....	D-13
	Site Name: Hannover.....	D-16
	Site Name: Lostwood NWR.....	D-19
	Site Name: Painted Canyon (TRNP - SU).....	D-23
	Site Name: TRNP-NU.....	D-25
	Site Name: Williston.....	D-28
Appendix E	SO ₂ Monitor Site Selection for Data Requirements Rule.....	E-1
	Introduction:.....	E-2
	Background:.....	E-2
	Method:.....	E-3
	Model:.....	E-3
	Meteorological Data:.....	E-4
	Emission Source Data:.....	E-4
	Ambient Air Boundary:.....	E-6

<i>Receptor Grid:</i>	E-6
<i>Off-Site Impacts, Nearby Sources, and Background Concentrations:</i>	E-6
<i>Building Downwash:</i>	E-6
<i>Output:</i>	E-7
Results and Discussion:.....	E-7
<i>Maximum Concentration Location:</i>	E-7
<i>Frequency of High Concentrations:</i>	E-9
<i>Model Score:</i>	E-11
<i>Site Selection:</i>	E-11
Conclusions:	E-15
Appendix F Public Comments	F-1

DRAFT

LIST OF TABLES

Table 1.	Ambient Air Quality Network Description.....	6
Table 2.	Major CO Sources (≥ 100 TPY) in 2015	8
Table 3.	Major NO _x Sources (≥ 100 TPY) in 2015.....	12
Table 4.	Major VOC Sources (≥ 100 TPY) in 2015	18
Table 5.	Major PM Sources (≥ 100 TPY)* in 2015.....	23
Table 6.	Major SO ₂ Sources (≥ 100 TPY) in 2015	28
Table 7.	Major Ammonia Sources (≥ 100 TPY) in 2015	33
Table 8.	Major Air Toxics Sources (≥ 10 TPY of a single HAP or ≥ 25 TPY aggregate HAPS) in 2015 ...	35
Table 9.	National and North Dakota Ambient Air Quality Standards.....	B-2
Table 10.	Values utilized in air dispersion modeling input files: Hess Tioga Gas Plant Parameters	E-5
Table 11.	Receptor Rank Order - Maximum Modeled Value (Data taken from Table 9 of Hess analysis report).....	E-7
Table 12.	Receptor Rank Order – Daily Max Frequency (Data taken from Table 10 of Hess analysis report).....	E-10
Table 13.	Percentage of Total Daily Maximums per Isopleth	E-10
Table 14.	Receptor Score Rank.....	E-12
Table 15.	Ambient Monitoring Data Summary: 2010 – 2015 (Data from Table 4 of Hess analysis report).....	E-13
Table 16.	Resultant Wind Vectors at Hess Tioga Gas Plant.....	E-14

LIST OF FIGURES

Figure 1.	North Dakota Ambient Air Quality Monitoring Sites (Indicated with White Labels)	5
Figure 2.	Major CO Sources in 2015	8
Figure 3.	CO Concentrations Compared to the 1-hour and 8-hour Standards	10
Figure 4.	Major Oxides of Nitrogen Sources in 2015	12
Figure 5.	Annual Oxides of Nitrogen Emissions	14
Figure 6.	NO ₂ Concentrations Compared to the 1-hour Standard	14
Figure 7.	NO ₂ Concentrations Compared to the Annual Standard	15
Figure 8.	NO ₂ 98 th Percentile 1-Hour Concentrations	16
Figure 9.	NO ₂ Annual Average Concentrations	16
Figure 10.	Major VOC Sources in 2015	18
Figure 11.	Ozone Concentrations Compared to the 8-hour Standard	20
Figure 12.	Annual 4 th Highest 8-HR Ozone Concentrations	20
Figure 13.	Major PM Sources in 2015	22
Figure 14.	Annual PM Emissions	23
Figure 15.	PM ₁₀ Concentrations Compared to the 24-hour Standard	24
Figure 16.	PM _{2.5} Concentrations Compared to the 24-hour Standard	24
Figure 17.	PM _{2.5} Concentrations Compared to the Annual Standard	25
Figure 18.	Major Sulfur Dioxide Sources in 2015	27
Figure 19.	Annual Sulfur Dioxide Emissions	29
Figure 20.	SO ₂ Concentrations Compared to the 1-hour Standard	29
Figure 21.	SO ₂ 99 th Percentile 1-Hour Concentrations	30
Figure 22.	Major Ammonia Sources in 2015	33
Figure 23.	NH ₃ Concentrations: Maximum Value and Arithmetic Mean	34
Figure 24.	Major Air Toxics Sources in 2015	35
Figure 25.	Organizational Chart	A-2
Figure 26.	Beulah Wind Rose for 2015	D-3
Figure 27.	Beulah NO ₂ Pollution Rose for 2015	D-3
Figure 28.	Beulah O ₃ Pollution Rose for 2015	D-4
Figure 29.	Beulah PM ₁₀ Pollution Rose for 2015	D-4
Figure 30.	Beulah PM _{2.5} Pollution Rose for 2015	D-5
Figure 31.	Beulah SO ₂ Pollution Rose for 2015	D-5
Figure 32.	Beulah NH ₃ Pollution Rose for 2015	D-6
Figure 33.	Bismarck Wind Rose for 2015	D-7
Figure 34.	Bismarck NO ₂ Pollution Rose for 2015	D-7
Figure 35.	Bismarck O ₃ Pollution Rose for 2015	D-8
Figure 36.	Bismarck PM ₁₀ Pollution Rose for 2015	D-8
Figure 37.	Bismarck PM _{2.5} Pollution Rose for 2015	D-9
Figure 38.	Bismarck SO ₂ Pollution Rose for 2015	D-9
Figure 39.	Dunn Center Wind Rose for 2015	D-10
Figure 40.	Dunn Center NO ₂ Pollution Rose for 2015	D-10
Figure 41.	Dunn Center O ₃ Pollution Rose for 2015	D-11
Figure 42.	Dunn Center PM ₁₀ Pollution Rose for 2015	D-11
Figure 43.	Dunn Center PM _{2.5} Pollution Rose for 2015	D-12
Figure 44.	Dunn Center SO ₂ Pollution Rose for 2015	D-12
Figure 45.	Fargo Wind Rose for 2015	D-13
Figure 46.	Fargo NO ₂ Pollution Rose for 2015	D-13
Figure 47.	Fargo O ₃ Pollution Rose for 2015	D-14

Figure 48.	Fargo PM ₁₀ Pollution Rose for 2015	D-14
Figure 49.	Fargo PM _{2.5} Pollution Rose for 2015.....	D-15
Figure 50.	Fargo SO ₂ Pollution Rose for 2015.....	D-15
Figure 51.	Hannover Wind Rose for 2015	D-16
Figure 52.	Hannover NO ₂ Pollution Rose for 2015	D-16
Figure 53.	Hannover O ₃ Pollution Rose for 2015.....	D-17
Figure 54.	Hannover PM ₁₀ Pollution Rose for 2015.....	D-17
Figure 55.	Hannover PM _{2.5} Pollution Rose for 2015	D-18
Figure 56.	Hannover SO ₂ Pollution Rose for 2015	D-18
Figure 57.	Lostwood Wind Rose for 2015	D-19
Figure 58.	Lostwood NO ₂ Pollution Rose for 2015	D-19
Figure 59.	Lostwood O ₃ Pollution Rose for 2015.....	D-20
Figure 60.	Lostwood PM ₁₀ Pollution Rose for 2015.....	D-20
Figure 61.	Lostwood PM _{2.5} Pollution Rose for 2015	D-21
Figure 62.	Lostwood SO ₂ Pollution Rose for 2015	D-21
Figure 63.	Lostwood NH ₃ Pollution Rose for 2015	D-22
Figure 64.	Design Value Isopleths (Reproduced from Figure 15 of the Hess analysis report).	E-9
Figure 65.	Plot of Top 25 Receptors Ranked by Daily Maximum Frequency (Rank Order ID)	E-11
Figure 66.	Tioga Gas Plant Wind Rose – Three Year Summary.....	E-13
Figure 67.	Concentration (ppb) as Compared to Wind Speed at Tioga Gas Plant Monitoring Site #3 (SE) – (reproduced from Figure 18 of Hess analysis report).....	E-14

ACRONYMS AND ABBREVIATIONS

- AQM – Ambient Air Quality Monitoring
- AQS – Air Quality System
- BAM – Beta Attenuation Particulate Monitor
- BART – Best Available Retrofit Technology
- CFR – Code of Federal Regulations
- CO – Carbon Monoxide
- CSN – Chemical Speciation Network
- DRR – Data Requirements Rule
- EPA – United States Environmental Protection Agency
- FEM – Federal Equivalent Method
- FRM – Federal Reference Method
- GIS – Geographic Information System
- H₂S – Hydrogen sulfide
- H₂SO₃ – Sulfurous acid
- H₂SO₄ – Sulfuric acid
- HAP – Hazardous Air Pollutant
- IMPROVE – Interagency Monitoring of Protected Visual Environments
- MSA – Metropolitan Statistical Area
- NAAMS – National Ambient Air Monitoring Strategy
- NAAQS – National (also North Dakota) Ambient Air Quality Standards
- NCore – National Core Monitoring Network
- NH₃ – Ammonia
- NO – Nitric oxide
- NO₂ – Nitrogen dioxide
- NO_x – Oxides of Nitrogen
- NO_y – Total Reactive Nitrogen
- NPS – National Park Service
- NTN – National Trends Network
- NWR – National Wildlife Refuge
- O₃ – Ozone
- PM – Particulate Matter
- PM₁₀ – Particulate Matter less than 10 microns in diameter
- PM_{2.5} – Particulate Matter less than 2.5 microns in diameter (fine particulate matter)
- PM_{10-2.5} - Particulate Matter between 2.5 and 10 microns in diameter (coarse particulate matter)
- ppb – parts per billion
- PSD – Prevention of Significant Deterioration
- SLAMS – State and Local Air Monitoring Stations
- SO₂ – Sulfur dioxide
- SPM – Special Purpose Monitoring
- STN – Speciation Trends Network
- TAD – Technical Assistance Document
- TEOM – Tapered Element Oscillating Microbalance
- TRNP – Theodore Roosevelt National Park (NU – North Unit; SU – South Unit at Painted Canyon)
- TPY – Tons Per Year
- UV - Ultraviolet
- VOC – Volatile Organic Compound

1.0 INTRODUCTION

The North Dakota Department of Health (Department), Division of Air Quality (Division)¹, 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 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 (NAAQS)² and the Prevention of Significant Deterioration of Air Quality (PSD) Rules.

To carry out this responsibility, the Division operates and maintains a network of ambient air quality monitoring (AQM) sites throughout the state³.

The Division conducts an annual review of the network to determine if all federal monitoring requirements as set forth in 40 CFR 58⁴ are being met. This document is an account of the review and demonstrates that siting and operation of each monitor in the network meets the requirements of appendices A, B, C, D, and E of the part, where applicable. The annual review also serves to identify any network modifications that are necessary to meet federal requirements. Modifications could include the establishment of new sites, relocation of sites to more appropriate areas, or the removal of sites where the original justification for the site no longer exists. Modifications described in this report are proposed for a period within 18 months of report publication.

Additionally, every five years the Division completes a longer range assessment to assure that the network has and will continue to meet all its monitoring obligations. The five year assessment allows for the evaluation of future possible expansions or retractions of the network and the possible incorporation of new technologies.

Each year, the Division completes a data summary report for the previous 12-month data collection season. In the past, this report was issued as a separate document from the network review. Upon inspection, it was found that much of the information included in the data summary report duplicates what was included in the network review. To avoid a doubling-up of effort, beginning in 2015, the data summary for state run AQM sites was combined with the network review resulting in one single comprehensive annual report document⁵.

¹ See Appendix A of this document for an organizational chart for the Division.

² See Appendix B of this document for a summary table of all applicable federal and state ambient air quality standards.

³ See Appendix C of this document for a full description for each site, site photographs, and a site map.

⁴ The Code of Federal Regulations - 40 CFR 58 was promulgated by the Environmental Protection Agency (EPA) on October 17, 2006 and updated effective April 27, 2016.

⁵ This document is subject to 30 days of public comment before finalization. See Appendix E of this document for applicable public comments received.

1.1 Site Selection

1.1.1 Monitoring Objectives

The AQM network consists of a number of individual sites located throughout North Dakota which host the equipment needed to measure pollution concentrations in the air. The process of selecting a monitoring site begins by identifying a monitoring objective. Appendix D of 40 CFR 58 defines the six basic monitoring objectives used to choose the locations of sites in a monitoring program:

- To determine the highest pollutant concentrations expected to occur in an area covered by the network.
- To determine representative concentrations in areas of high population density.
- To determine the impact on ambient pollution levels by a significant source or source categories⁶.
- To determine the general/background concentration levels.
- To determine the impact on air quality by regional transport.
- To determine welfare-related impacts (such as impacts on visibility and vegetation).

1.1.2 Spatial Scale

Once an objective for a site has been identified, a spatial scale is chosen. EPA has defined a set of spatial scales based on physical dimensions that, given a particular objective, would be likely to have similar pollutant concentrations throughout. These are:

- **Micro-scale**
 - 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 to 50 km (Usually requires

⁶ Sources of interest could be point sources (a major industrial facility), area sources (a number of smaller emissions sources that collectively impact ambient air quality), or mobile sources (automobiles on a busy roadway or non-road sources including aircraft, construction vehicles, farm equipment, etc.)

more than one site for definition).

- **Regional Scale**
 - Rural areas of reasonably homogeneous geography covering from 50 km to hundreds of km.
- **National or Global Scale**
 - The entire nation or greater.

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

Monitoring Objective	Appropriate Siting Scales
Highest Concentration	Micro, middle, neighborhood, (sometimes urban or regional for secondarily formed pollutants)
Population Oriented	Neighborhood, urban
Source Impact	Micro, middle, neighborhood
General/Background	Urban, regional
Regional Transport	Urban, regional
Welfare-related Impacts	Urban, regional

Spatial scales appropriate to the criteria pollutants monitored in North Dakota are shown below⁷:

Criteria Pollutant	Spatial Scales
Inhalable Particulate	micro, middle, neighborhood, urban, regional
Sulfur Dioxide	middle, neighborhood, urban, regional
Ozone	middle, neighborhood, urban, regional

⁷ Carbon monoxide (CO) is also monitored at the North Dakota National Core (NCore) site in order to meet federal requirements. Appendix D to 40 CFR 58 does not identify an urban spatial scale (4 to 50 kilometers) for Carbon monoxide because this pollutant is primarily associated with automobile traffic on a neighborhood or smaller scale. However, because the CO monitor is present to satisfy NCore specific requirements, it has historically been considered by the Department to be an urban scale monitor in alignment with the other monitors at the site.

A good understanding of the appropriate monitoring objective and spatial scale permits a site location to be chosen. Using these criteria 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 assessing each site and associated monitors to confirm that all still meet their intended purpose. Sites and/or monitors that no longer satisfy the intended purpose are either discontinued or modified accordingly.

1.2 General Monitoring Needs

Each air pollutant has certain characteristics that must be considered when establishing a monitoring site. These characteristics may result from:

- (A) Variations in the number and types of sources and emissions in question;
- (B) Reactivity of a particular pollutant with other constituents in the air;
- (C) Local site influences such as terrain and land use; and
- (D) Climatology.

The Department's AQM network is designed to monitor air quality data for five basic objectives:

- (1) Monitoring of criteria pollutant background concentrations;
- (2) Quantifying population exposure to pollutants;
- (3) Monitoring significant sources of pollutants or class category;
- (4) Long-range transport of pollutants; and
- (5) Regional haze.

The 2008 National Ambient Air Monitoring Strategy (NAAMS⁸) establishes a monitoring site classification system for the national AQM network. State and Local Monitoring Stations (SLAMS) make up the primary component for determining criteria pollutant NAAQS compliance. The Department operates eight ambient air quality monitoring sites in North Dakota (Figure 1). Additionally a ninth site, the Theodore Roosevelt National Park – South Unit site at Painted Canyon (TRNP – SU), is operated by the Department in partnership with the National Park Service (NPS). All of the state operated sites and the partnership site at Painted Canyon have been designated SLAMS sites⁹.

⁸ U.S. EPA (2008). Ambient Air Monitoring Strategy for State, Local, and Tribal Air Agencies. Available via link at: www.epa.gov/ttn/amtic/monstratdoc.html.

⁹ See Appendix C of this report for specific information on the location of each monitoring site.

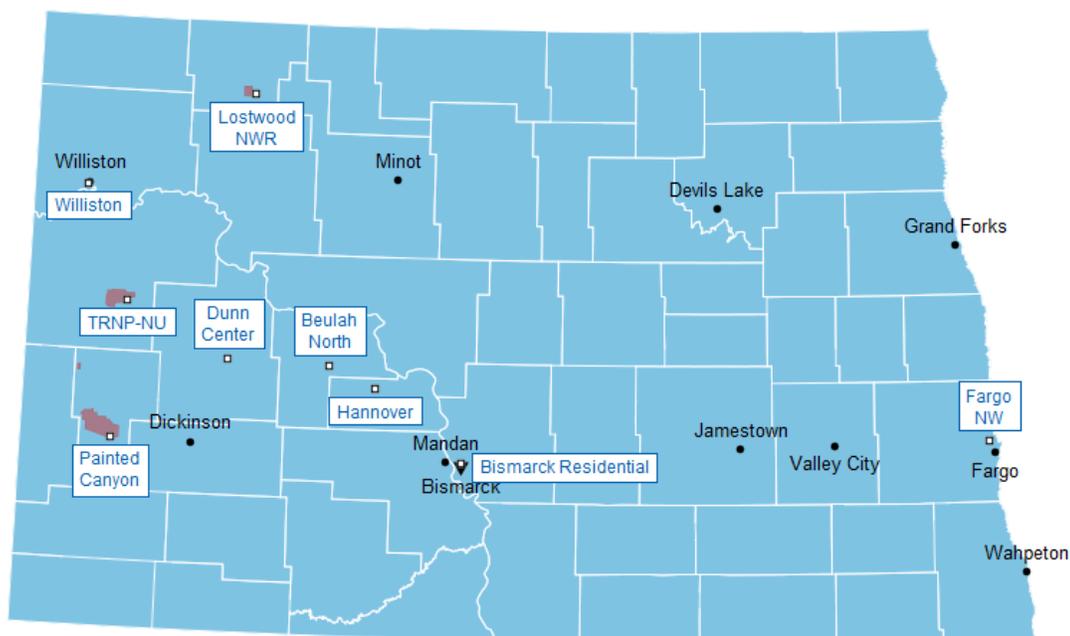


Figure 1. North Dakota Ambient Air Quality Monitoring Sites (Indicated with White Labels)

A National Core (NCore) site is a one in a network of approximately 80 multi-pollutant monitoring sites throughout the United States designed to support specific EPA core monitoring objectives in public reporting, emissions trends tracking, and NAAQS compliance evaluation. Each state is required to have one or more NCore designated sites. In addition to being a SLAMS site, on April 18, 2016, EPA approved the Department's request to designate the Bismarck Residential site as the required NCore site in North Dakota¹⁰.

The Bismarck site is also a part of EPA's Chemical Speciation Network (CSN) as a trends site. The Speciation Trends Network (STN; a subset of the CSN) was established to monitor long term trends in concentration of selected particulate matter constituents. The NAAMS document provides additional information regarding these national networks.

1.3 Monitoring Objectives

The monitoring sites in the state fall into two categories: 40 CFR 58 required (3 sites) and supplemental (6 sites). The primary function of the Department's three required sites is to satisfy five monitoring objectives (Table 1).

The **Beulah** monitoring site, which lies between the city of Beulah and two major air

¹⁰ Previously the Fargo NW site was the North Dakota designated NCore site. See the NCore Relocation addendum to the 2014-2015 Annual Report for more information on the relocation request. Available online at: http://www.ndhealth.gov/AQ/ambient/Annual%20Reports/ARNP_14-15_Addendum.pdf

pollutant emissions sources (and in the vicinity to a third), has been designated a significant source and population-oriented site.

The **Fargo NW** site has been designated a population orientated site because the city of Fargo is a major population center in North Dakota with five major emissions sources located in the area. The data from the Fargo site are used in dispersion modeling to evaluate construction and operating permit applications for projects located in the eastern part of the state.

The **Theodore Roosevelt National Park North Unit (TRNP-NU)** site is used to evaluate background concentrations, long-range transport, and welfare-related impacts of pollutants.

Table 1. Ambient Air Quality Network Description

Site Name AQS* Site Number	Parameter Monitored										Monitoring Objective	
	SO ₂	NO ₂	O ₃	CO	Continuous PM _{2.5}	Continuous PM ₁₀	Continuous PM _{2.5} Manual Speciation	PM ₁₀ fine	NH ₃	NO _y		Wind Speed & Direction
1 Beulah North 380570004	★	★	★		★	★	★		★		★	Population Exposure & Significant Source
2 Bismarck Residential** 380150003	★	★	★	★	★	★	★	★		★	★	Population Exposure
3 Dunn Center 380250003	★	★	★		★	★					★	General Background
4 Fargo NW** 380171004	★	★	★		★	★	★				★	Population Exposure
5 Hannover 380650002	★	★	★		★	★					★	Source Impact
6 Lostwood NWR 380130004	★	★	★		★	★		★	★		★	General Background & Significant Source
7 Painted Canyon 380070002	★		★		★		★				★	General Background
8 TRNP – NU 380530002	★	★	★		★	★					★	General Background, Long-range Transport, & Welfare-related
9 Williston 381050003			★		★	★					★	Population Exposure

* Air Quality System – EPA’s computer database and information system of ambient air quality data.
 ** Parameters shown represent the monitoring coverage after the completion of the Fargo to Bismarck NCore relocation.

The remaining six sites are used to support air dispersion model calibration and/or validation and to supplement data collected at the required sites.

Background, welfare-related and long-range transport sites are chosen to determine concentrations of air contaminants in areas remote from urban sources. These are generally sited using the regional spatial scale. Once a specific location is selected for a site, the site is established in accordance with the specific sitting criteria specified in 40 CFR 58, Appendices A, C, D and E.

The Department evaluates any monitoring requirements and site changes needed to support the visibility regulations in 40 CFR 51.300, 40 CFR 51.308 (regional haze rules) and 40 CFR 51, Appendix Y (Best Available Retrofit Technology, BART).

2.0 AMBIENT AIR MONITORING NETWORK COVERAGE

The nine ambient air quality monitoring sites in the state are positioned to satisfy the five monitoring objectives (described in Section 1.3 of this report), to collect data to support dispersion modeling activities relating to visibility/regional haze and source permit evaluation, and to compare to the State and Federal ambient air quality standards.

The NAAQS¹¹ are established by EPA in order to meet the requirements of the Clean Air Act and address concentrations of six criteria pollutants in the ambient air. The following sections describe the pollutants and outline state monitoring efforts with respect to each pollutant. Monitoring results in relation to the NAAQS are presented in each section. Additionally, Appendix D of this document includes wind and pollution roses for each monitoring site.

2.1 Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless, and toxic gas. Worn or poorly adjusted and maintained combustion devices (e.g. boilers and furnaces), or those with improperly sized, blocked, disconnected, or leaking flues, can be significant sources of CO. Auto, truck, or bus exhaust can also be a source of CO. Many large urban areas in the United States have problems attaining the NAAQS for CO where the primary source of CO is automobiles. To date, North Dakota does not have large population centers 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 tons per year (TPY) of CO.

¹¹ Appendix B.

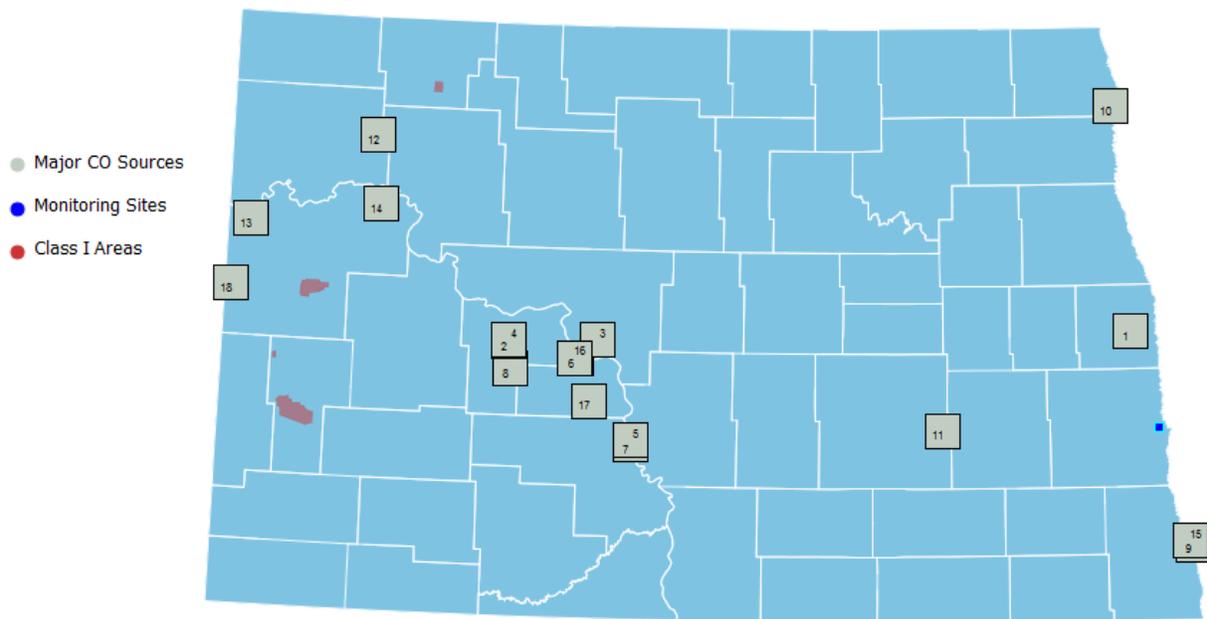


Figure 2. Major CO Sources in 2015

Table 2. Major CO Sources (≥ 100 TPY) in 2015

#	COMPANY	SOURCE	EIS Facility ID
1	American Crystal Sugar Company	Hillsboro Plant	7939011
2	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
3	Great River Energy	Coal Creek Station	8011011
4	Basin Electric Power Cooperative	Antelope Valley Station	8086511
5	Montana Dakota Utilities Company	RM Heskett Station	8087011
6	Basin Electric Power Cooperative	Leland Olds Station	8086311
7	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
8	Otter Tail Power Company	Coyote Station	8086611
9	Minn-Dak Farmers Cooperative	Wahpeton Plant	7924011
10	American Crystal Sugar Company	Drayton Plant	7923811
11	Great River Energy	Spiritwood Station	16937511
12	Hess Corporation	Tioga Gas Plant	8013911
13	ONEOK Rockies Midstream, L.L.C.	Fort Buford Compressor Station	10612511
14	Hess North Dakota Pipelines LLC	Hawkeye Compressor Station	10613211
15	Cargill Corn Milling	Wahpeton Facility	10612711
16	Great River Energy	Stanton Station	8086411
17	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
18	ONEOK Rockies Midstream, LLC	Grasslands Gas Plant	8085511

The effects of CO exposure can vary greatly from person to person depending on age, overall health and the concentration and length of exposure. At lower levels of exposure, CO causes mild

effects that are often mistaken for a cold or the flu virus. These symptoms include headaches, dizziness, disorientation, nausea, and fatigue. In individuals with heart disease, chest pain may be a symptom. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At very high concentrations, CO exposure can be fatal. Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake.

2.1.1 Point Sources

The major stationary CO sources (>100 TPY) are listed in Table 2. Figure 2 shows the approximate locations of these facilities (the numbers correspond to the site and source tables). Most of these sources are the same sources that are the major emitters of sulfur dioxide and oxides of nitrogen. However, the corresponding CO levels from these sources are considerably lower.

2.1.2 Monitoring Network

Carbon monoxide monitoring in North Dakota ended in 1994, after operating five years. The conclusion drawn from the data was that CO concentrations in North Dakota were well below the NAAQS and exceedances were unlikely. 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 its traffic planning program. Since 2009, the Department has operated a Trace Level CO analyzer at the Fargo NW site in order to comply with the NCore requirements. Figure 3 shows CO concentrations at Fargo in comparison to the 1- and 8-hour NAAQS.

2.1.3 Network Changes

There were no significant changes made to the CO network in 2015. Concentrations measured by the trace level CO monitor at Fargo have consistently been lower than the NAAQS. No changes to the CO emissions inventory that would result in significant changes in ambient concentrations of this pollutant are foreseen.

With the relocation of the NCore site the trace level CO monitor will be moved from Fargo to Bismarck. This change will be reflected in next year's annual report.

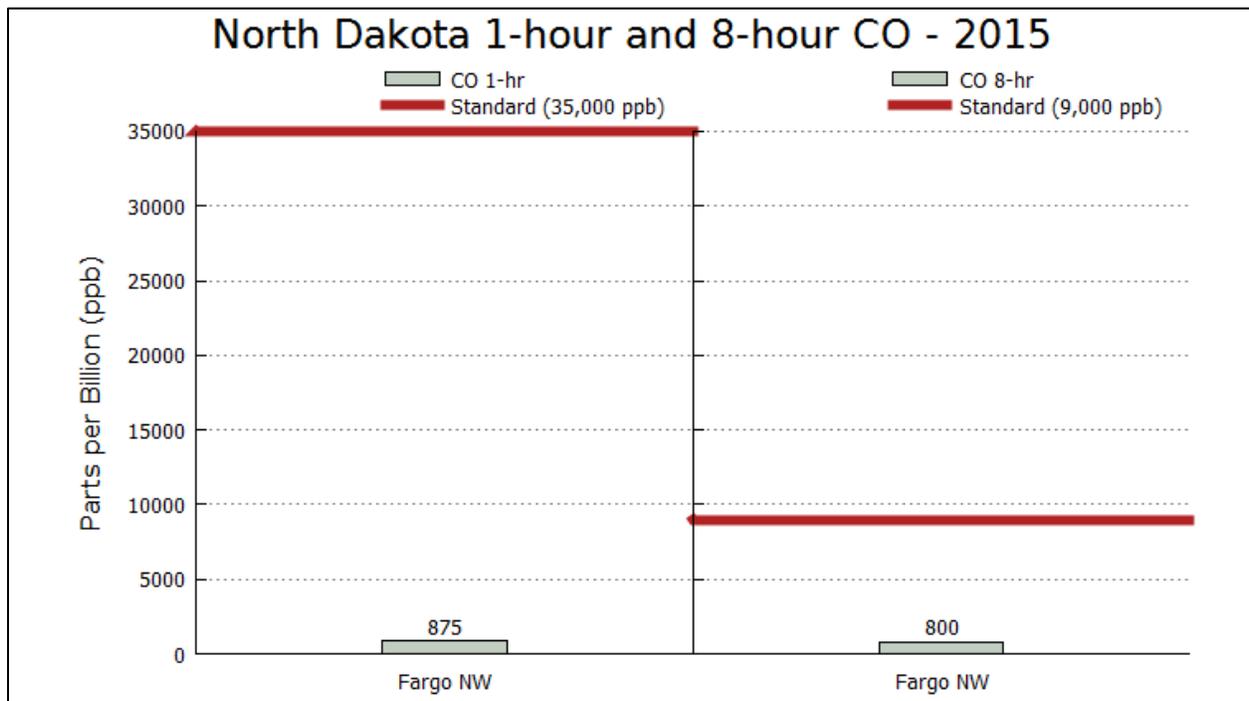


Figure 3. CO Concentrations Compared to the 1-hour and 8-hour Standards

2.2 Lead

Lead is a heavy metal that can be emitted through some heavy industrial manufacturing processes, including metals processing. Lead is also used as a fuel additive to increase engine performance and reduce valve wear. Although phased out of general use in the United States for on-road automobile and truck fuel in the 1970s, lead additive is still used in some aviation fuels.

High lead levels in the body can affect the nervous system, kidneys, and the immune system. Reproductive and cardiovascular health can also be impacted.

Through prior sampling efforts, the Department has determined that the state has low lead concentrations and no significant lead sources. This determination, coupled with the federal lead monitoring requirements, resulted in the state lead monitoring program ending effective Dec. 31, 1983.

2.2.1 Network Changes

There were no significant changes made to the lead monitoring network in 2015. There are no changes planned for 2016.

2.3 Oxides of Nitrogen

Oxides of Nitrogen (NO_x) is the term used to represent nitric oxide (NO) plus nitrogen dioxide (NO_2). NO and NO_2 are formed when the nitrogen and oxygen in the air are combined in high-temperature combustion. Major NO_x sources in North Dakota are coal conversion processes, natural gas processing plants, and natural gas compressor stations.

In its pure state, NO_2 is a reddish-orange-brown gas with a characteristic pungent odor. As a pollutant in ambient air, however, NO_2 is virtually odorless – although it may be an irritant to the eyes and throat. NO_2 is corrosive and a strong oxidizing agent. The dark orange-brown colored plume that can sometimes be seen downwind from a major combustion emissions source is most likely the result of NO_2 or the conversion of NO to NO_2 .

There is no ambient air quality standard for NO, a colorless gas. NO released into ambient air combines with excess oxygen to form NO_2 . The speed with which this conversion occurs is dependent on several factors, including the relative concentrations of NO and ozone, the amount of ultraviolet light available, and meteorological conditions.

NO_x exposure can result in respiratory distress, including airway inflammation and aggravation of asthmatic symptoms. Ozone, with its own health concerns, is a byproduct of the chemical reaction of NO_x and volatile organic compounds with heat and sunlight. In the form of the corrosive species nitrous and nitric acid, NO_x can result in impacts on vegetation and materials. In combination with ammonia and water vapor, NO_x can form small particulates, impairing visibility and impacting health.

NO_y , or “total reactive nitrogen”, consists of oxidized compounds of nitrogen (i.e. NO_x + nitric acid and organic nitrates). A NO_y monitor works by converting all reactive species to NO. Non- NO_x species concentrations can be determined by subtracting monitored ambient NO and NO_2 concentrations from the resultant total concentration of converted NO. There is no ambient air quality standard for NO_y .

2.3.1 Point Sources

The major NO_x stationary point sources (>100 TPY) are listed in Table 3, along with their emissions as calculated from the most recent emission inventories reported to the Department.

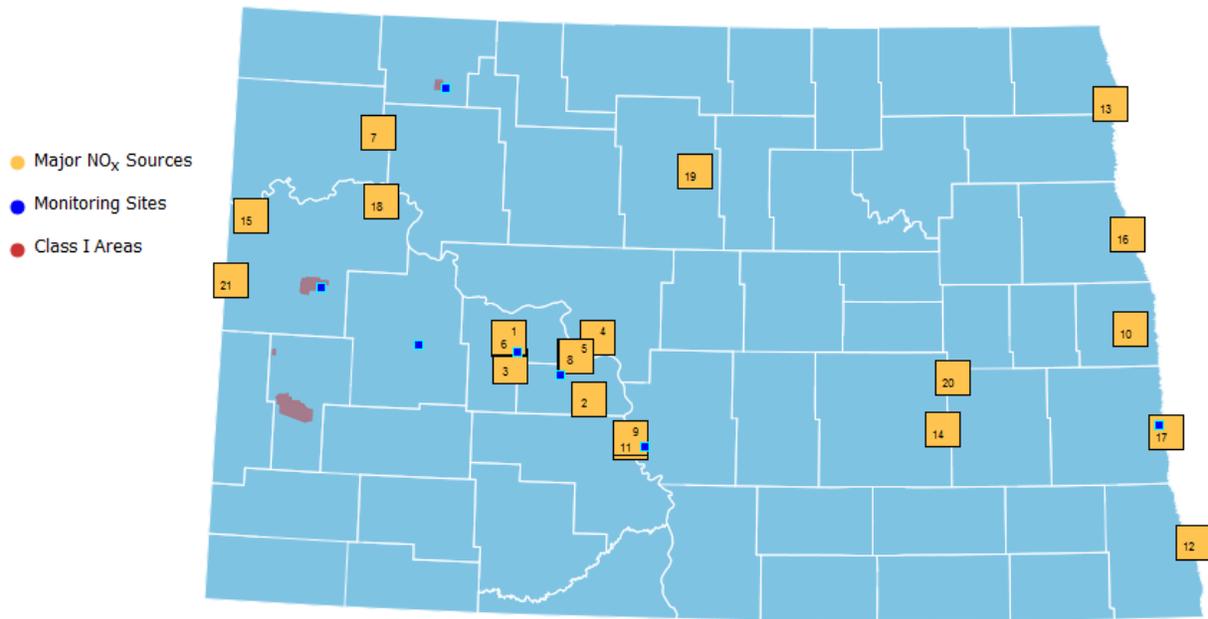


Figure 4. Major Oxides of Nitrogen Sources in 2015

Table 3. Major NO_x Sources (≥ 100 TPY) in 2015

#	Company	Source	EIS Facility ID
1	Basin Electric Power Cooperative	Antelope Valley Station	8086511
2	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
3	Otter Tail Power Company	Coyote Station	8086611
4	Great River Energy	Coal Creek Station	8011011
5	Basin Electric Power Cooperative	Leland Olds Station	8086311
6	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
7	Hess Corporation	Tioga Gas Plant	8013911
8	Great River Energy	Stanton Station	8086411
9	Montana Dakota Utilities Company	RM Heskett Station	8087011
10	American Crystal Sugar Company	Hillsboro Plant	7939011
11	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
12	Minn-Dak Farmers Cooperative	Wahpeton Plant	7924011
13	American Crystal Sugar Company	Drayton Plant	7923811
14	Great River Energy	Spiritwood Station	16937511
15	ONEOK Rockies Midstream, LLC	Fort Buford Compressor Station	10612511
16	University of North Dakota	UND Heating Plant	7292911
17	North Dakota State University	NDSU Heating Plant	8448211
18	Hess North Dakota Pipelines LLC	Hawkeye Compressor Station	10613211

19	Alliance Pipeline, LP	Towner Compressor Station	10612311
20	Alliance Pipeline, LP	Wimbledon Compressor Station	10612411
21	ONEOK Rockies Midstream, LLC	Grasslands Gas Plant	8085511

Figure 4 shows the approximate locations of these facilities (the numbers correspond to 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. Figure 5 shows the contribution of point sources to the total NO_x emissions. The “Point Sources” category consists of utility boilers (power plant boilers) and oil and gas wells.

2.3.2 Area Sources

Another source of NO_x is automobile emissions. North Dakota has no significant urbanized areas with respect to oxides of nitrogen; the entire population of the state is less than 1,000,000 people and the largest Metropolitan Statistical Area (MSA; includes Fargo) has a population of 233,836 (2015 estimate¹²). Figure 5 shows the contribution of “Other Point Sources” and “Utility Boilers.” The “Other Point Sources” category consists of coal gasification, oil refineries, natural gas processing plants and agricultural processing plants.

2.3.3 Monitoring Network

The Department currently operates seven NO/NO₂/NO_x analyzers. From Figure 4 it can be seen that NO/NO₂/NO_x analyzers are well placed with respect to the major NO_x sources. Additionally, as part of the NCore network site at Fargo, the Department operates a NO_y monitor.

2.3.4 Network Analysis

Figures 6 and 7 show the 2015 NO₂ monitoring results in comparison to the 1-hour and annual NO₂ NAAQS, respectively. Numbers above the bars indicate monitored concentrations.

Nine of the ten largest NO_x sources in the state are within 45 miles of the Beulah and Hannover monitoring sites. Figures 8 and 9 show the 1-hour and annual average concentrations for the Department-operated sites for 1980 – 2015, respectively.

¹² US Census Bureau. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2015 – United States – Metropolitan and Micropolitan Statistical Area; and for Puerto Rico 2015 Population Estimates. <https://www.census.gov/popest/data/metro/totals/2015/>. Retrieved 5/26/2016

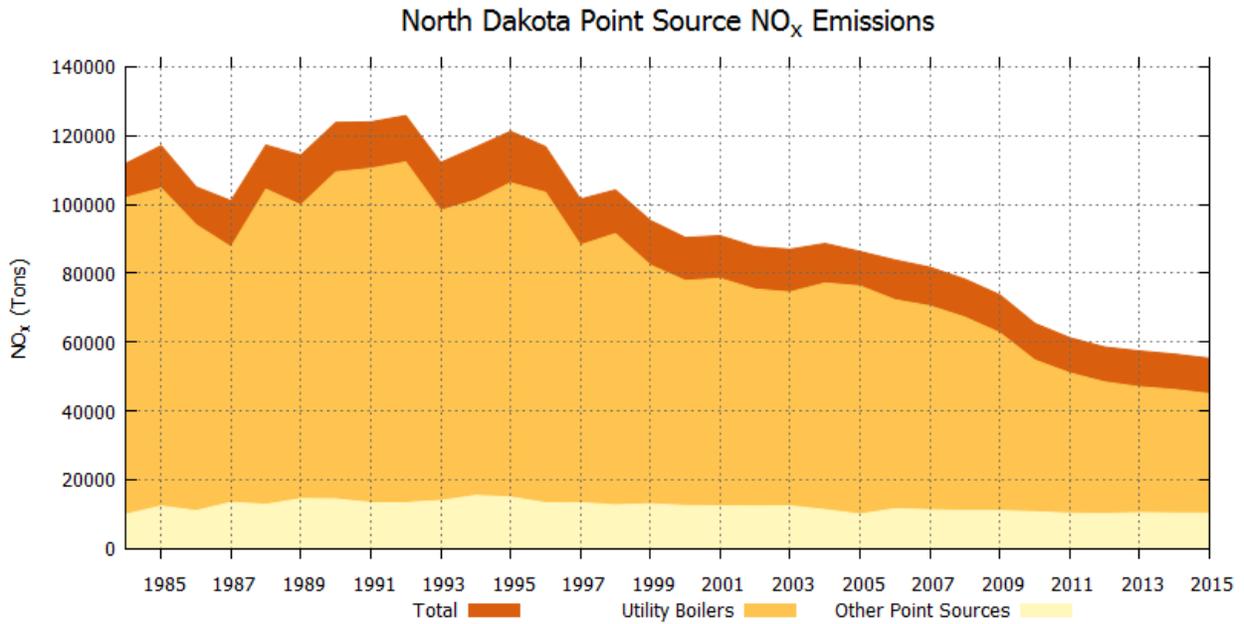


Figure 5. Annual Oxides of Nitrogen Emissions

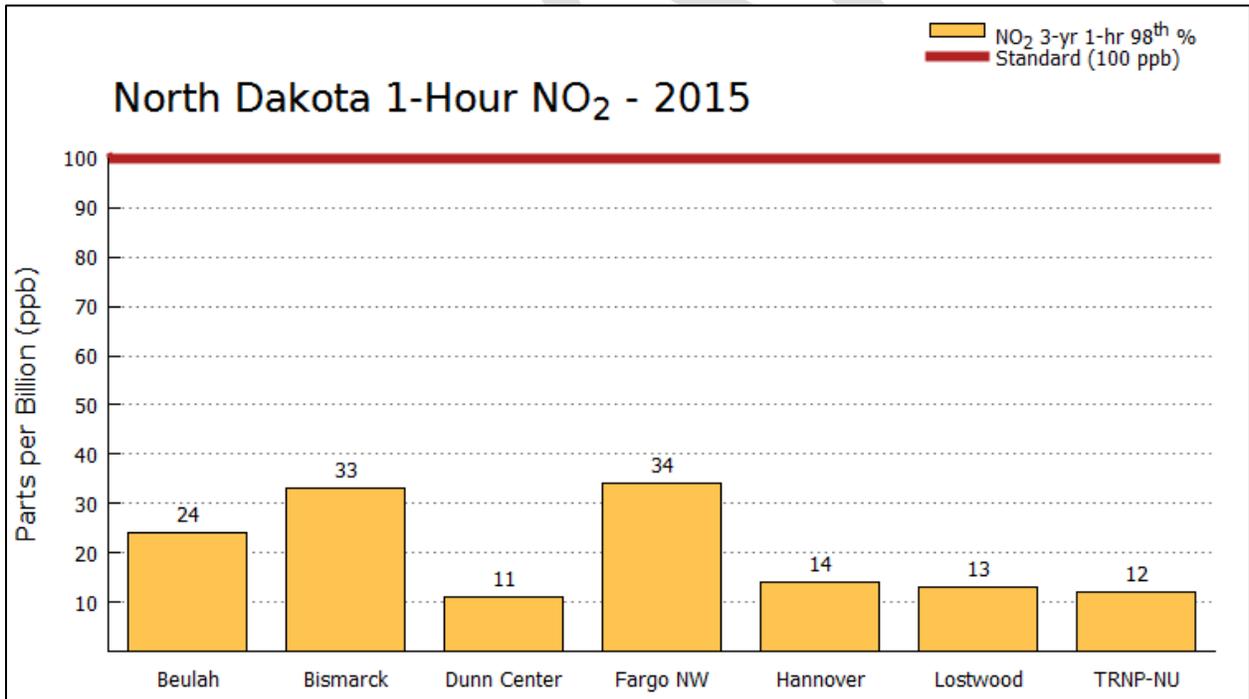


Figure 6. NO₂ Concentrations Compared to the 1-hour Standard

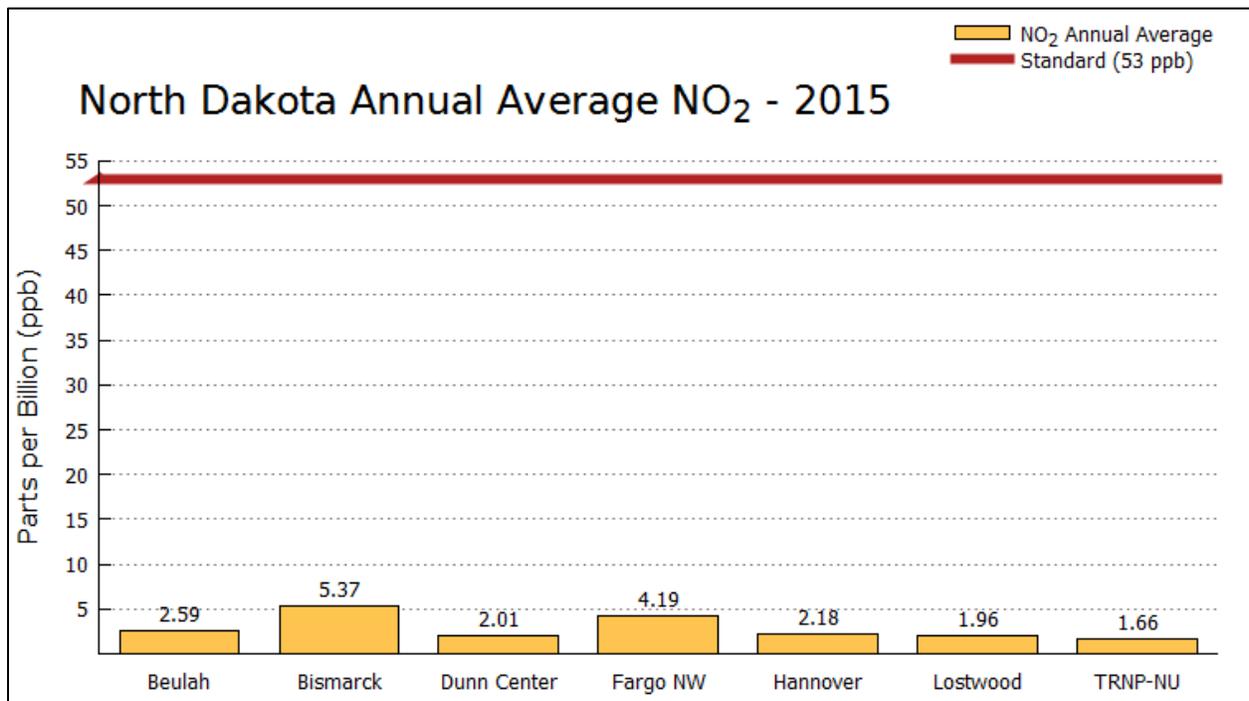


Figure 7. NO₂ Concentrations Compared to the Annual Standard

2.3.5 Network Changes

There were no significant changes made to the NO₂ network in 2015.

With the relocation of the NCore site, the NO_y monitor will move from Fargo to Bismarck. Trace level monitoring for NO₂ will end in Fargo and begin in Bismarck. Standard NO₂ monitoring will begin in Fargo.

See section 3.0 – Network Site Changes for discussion of the addition of a new ambient monitoring station to the network.

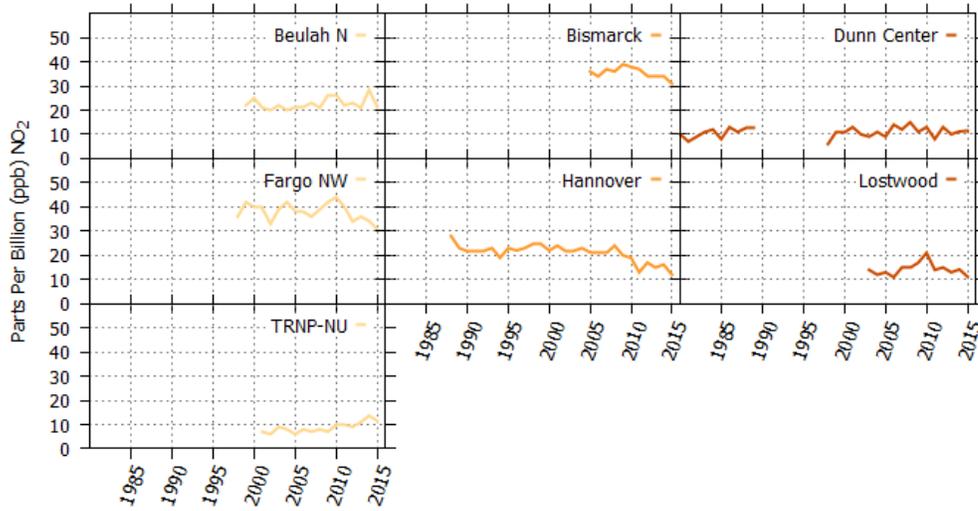


Figure 8. NO₂ 98th Percentile 1-Hour Concentrations

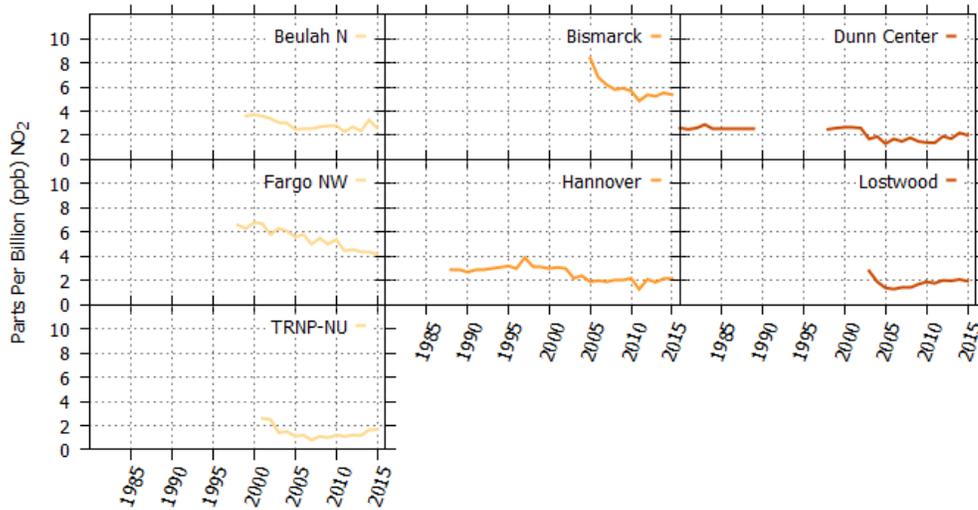


Figure 9. NO₂ Annual Average Concentrations

2.4 Ozone

Ozone (O₃) is a highly reactive form of oxygen. At very high concentrations, it is a blue, unstable gas with a characteristic pungent odor. It can often be detected around an arcing electric motor, lightning storms, or other electrical discharges. However, at ambient concentrations, O₃ is

colorless and odorless.

Unlike most other pollutants, O₃ is not emitted directly into the atmosphere, but results from a complex photochemical reaction between volatile organic compounds (VOC), NO_x, and solar radiation. Both VOC and NO_x are emitted directly into the atmosphere. Sources of VOC include automobile exhaust, gasoline and oil storage and transfer, industrial paint solvents, degreasing agents, cleaning fluids, and ink solvents. Some vegetation can also emit VOC (e.g. terpene from pine trees).

Production of O₃ is a year-round phenomenon. However, the highest O₃ levels generally occur during the summer months when sunlight is stronger and stagnant meteorological conditions can cause reactive pollutants to remain in an area for several days. Ozone produced under these conditions can be transported many miles. 40 CFR 58 defines the O₃ monitoring season for North Dakota as March 1 through September 30¹³.

At ground level where it can be breathed, O₃ is a pollutant. However, ground-level O₃ should not be confused with the stratospheric O₃ located between 12 and 20 miles above the earth's surface. The stratospheric O₃ layer shields the earth from intense cancer-causing ultraviolet radiation. Concentrations of O₃ in this layer are approximately 10,000 to 12,000 ppb, or 100 times the state's ambient air quality standard. Occasionally, meteorological conditions can result in stratospheric O₃ being brought to ground level. This can increase ambient air concentrations by 50 to 100 ppb.

Short-term exposure to O₃ in the range of 150 to 250 ppb may impair mechanical functions of the lungs and may induce respiratory difficulties and related symptoms in sensitive individuals (those who have asthma, emphysema, or reduced lung function). Symptoms and effects of O₃ exposure are more readily induced in people who are exercising.

O₃ is the major component of photochemical "smog", although the haziness and odors of the smog are caused by other components. The deterioration and degradation of material, especially the splitting and cracking of rubber tires and windshield wiper blades, is associated with O₃. Many plants, such as soybeans and alfalfa, are sensitive to O₃ and can be damaged by extended exposure to low levels.

2.4.1 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 4. Figure 10 shows the approximate locations of these facilities.

¹³ The required O₃ monitoring season for NCore stations is January through December. The Department typically collects O₃ monitoring data year-round at all ozone monitoring sites.

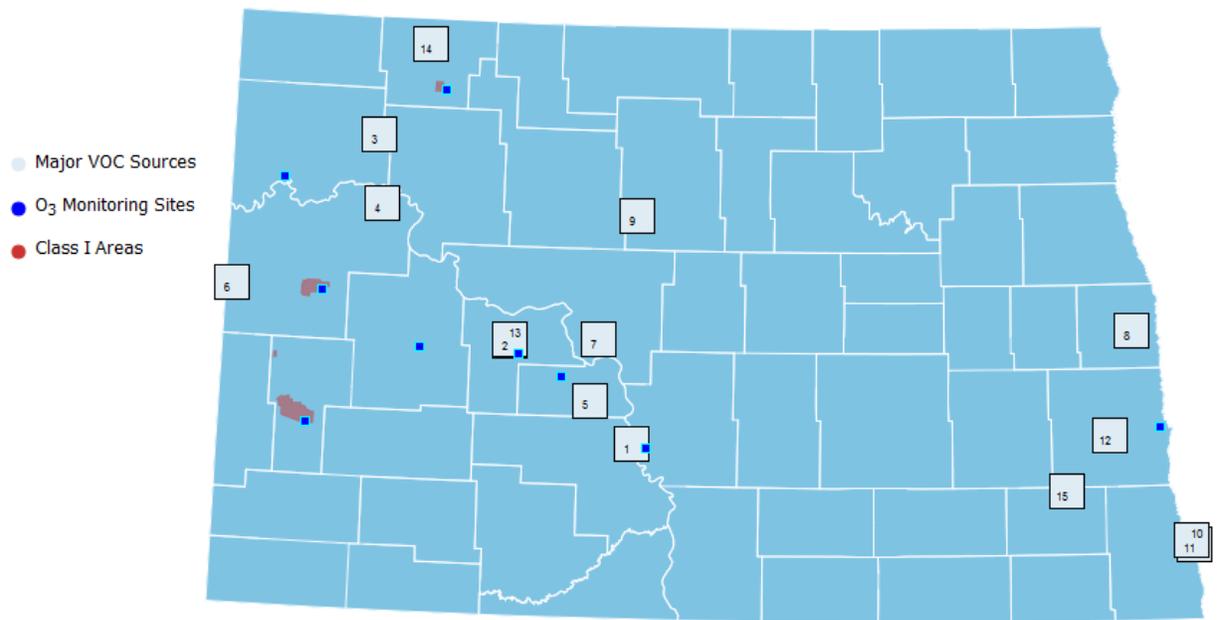


Figure 10. Major VOC Sources in 2015

Table 4. Major VOC Sources (≥ 100 TPY) in 2015

#	Company	Source	EIS Facility ID
1	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
2	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
3	Hess Corporation	Tioga Gas Plant	8013911
4	Hess North Dakota Pipelines LLC	Hawkeye Compressor Station	10613211
5	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
6	ONEOK Rockies Midstream, LLC	Grasslands Gas Plant	8085511
7	Great River Energy	Coal Creek Station	8011011
8	American Crystal Sugar Company	Hillsboro Plant	7939011
9	ADM Processing	Velva Facility	8085211
10	Cargill Corn Milling	Wahpeton Facility	10612711
11	Minn-Dak Farmers Cooperative	Wahpeton Plant	7924011
12	Tharaldson Ethanol Plant I, LLC	Tharaldson Ethanol Plant I, LLC	12682411
13	Basin Electric Power Cooperative	Antelope Valley Station	8086511
14	ONEOK Rockies Midstream, LLC	Lignite Gas Plant	8024311
15	Northern Sun (Division of ADM)	Enderlin Facility	7923911

2.4.2 Area Sources

Point sources contribute only part of the total VOC and NO_x emissions. The remaining emissions can be attributed to oilfield-related activities and mobile sources in urban areas. The EPA has specified design criteria for selecting locations for population-oriented O₃ monitoring as any urbanized area having a population of 50,000 to less than 350,000. North Dakota has three urbanized areas (Bismarck; Fargo, ND-Moorhead, MN; and Grand Forks) that meet these criteria. However, to require monitoring, the 4th highest 8-hour average concentration must be at least 68 parts per billion. As can be seen from Figure 11 (numbers above the bars indicate concentration), none of the O₃ monitors at SLAMS sites reach this threshold.

2.4.3 Monitoring Network

The Department currently has nine continuous ultraviolet (UV) photometric ozone analyzers in operation (Figure 10), two of which are co-located with chemiluminescence ozone analyzers (Lostwood and Beulah). Figure 11 presents the 2015 8-hour data summaries. Co-location was implemented in order to determine the cause(s) of elevated readings occurring at select UV photometric analyzers. The readings are suspected to be the result of UV photometric method-specific interference as they do not appear to register in the chemiluminescence based machine. For the time being, the Department will continue to operate collocated UV and chemiluminescence based analyzers to observe and resolve any differences in method results.

2.4.4 Network Analysis

Only three of the nine monitoring sites are in an area not significantly influenced by VOC sources (see Figure 10). Beulah and Hannover are within 45 miles of five of the 12 major VOC sources in the state. Lostwood National Wildlife Refuge (NWR) and TRNP - NU are located in Class I areas¹⁴ surrounded by oil fields. Bismarck Residential and Fargo NW are located in population centers and influenced by city traffic. Williston is also in a population center located in the heart of oil country. Dunn Center is located in a rural area surrounded by crop land. With this diversity of site locations and influences, one would expect to see a diversity of ozone concentrations. On the contrary, Figure 11 shows a striking similarity among the 4th maximum 8-hour annual concentrations. Since 1980, only four 8-hour averages have been higher than 70 ppb. Another, even stronger, indication of a uniform ozone distribution is the 8-hour concentrations: for all sites, the difference among the 4th highest average is 4 ppb (see Figure 11). Figure 12 shows the annual average concentrations for the Department-operated sites for 1980 - 2015.

¹⁴ A Class I area is one of 156 parks and wilderness areas given special protection under the Clean Air Act for the purpose of visibility protection.

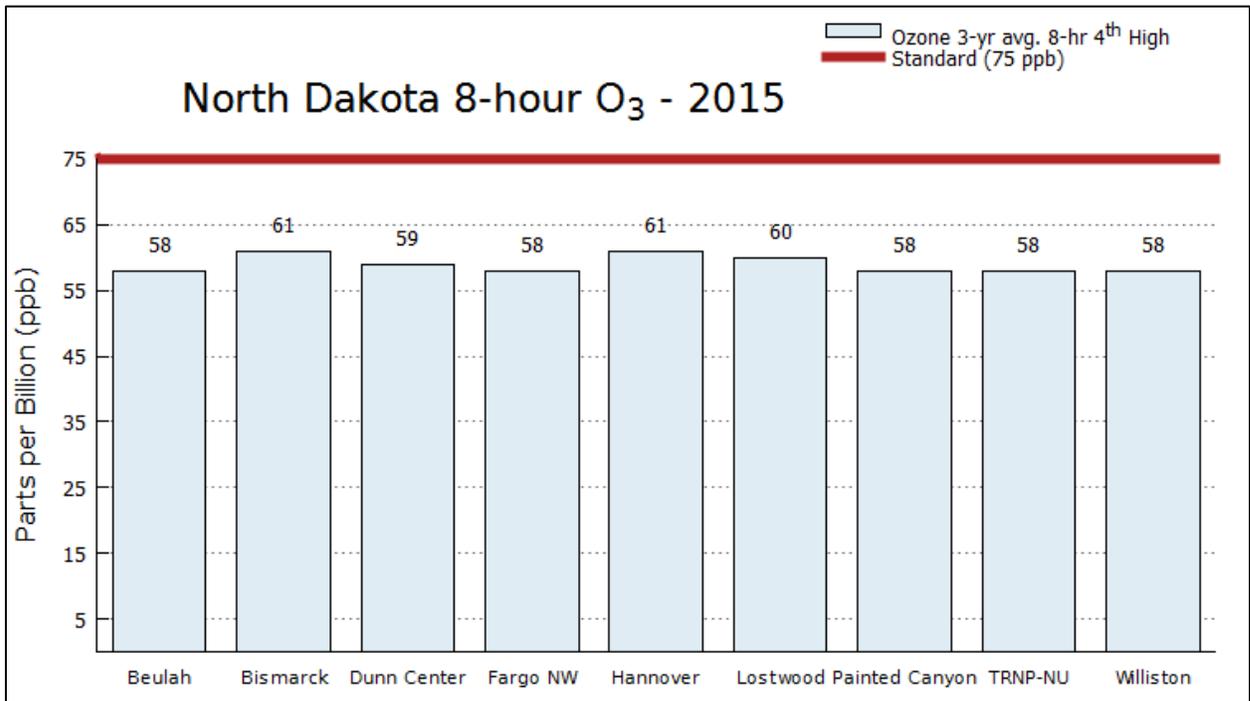


Figure 11. Ozone Concentrations Compared to the 8-hour Standard

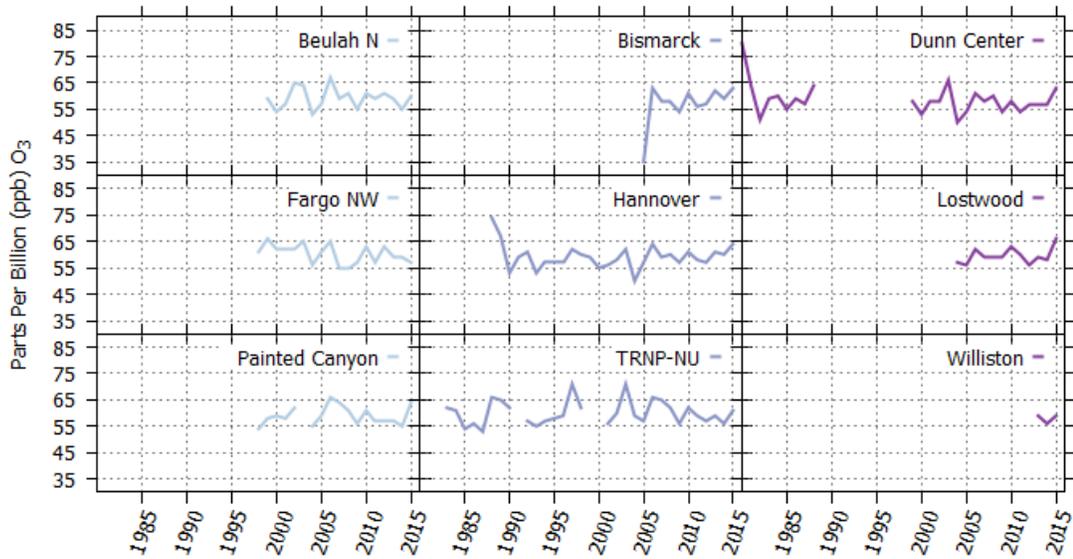


Figure 12. Annual 4th Highest 8-HR Ozone Concentrations
 (As of December 28, 2015 the ozone standard changed from 75 ppb to 70 ppb)

2.4.5 Network Changes

There were no significant changes made to the O₃ network in 2015. The Department will continue to evaluate the utility of collocating ozone monitors to evaluate functional differences. Changes will be made to the collocations as necessary.

See section 3.0 – Network Site Changes for discussion of the addition of a new ambient monitoring station to the network.

2.5 Particle Pollution

Particulate matter (PM) is the term given to the tiny particles of solid or semi-solid material found in the atmosphere. The inhalable PM standards are designed to protect against those particulates that can be inhaled deep into the lungs and cause respiratory problems.

Particles larger than 10 micrometers are usually due to “fugitive dust” (windblown sand and dirt from roadways, fields, and constructions sites) and contain large amounts of silica (sand-like) materials. The majority of anthropogenic (man-made) PM is in the 0.1 to 10 micrometer particle diameter range. Within the NAAQS, there are two subgroups of PM identified: PM₁₀ and PM_{2.5}. The PM₁₀ particles have an aerodynamic diameter less than or equal to a nominal 10 microns, while the PM_{2.5} particles have an aerodynamic diameter less than or equal to a nominal 2.5 microns.

PM₁₀ is generally created during a burning process and includes fly ash (from power plants), carbon black (from automobiles and diesel engines), and soot (from fireplaces and wood-burning stoves); or industrial processes including grinding, crushing, or agricultural processing. PM₁₀ from these sources contain a large percentage of elemental and organic carbon, which play a role in both visual haze and health issues. PM_{2.5} can also form directly through combustion processes, but can also be the result of indirect formation through chemical reactions between various other compounds and meteorological factors in the atmosphere. The EPA has also defined PM subgroup of particles called “coarse fraction,” designated PM_{10-2.5}, with an aerodynamic diameter between 10 and 2.5 microns.

The health risk from an inhaled dose of PM depends on the size and concentration of the particulate. Size determines how deeply the inhaled particulate will penetrate into the respiratory tract, where it can persist and do damage. Particles less than 10 micrometers in diameter are easily inhaled deeply into the lungs. PM_{2.5} (also called fine particulate pollution) affects the health of certain subgroups, which can be identified as potentially at risk of adverse health effects from airborne pollutants. There is very strong evidence that asthmatics are much more sensitive (i.e., respond with symptoms at relatively low concentrations) to the effects of particulates than is the general healthy population.

The effects of PM exposure may be the most widespread of all pollutants. Because of the

potential for extremely long-range transport of $PM_{2.5}$ particles and because of the chemical reactions that occur, no place on earth has been spared from the particulate generated by urban and rural sources. The effects of PM range from visibility degradation to climate changes to vegetation damage. General soiling can have long-term effects on paint and other materials. Acid deposition can be detected in the most remote areas in the world.

2.5.1 Point Sources

The major PM point sources (>100 TPY of PM_{10} -Filterable + PM-Condensable) are listed in Table 5. Figure 13 shows the approximate locations of these facilities (the numbers correspond to the site and source tables). Most of these sources are large coal-fired facilities, and the 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. Figure 14 shows the contribution of point sources to the total PM emissions. The “Utility Boilers” category consists of power plant boilers. The “Other Point Sources” category consists of coal gasification, oil refineries, natural gas processing plants and agricultural processing plants.

2.5.2 Monitoring Network

The Department operated eight continuous PM_{10} analyzer sites, four Federal Reference Method (FRM) manual $PM_{2.5}$ sites, nine Federal Equivalent Method (FEM) continuous $PM_{2.5}$ analyzer sites, and one speciation sampler site.

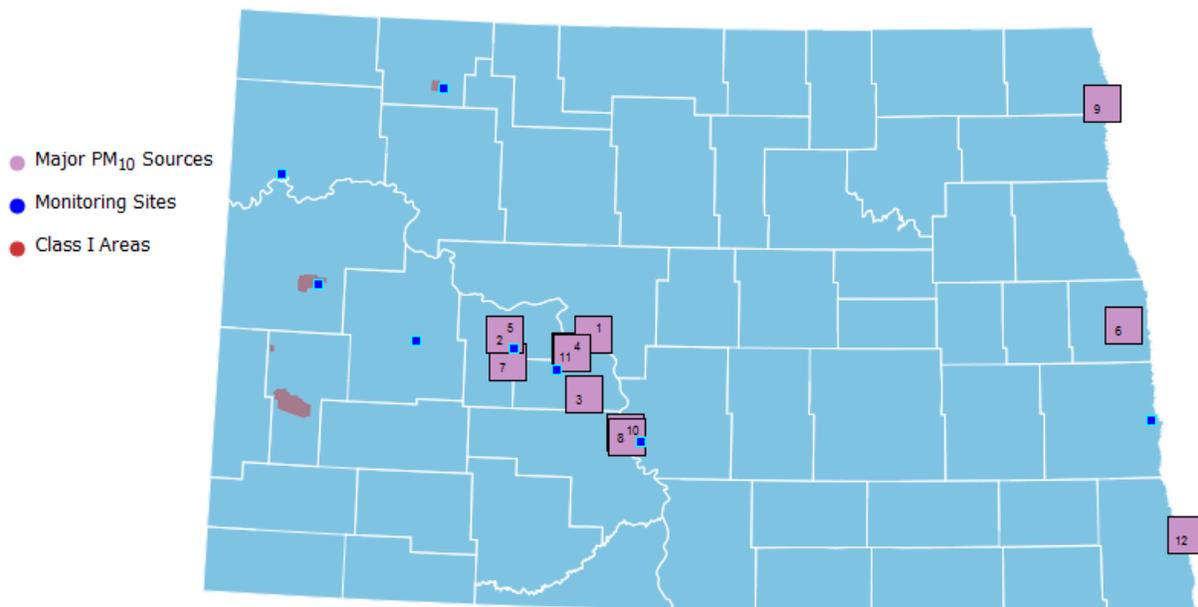


Figure 13. Major PM Sources in 2015

Table 5. Major PM Sources (≥ 100 TPY)* in 2015

#	COMPANY	SOURCE	EIS Facility ID
1	Great River Energy	Coal Creek Station	8011011
2	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
3	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
4	Basin Electric Power Cooperative	Leland Olds Station	8086311
5	Basin Electric Power Cooperative	Antelope Valley Station	8086511
6	American Crystal Sugar Company	Hillsboro Plant	7939011
7	Otter Tail Power Company	Coyote Station	8086611
8	Montana Dakota Utilities Company	RM Heskett Station	8087011
9	American Crystal Sugar Company	Drayton Plant	7923811
10	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
11	Great River Energy	Stanton Station	8086411
12	Minn-Dak Farmers Cooperative	Wahpeton Plant	7924011

* Total PM_{10} -Filterable + PM-Condensable as reported.

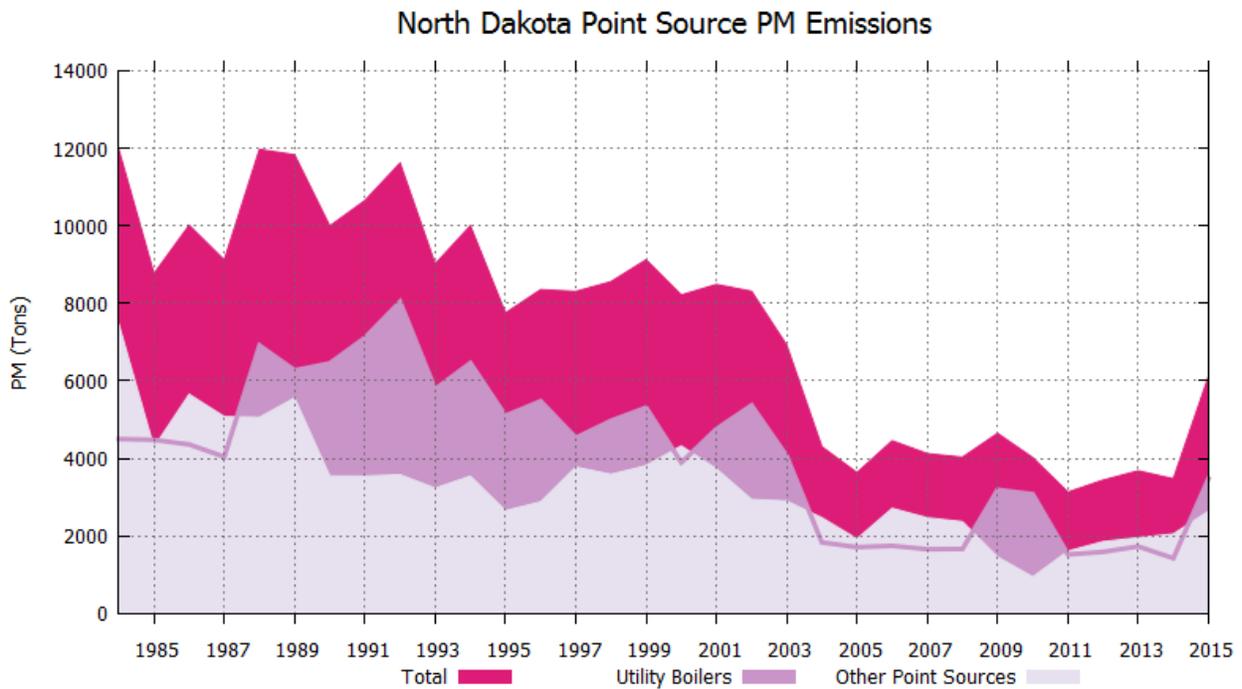


Figure 14. Annual PM Emissions¹⁵

¹⁵ From 2015, values represent PM_{10} -Filterable + PM-Condensable.

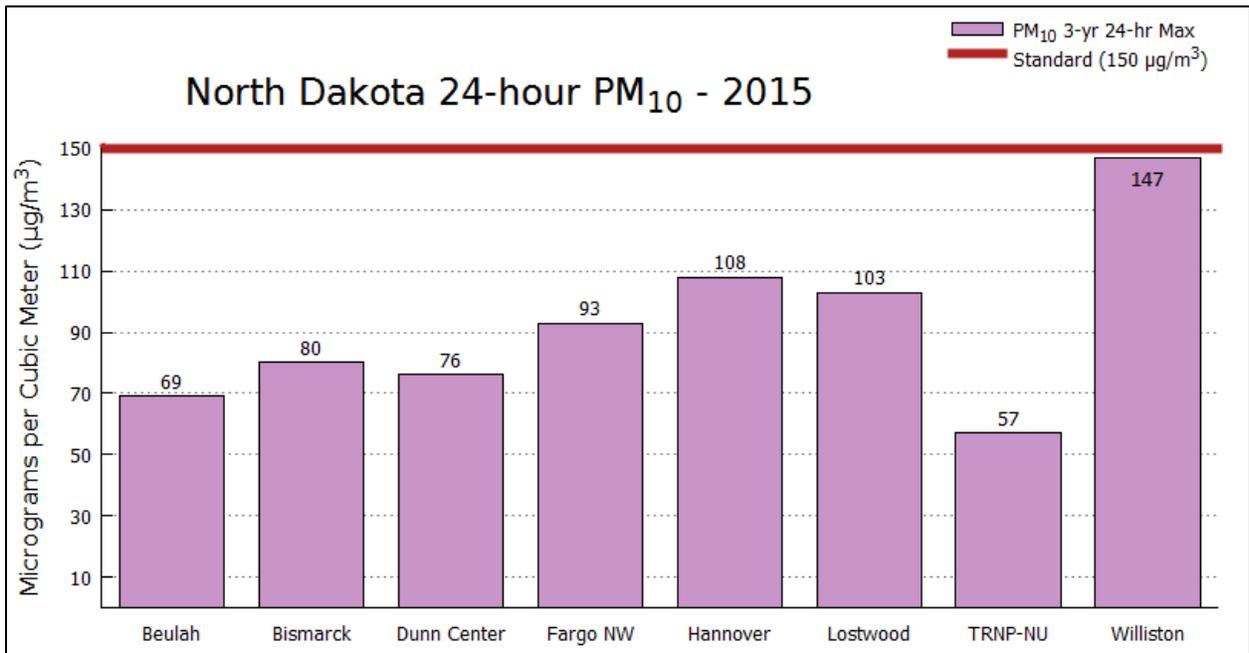


Figure 15. PM₁₀ Concentrations Compared to the 24-hour Standard¹⁶

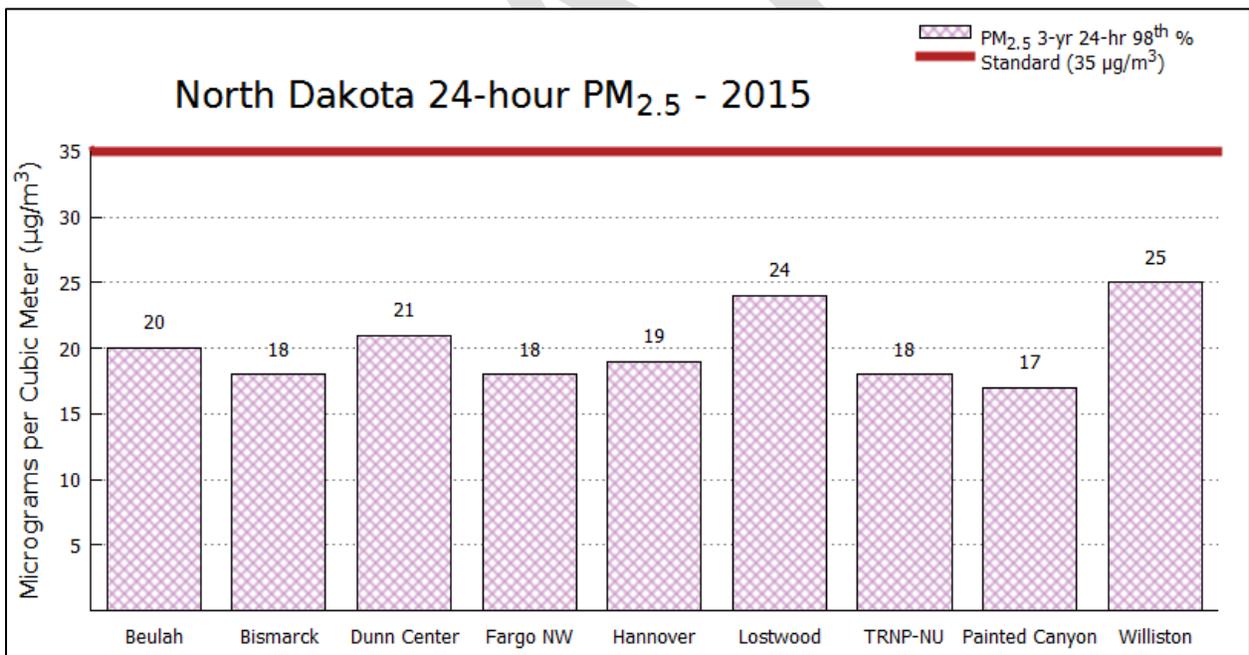


Figure 16. PM_{2.5} Concentrations Compared to the 24-hour Standard

¹⁶ Values shown represent the high value over three years.

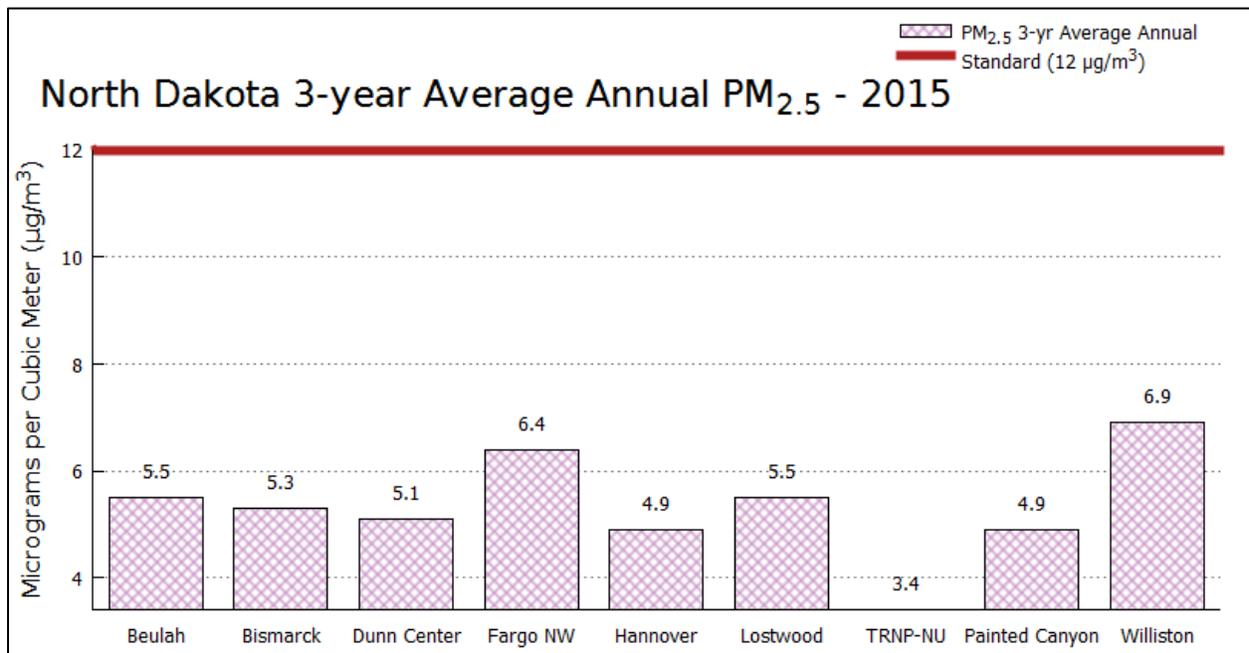


Figure 17. PM_{2.5} Concentrations Compared to the Annual Standard

2.5.3 PM₁₀ Network Analysis

PM₁₀ and smaller particles are of concern mainly because of their health effects. Continuous PM₁₀ analyzers are used with the continuous PM_{2.5} analyzers to determine the PM_{10-2.5} fraction. The data also are compared to both the state and federal ambient air quality standards. Figure 15 shows the 2015 PM₁₀ particulate monitoring results in comparison to the 24-hour NAAQS. Numbers above the bars indicate monitored concentrations.

2.5.4 PM_{2.5} Network Analysis

The manual PM_{2.5} network currently has four sites: Bismarck, Beulah, Fargo and Painted Canyon. Bismarck and Fargo operate on a 1-in-3 day schedule, while Beulah and Painted Canyon operate on a 1-in-6 day schedule. FEM continuous PM_{2.5} analyzers have been installed at all sites in the network. Figures 16 and 17 show the 2015 PM_{2.5} particulate monitoring results in comparison to the 24-hour and annual standards. Numbers above the bars indicate monitored concentrations.

2.5.5 Speciation Network

One speciation sampler is installed as a National Trends Network sampler in Fargo. The data collected by this sampler are added to the Air Quality System (AQS) database by an EPA

contractor¹⁷.

2.5.6 Network Changes

The Department has evaluated co-location requirements for PM_{2.5} particulate matter samplers and determined that a number of FRM manual samplers present in the network are redundant. Because the Department operates FEM continuous analyzers as primary monitors at all nine of the current monitoring sites, the Beulah and Painted Canyon manual FRM monitors will be removed. Additionally, with the NCore relocation from Fargo to Bismarck, manual sampling for PM_{2.5} at Fargo will also end.

The Bismarck FRM will continue to operate on a 1-in-3 day schedule with a second FRM also on a 1-in-3 day schedule. The PM_{2.5} speciation samplers will be located at Bismarck as well.

See section 3.0 – Network Site Changes for discussion of the addition of a new ambient monitoring station to the network.

2.6 Sulfur Dioxide

Sulfur dioxide (SO₂) is a colorless gas with a pungent odor detectable by the human nose at concentrations of 500 to 800 ppb. It is highly soluble in water where it forms sulfurous acid (H₂SO₃). In the atmosphere, sulfurous acid is easily converted to sulfuric acid (H₂SO₄), the major acidic component of “acid rain”, which then may convert again to form particulate sulfate compounds. On a worldwide basis, sulfur dioxide is considered to be a major pollutant. It is emitted mainly from stationary sources that burn coal and oil. Energy development in the west and west-central portions of North Dakota has produced a number of sources of SO₂. These sources include coal-fired steam-powered electrical generating facilities, a coal gasification plant, natural gas processing plants, oil refineries, and flaring at oil/gas well sites.

Sulfuric acid aerosols and particulate sulfate compounds, the result of conversions of SO₂ in the atmosphere, are corrosive and potentially carcinogenic (cancer-causing). The major health effects of SO₂ appear when it is associated with high levels of other pollutants, such as particulate. SO₂ also may play an important role in the aggravation of chronic illnesses, such as asthma. The incidence and intensity of asthma attacks have increased when asthmatics are exposed to higher levels of sulfur dioxide and particulate matter sulfates¹⁸.

Particulate matter sulfates resulting from SO₂ emissions can also affect visibility. In combination with high humidity, sulfates can develop to sizes that are effective at scattering sunlight, thus resulting in reduced visibility through haze formation. SO₂ is one of the Department's primary

¹⁷ RTI International

¹⁸ U.S. EPA (2008). Integrated Science Assessment (ISA) for Sulfur Oxides – Health Criteria (Final Report). Available at: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=198843>.

interests with respect to visibility: first, to aid in establishing the visibility baseline, then to track visibility improvement over time.

2.6.1 Point Sources

The major SO₂ point sources (>100 TPY) based on 2015 emissions are listed in Table 6. Figure 18 shows the approximate locations of these facilities. Figure 19 shows the total annual SO₂ emissions from point sources and three sub-categories for 1984 through 2015.

2.6.2 Other Sources

The western part of the state has a number of potential SO₂ sources including oil wells, oil storage facilities, and natural gas compressor stations. These sources may directly emit amounts of hydrogen sulfide to the ambient air (see Section 2.7 for further discussion on hydrogen sulfide) or they may flare the hydrogen sulfide creating SO₂ and contributing to concentrations of this pollutant.

2.6.3 Monitoring Network

There are eight SO₂ monitoring sites in the state. As can be seen in Figure 18, the majority of the 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 west-central part of the state.

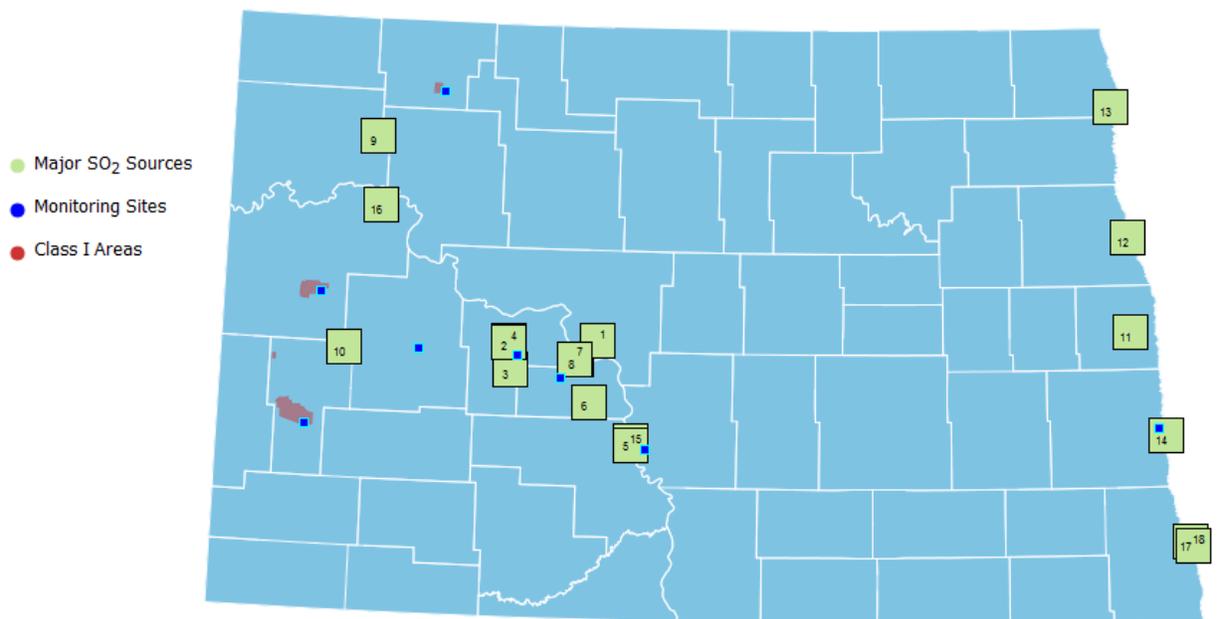


Figure 18. Major Sulfur Dioxide Sources in 2015

Table 6. Major SO₂ Sources (≥100 TPY) in 2015

#	Company Name	Source	EIS Facility ID
1	Great River Energy	Coal Creek Station	8011011
2	Basin Electric Power Cooperative	Antelope Valley Station	8086511
3	Otter Tail Power Company	Coyote Station	8086611
4	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
5	Montana Dakota Utilities Company	RM Heskett Station	8087011
6	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
7	Great River Energy	Stanton Station	8086411
8	Basin Electric Power Cooperative	Leland Olds Station	8086311
9	Hess Corporation	Tioga Gas Plant	8013911
10	Petro-Hunt, LLC	Little Knife Gas Plant	8023811
11	American Crystal Sugar Company	Hillsboro Plant	7939011
12	University of North Dakota	UND Heating Plant	7292911
13	American Crystal Sugar Company	Drayton Plant	7923811
14	North Dakota State University	NDSU Heating Plant	8448211
15	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
16	Hess North Dakota Pipelines LLC	Hawkeye Compressor Station	10613211
17	Cargill Corn Milling	Wahpeton Facility	10612711
18	Minn-Dak Farmers' Cooperative	Wahpeton Plant	7924011

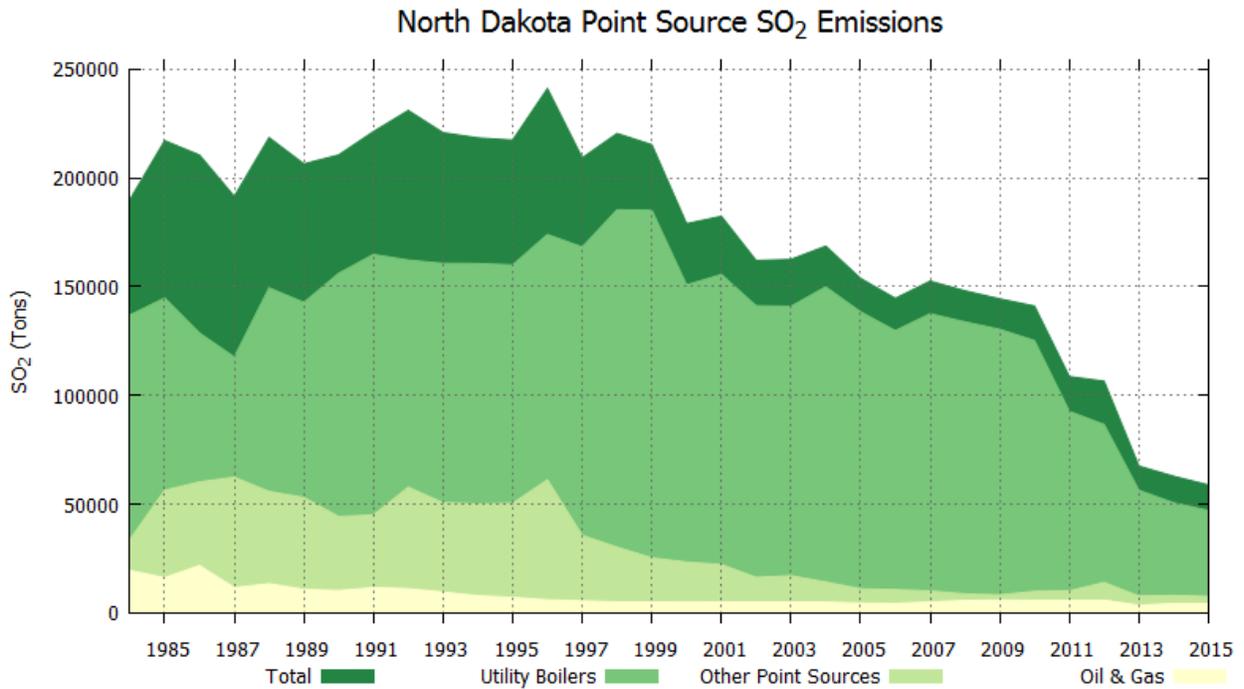


Figure 19. Annual Sulfur Dioxide Emissions

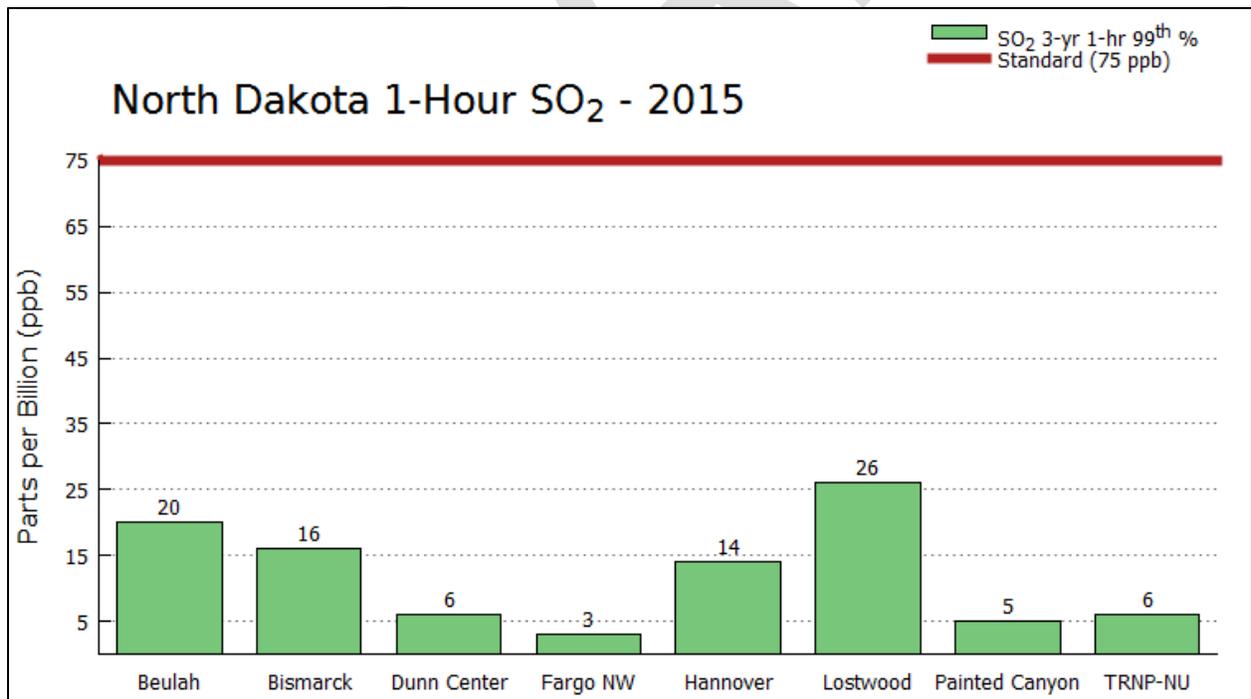


Figure 20. SO₂ Concentrations Compared to the 1-hour Standard

2.6.4 Network Analysis

Figure 20 shows the 2015 SO₂ monitoring results in comparison to the 1-hour SO₂ NAAQS. Numbers above the bars indicate monitored concentrations.

Ten major SO₂ sources are within 45 miles of both the Beulah and Hannover sites. This makes these two sites very important in tracking the impact of these sources on the ambient air. Also, Lostwood NWR is within 45 miles of four major sources: two natural gas processing plants and two power plants. The two power plants are located near Estevan, Saskatchewan, approximately 40 miles to the northwest.

One would expect that as the large sources in Oliver and Mercer counties 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 sources combined has been demonstrated in the data. Figure 21 presents 1-hour maximums for the Department-operated sites.

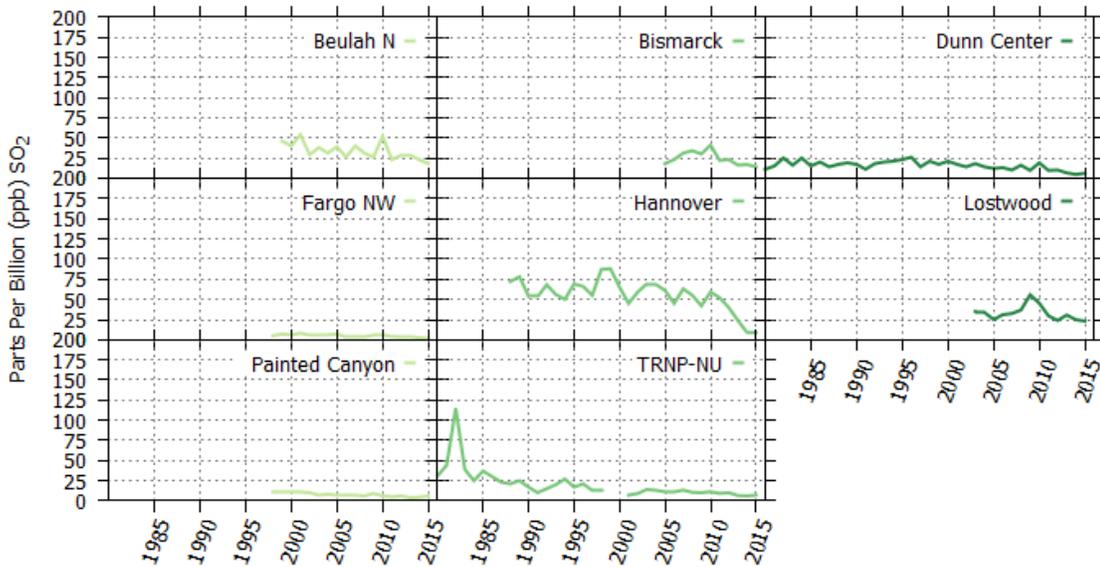


Figure 21 SO₂ 99th Percentile 1-Hour Concentrations

Beginning in 1980, major events are traceable. In 1980, the oil industry was expanding and in 1982 the oil industry in western North Dakota hit a peak in activity prior to the most recent increase. Dunn Center and TRNP – NU show the influence from the oil field activity as the oil fields expanded and flared the gas. As pipelines were built and wells were tied into the pipelines, the amount of hydrogen sulfide gas flared decreased, reducing the amount of sulfur dioxide emitted. Once the wells were tied into pipelines, the predominant influence at these two sites has been long-range transport from major point sources.

Dunn Center and TRNP – NU are indicators of the “oil patch” activity and tracked the activity very well. Since TRNP – NU is more centrally located in the “oil patch,” it is the stronger indicator. Dunn Center, which is on the eastern edge of the oil development area, demonstrates influences from both the “oil patch” and the coal conversion facilities to the east.

2.6.5 Network Changes

There were no significant changes made to the SO₂ monitoring network in 2015.

With the relocation of the NCore site, trace level monitoring for SO₂ will end in Fargo and begin in Bismarck. Standard SO₂ monitoring will begin in Fargo. Additionally, the Department has determined that because of continued low design values and fairly consistent data results for SO₂ at the TRNP-NU, Lostwood, and Dunn Center sites, trace level SO₂ monitoring will be suspended and standard SO₂ monitoring will be initiated at these sites as well.

See section 3.0 – Network Site Changes for the discussion on the addition of a new SLAMS ambient monitoring station to the network as well as ambient monitor site selection in response to the requirement of 40 CFR 51.1203 (b) concerning characterization of 1-hour SO₂ concentrations for the Tioga area.

2.7 Hydrogen Sulfide

Hydrogen sulfide (H₂S) is a colorless gas with a rotten egg odor. It is incompatible with strong oxidizers and reacts violently with metal oxides. It will attack many metals, forming sulfides.

A 5-minute exposure to 800 ppm H₂S has resulted in death. Inhalation of 1,000 to 2,000 ppm may cause a coma after a single breath. Exposure to lower concentrations may cause headache, dizziness and upset stomach. Low concentrations (20 to 150 ppm) can cause eye irritation which may be delayed in onset. Although the odor is detectable at very low concentrations, it rapidly causes olfactory fatigue at higher levels, and, therefore, is not considered to have adequate warning.

Although no Federal Ambient Air Quality Standard exists for H₂S, the state of North Dakota has

developed H₂S standards in response to historically high petroleum sulfur content (during the 1980s in particular) and associated high H₂S. The major source of H₂S is oil wells. Other sources are natural gas processing plants, lagoons, and sloughs. Emissions have been reduced significantly over time as production from these older sites has declined. The Bakken formation, the focus of the most recent oil and gas activity in the state, has been found to result in very low H₂S emissions when compared to legacy (non-Bakken) operations.

2.7.1 Point Sources

H₂S emissions of concern stems almost totally from the oil and gas operations in the western part of the state. Flares and treater stacks associated with oil/gas wells, oil storage tanks, compressor stations, pipeline risers, and natural gas processing plants are potential H₂S emission sources.

2.7.2 Monitoring Network

Currently there are no state H₂S monitoring sites.

2.7.3 Network Changes

There were no significant changes made to the H₂S network in 2015. There are no changes planned for 2016.

2.8 Ammonia

Ammonia (NH₃) is a corrosive, colorless gas with a strong irritating odor. It is used in making fertilizer, plastics, dyes, textiles, detergents, and pesticides. It reacts with acids and oxidizing materials (fluorine, chlorine, etc.). It is corrosive to copper, zinc, and many metal surfaces and reacts with hypochlorite and halogens to form explosive compounds that are pressure and temperature sensitive. In combination with oxides of nitrogen and sulfur, NH₃ can form small particulates with potential impact to health and visibility.

In mild concentrations (< 25,000 ppb), NH₃ will cause conjunctivitis and dermatitis. At higher concentrations, it will cause swelling of tissue, painful burns, lesions, and possible loss of vision. On contact with the skin, it will cause caustic-like burns and inflammation. Toxic level skin exposure (± 300,000 ppb) may cause skin lesions resulting in early necrosis and scarring. Inhalation of NH₃ is corrosive and irritating to the upper respiratory system and mucus membranes. Depending on the concentration inhaled, NH₃ may cause burning sensations, coughing, wheezing, shortness of breath, headache and nausea, with eventual collapse and death.

There is no ambient air quality standard for NH₃. However, because NH₃ concentrations are an important factor in the secondary formation of fine particulate matter through reactions with NO_x and SO₂, the Department maintains a select number of NH₃ monitors throughout North Dakota.

2.8.1 Point Sources

The major sources of NH₃ are listed in Table 7 and Figure 22 shows the approximate locations of these facilities (the numbers correspond to the source table).

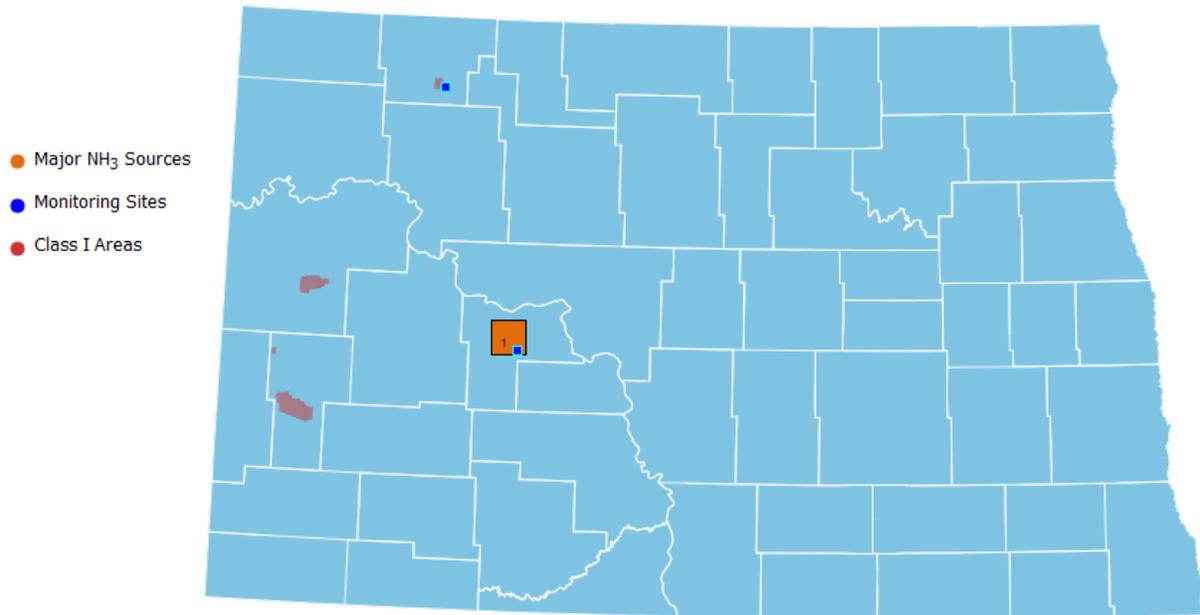


Figure 22. Major Ammonia Sources in 2015

Table 7. Major Ammonia Sources (≥ 100 TPY) in 2015

#	COMPANY	SOURCE	EIS Facility ID
1	Dakota Gasification Company	Great Plains Synfuels Facility	8086711

2.8.2 Monitoring Network

Currently there are two NH₃ monitoring sites in the state.

2.8.3 Network Analysis

Figure 23 shows maximum monitored NH₃ concentrations at the two monitoring sites in comparison with the arithmetic mean yearly concentration. As there is currently no NAAQS for NH₃, none is shown on the chart.

2.8.4 Network Changes

There were no significant changes made to the NH₃ network in 2015. There are no changes planned for 2016.

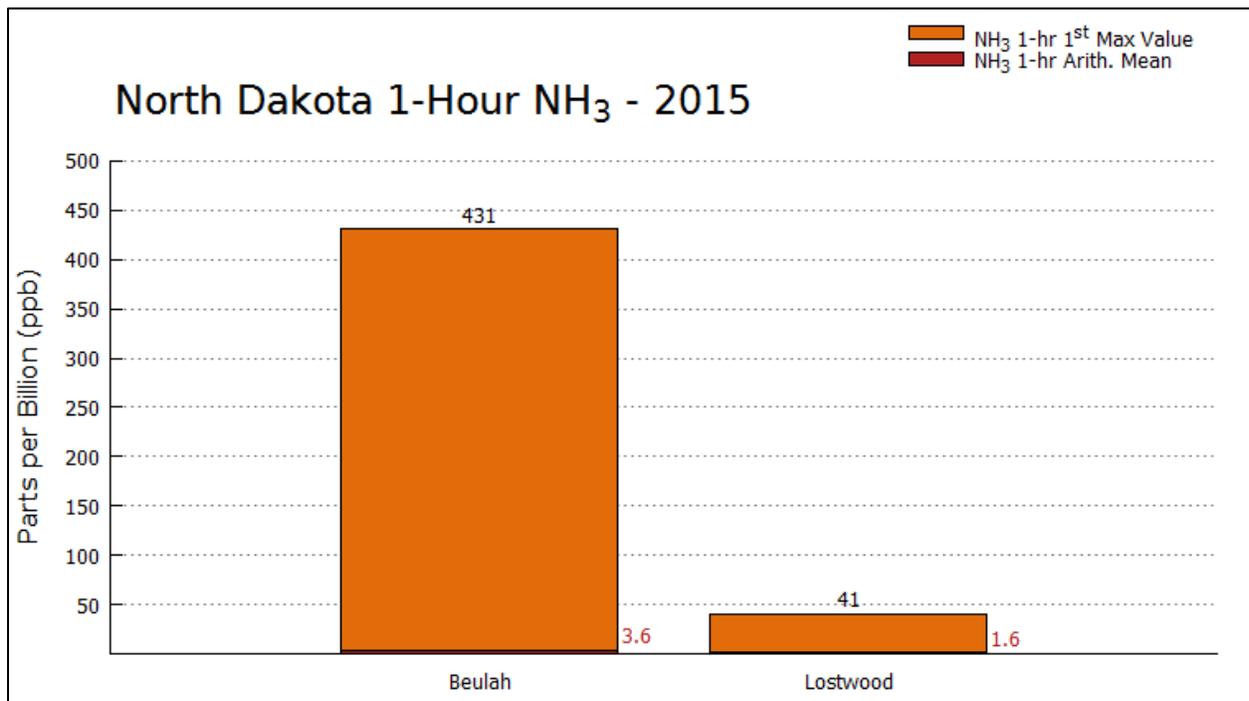


Figure 23. NH₃ Concentrations: Maximum Value and Arithmetic Mean

2.9 Air Toxics

The term ‘air toxics’ refers to Hazardous Air Pollutants (HAP) - air contaminants, other than those listed above, that at certain concentrations could be “injurious to human health or well-being or unreasonably interfere with the enjoyment of property or that would injure plant or animal life.”¹⁹ Currently there are no state or federal air toxics monitoring sites in North Dakota.

2.9.1 Point Sources

The major air toxics sources are listed in Table 8 and Figure 24 shows the approximate locations of these facilities (the numbers correspond to the source table).

2.9.2 Monitoring Network

Currently there are no state air toxics monitoring sites. The historic raw data and associated summaries are available in EPA’s AQS.

¹⁹ NDDoH (2010). Policy for the Control of Hazardous Air Pollutant Emissions in North Dakota (Air Toxics Policy). Available via link at <http://www.ndhealth.gov/AQ/HAPs.aspx>

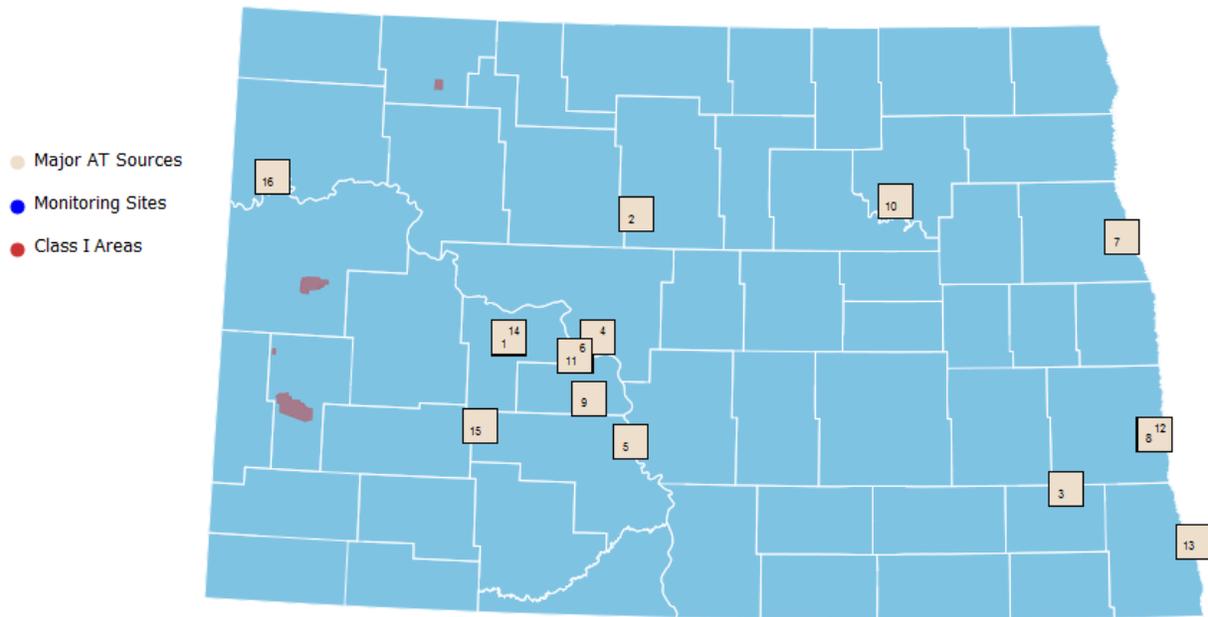


Figure 24. Major Air Toxics Sources in 2015

Table 8. Major Air Toxics Sources (≥ 10 TPY of a single HAP or ≥ 25 TPY aggregate HAPS) in 2015

#	COMPANY	SOURCE	EIS Facility ID
1	Dakota Gasification Company	Great Plains Synfuels Facility	8086711
2	ADM Processing	Velva Facility	8085211
3	Northern Sun (Division of ADM)	Enderlin Facility	7923911
4	Great River Energy	Coal Creek Station	8011011
5	Tesoro Refining and Marketing Company	Mandan Refinery	7923611
6	Great River Energy	Stanton Station	8086411
7	LM Wind Power Blades	Grand Forks Facility	7293311
8	Cargill, Inc.	Cargill Oilseeds Processing	9271111
9	Minnkota Power Cooperative, Inc.	Milton R. Young Station	8087911
10	Nordic Fiberglass, Inc.	Devils Lake Plant	8203411
11	Basin Electric Power Cooperative	Leland Olds Station	8086311
12	Trinity Containers, LLC	Trinity Containers, LLC – Plant #1593	10612911
13	Minn-Dak Farmers Cooperative	Wahpeton Plant	7924011
14	Basin Electric Power Cooperative	Antelope Valley Station	8086511
15	Hebron Brick Company	Hebron Brick Plant	8087211
16	Mor-Tech-Fab, Inc.	Williston Plant	8014311

2.9.3 Network Changes

There were no significant changes made to the Air Toxics network in 2015. There are no changes planned for 2016.

3.0 NETWORK SITE CHANGES

3.1 NCore (Bismarck/Fargo)

On April 18, 2016, EPA approved the Bismarck Residential site (AQS# 38-015-0003) to be the required NCore site for North Dakota²⁰. The Fargo NW station (AQS# 38-017-1004) was the previously designated NCore site in the state. Because of the new designation, monitors associated exclusively with the NCore site will move from Fargo to Bismarck – these include NO_y, CO, trace level SO₂ and NO₂ (although standard SO₂ and NO₂ monitoring will continue in Fargo), PM_{10-2.5}, and PM_{2.5} speciation. Bismarck will host two PM_{2.5} FRM manual samplers operating on 1-in-3 day schedules. The move is tentatively scheduled to be completed in June of 2016.

3.2 Dunn Center/Lake Ilo

A monitoring station in the Dunn Center area (AQS# 38-025-0003) has been providing air quality data for approximately 40 years. The current site is located on leased private land and future accessibility has been called into question. The Department has entered into an agreement with the U.S. Fish and Wildlife Service to allow a new air monitoring site to be located at the Lake Ilo National Wildlife Refuge. The Lake Ilo site is about 1 mile west of the city of Dunn Center and about 6 miles WNW of the current Dunn Center monitoring site location. Initially, the Lake Ilo site will be operated concurrently with the Dunn Center station. This will allow for comparison of monitoring results as the same pollutants will be monitored at both sites. The Department plans a minimum of one quarter of valid data collection to show concurrence between the two stations. If, based on a review of the collected data, concurrence is satisfactorily demonstrated, monitoring at the current Dunn Center site will end and the Lake Ilo site will be re-designated a SLAMS site. Monitoring is projected to begin at Lake Ilo in the third quarter of 2016.

Lake Ilo site specifics will be provided prior to the start of monitoring at the site; in either a future addendum to this annual report document or the next annual report.

3.3 Ryder (Minot)

To continue its mission to gain an accurate picture of the air quality in North Dakota, the Department has been charged with deploying a new, 10th, ambient monitoring station. The purpose of this station is to gain a fuller understanding of the impacts on air quality due to oil and

²⁰ See the NCore Relocation addendum to the 2014-2015 Annual Report for more information on the relocation request. Available online at: http://www.ndhealth.gov/AQ/ambient/Annual%20Reports/ARNP_14-15_Addendum.pdf

gas development in the state.

The siting process has identified a location on state owned land in Ryder, ND, approximately 20 miles southwest of Minot. This location is on the eastern edge of the oil patch in Ward County.

The new site is will consist of a suite of pollutant monitoring instruments selected to best provide an accurate assessment of air quality conditions. Monitors at the station will include ones designed to measure NO₂, SO₂, O₃, and PM_{2.5}. Additionally, the site will host a complement of meteorological instrumentation (e.g. wind speed and wind direction).

The Ryder site is anticipated to begin operations upon the conclusion of the Dunn Center/Lake Ilo concurrent monitoring period described in Section 3.2.

Ryder site specifics will be provided prior to the start of monitoring at the site; in either a future addendum to this annual report document or the next annual report.

3.4 Peak 1-Hour SO₂ Characterization for the Tioga Area

Effective September 21, 2015, EPA promulgated the Data Requirements Rule (DRR) for the 2010 1-hour SO₂ standard which requires state air agencies to characterize air quality in areas with large sources of SO₂ emissions. The Hess Corporation's Tioga Gas Plant in Williams County is subject to this rule as an applicable source due to non-regulatory monitors in the area suggesting excessive ambient concentrations of SO₂. This applicability is outlined in the March 18, 2016 DRR Response letter from EPA²¹. One of the pathways for a state agency to characterize air quality is to use ambient air quality monitoring by use of SLAMS or SLAMS-like²² monitors. The decision to use monitoring for air quality characterization must be communicated to EPA by July 1, 2016. It is the intent of the Department to use SLAMS-like monitors to meet this requirement.

In support of the ambient monitoring decision, the Department reviewed the two current industry operated ambient monitoring sites associated with the Tioga Gas Plant. These are located 0.8 miles north and 0.5 miles southeast, respectively, of the facility. Preliminary screening air dispersion modeling conducted by the Department suggested that a monitor location along the facility fenceline to the northwest of the facility may show higher concentrations than either of the two existing monitoring sites.

Based on these preliminary findings, the Department requested that the Hess Corporation prepare a comprehensive air dispersion modeling analysis for the Tioga Gas Plant to aid in monitor siting. Hess conducted the analysis in accordance with applicable sections of 40 CFR 51, Appendix W and recommendations of the SO₂ NAAQS Designations Source-oriented Monitoring Technical

²¹ Available at <https://www3.epa.gov/airquality/sulfurdioxide/drr/nd-response.pdf>

²² Monitors operated in a manner equivalent to SLAMS as to meet all applicable requirements of 40 CFR 58, appendices A, C, and E, and subject to the data certification and reporting requirements of 40 CFR 58.15 and 58.16.

Assistance Document (TAD²³). The results of this analysis are provided in Appendix E and suggest that the current high reading monitor (the site located to the SE of the facility and the one that triggered the action under the DRR) should be retained and supplemented by a second monitor located approximately five miles NNE of the facility. This second location was shown through the modeling analysis as the point of maximum concentration and frequency. After a thorough review, The Department concurs with the conclusions reported in the analysis and has determined that SO₂ monitors should be located in the locations as proposed. These two monitors will be sufficient to characterize the air quality in the ambient air impacted by the Tioga Gas Plant.

4.0 SUMMARY AND CONCLUSIONS

The North Dakota Ambient Air Quality Monitoring Network is designed to monitor those air pollutants that 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.

4.1 • Carbon Monoxide (CO)

Neither the state nor federal CO standards of 35,000 ppb (1-hour) or 9,000 ppb (8-hour) were exceeded at the monitoring site. The maximum concentrations are as follows: 1-hour – 875 ppb; 8-hour – 800 ppb.

The Department will move the trace-level CO monitor from Fargo to Bismarck as part of the larger NCore site relocation.

4.2 Lead

No lead monitoring was conducted. No changes to the network were identified.

4.3 • Nitrogen Dioxide (NO₂)

Neither the state nor federal NO₂ standards of 100 ppb (1-hour) or 53 ppb (annual) were exceeded at any of the monitoring sites. The maximum concentrations were as follows: Three year average of the 98th percentile 1-hour average concentrations – 34 ppb; annual – 5.37 ppb.

The Department will move the NO_y monitor from Fargo to Bismarck as part of the larger NCore

²³ In Draft. Updated February, 2016 and available online at <https://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf>

site relocation. NO₂ monitors will be installed at the new ambient monitoring stations at Lake Ilo and Ryder and contingent on concurrence being demonstrated between Lake Ilo and Dunn Center, NO₂ monitoring will end at Dunn Center.

4.4 • Ozone (O₃)

Neither the state nor federal O₃ standard of 75 ppb was exceeded during the year. The maximum fourth-highest 8-hour concentration was 61 ppb.

O₃ monitors will be installed at the new ambient monitoring stations at Lake Ilo and Ryder and contingent on concurrence being demonstrated between Lake Ilo and Dunn Center, O₃ monitoring will end at Dunn Center.

4.5 • Particulate Matter (PM₁₀, PM_{2.5})

The federal PM₁₀ 24-hour standard states that the concentration of PM₁₀ in the ambient air should not go over 150 µg/m³ more than once per year on average over a three year period. Neither the state nor federal PM₁₀ standard was exceeded during the year. The highest applicable concentration recorded in the state was 147.0 µg/m³.

Neither the state nor federal PM_{2.5} standards of 35 µg/m³ (24-hour) and 12 µg/m³ (annual) were exceeded during the year. The maximum concentrations are as follows: 24-hour – 24 µg/m³; annual – 6.9 µg/m³.

The Department will move the PM_{10-2.5} and PM_{2.5} speciation samplers from Fargo to Bismarck as part of the larger NCore site relocation. Manual FRM PM_{2.5} sampling will end at Beulah, Painted Canyon, and Fargo. Bismarck will operate two manual FRM PM_{2.5} samplers on a 1-in-3 day schedule. Continuous FEM PM_{2.5} monitors will be installed at the new ambient monitoring stations at Lake Ilo and Ryder and contingent on concurrence being demonstrated between Lake Ilo and Dunn Center, PM_{2.5} monitoring will end at Dunn Center.

4.6 • Sulfur Dioxide (SO₂)

Neither the state nor federal SO₂ standard of 75 ppb (1-hour) was exceeded at any state operated monitoring site. The maximum concentrations were as follows: 3-year average 1-hour 99th percentile – 26 ppb.

The Department will move the trace level SO₂ monitor from Fargo to Bismarck as part of the larger NCore site relocation. Standard SO₂ monitoring will commence in Fargo. Additionally, trace level monitoring for SO₂ will end and standard SO₂ monitoring will begin at the TRNP-NU and Lostwood sites. SO₂ monitors will be installed at the new ambient monitoring stations at Lake Ilo and Ryder and contingent on concurrence being demonstrated between Lake Ilo and Dunn Center, SO₂ monitoring will end at Dunn Center.

In order to fulfill the obligations of the DDR, two SO₂ monitoring sites will be operated as SLAMS-like monitors in the vicinity of the Hess Corporation Tioga Gas Plant in Williams County. These will be located 0.5 miles to the SE and 5 miles to the NNE of the facility, respectively. Specific location information will be provided in a network plan addendum.

4.7 • Hydrogen Sulfide (H₂S)

No H₂S monitoring was conducted. No changes to the network were identified.

4.8 • Ammonia (NH₃)

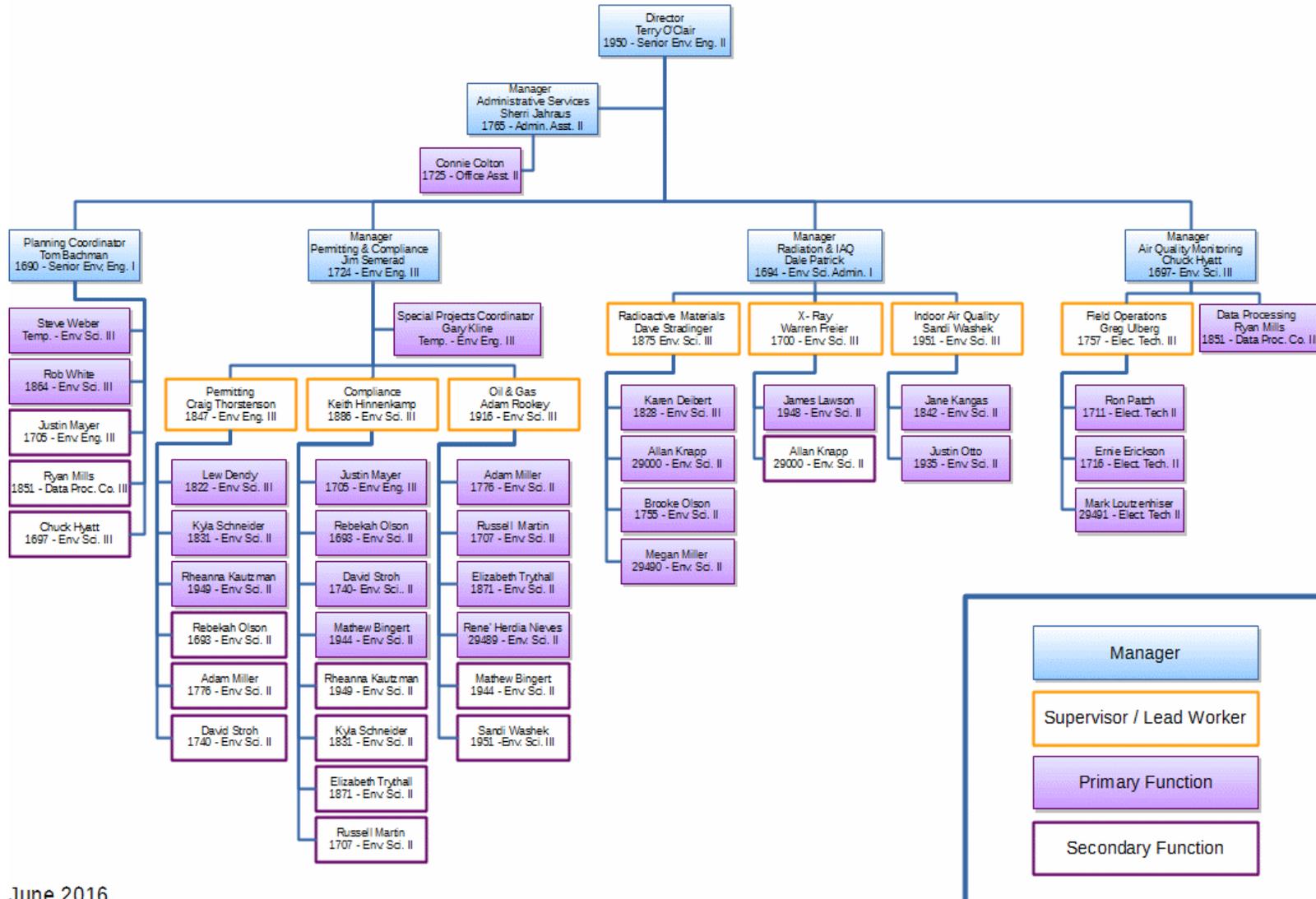
There is no ambient air quality standard for ammonia. The maximum 1-hour concentration measured was 431 ppb with a maximum yearly average (arithmetic mean) of 3.6 ppb. No changes to the network were identified.

4.9 • Air Toxics (HAP)

No Air Toxics monitoring was conducted. No changes to the network were identified.

DRAFT

Air Quality Division



June 2016

Figure 25. Organizational Chart

DRAFT

Table 9. National and North Dakota Ambient Air Quality Standards

Ambient Air Quality Standards					
Pollutant	Averaging Period	North Dakota		Federal	
		µg/m ³	ppb	µg/m ³	ppb
Carbon Monoxide (CO)	1-hour ^a	40,000	35,000	40,000	35,000
	8-hour ^a	10,000	9,000	10,000	9,000
Lead	3-month ^b	0.15	--	0.15	--
Nitrogen Dioxide (NO ₂)	Annual ^c	100	53	100	53
	1-hour ^d	188	100	188	100
Ozone (O ₃)	8-hour ^e	147	75	147	75 ^{**}
Particulate Matter	PM ₁₀	24-hour ^f	150	--	150
	PM _{2.5}	24-hour ^g	35	--	35
		Annual ^h	12	--	12
Sulfur Dioxide (SO ₂)	1-hour ⁱ	196	75	196	75
	3-hour ^a	1309	500	1309	500
	24-hour ^{a*}	--	--	365	140
	Annual ^{c*}	--	--	80	30
Hydrogen Sulfide (H ₂ S)	Instantaneous	14,000	10,000	--	--
	1-hour ^j	280	200	--	--
	24-hour ^a	140	100	--	--
	Quarter	28	20	--	--

^a Not to be exceeded more than once per calendar year.

^b Not to be exceeded by a rolling three month arithmetic mean.

^c Annual arithmetic mean.

^d Three year average of 98th percentile of 1-hour daily maximum concentrations.

^e Three year average of the annual fourth-highest daily maximum 8-hour concentrations.

^f Not to be exceeded more than once per year on average over a 3 year period.

^g Three year average of the annual 98th percentile values.

^h Three year average of annual concentrations.

ⁱ Three year average of 99th percentile of 1-hour daily maximum concentrations.

^j Not to be exceeded more than once per month.

* The 24-hour and Annual SO₂ standards were revoked per the 2010 rulemaking. However, these standards will remain in effect until one year after attainment status designations for the 2010 1-hour SO₂ standard are complete for a given area.

** On October 26, 2015 EPA revised the primary ozone standard level to from 75 to 70 ppb with an effective date of December 28, 2015. Charts and graphs in this report reflect the 75 ppb level that was in effect for the majority of the 2015 monitoring season.

DRAFT

This appendix includes site descriptions and information relating to State operated analyzers and samplers onsite. Please note that all sites meet the siting criteria specified in 40 CFR 58, Appendices A, C, D, and E. When selecting a site, five factors are considered: modeling results, landowner permission, power availability, year-round access to the site, and prevailing wind direction.

The sites addressed in this report are only the current active sites. A complete list of sites and all monitoring that has been conducted at each site can be found in the AQS system at www.epa.gov/air/data/aqsdb.html. Also available at this site are air quality summary data and emissions data.

Map images in this appendix are from the North Dakota Geographic Information Systems (GIS) Hub site at <http://www.nd.gov/gis>.

DRAFT

Site Name: Beulah – North

Station Type: SLAMS (required)

AQS#: 38-057-0004

MSA: 0000

Address: 6024 Highway 200

Beulah, ND

Latitude: +47.298611

Longitude: -101.766944

Site Description: This is one of three key sites in the Department’s ambient monitoring network to meet the six required monitoring objectives. When this site was established, it was decided to enhance the site to include ammonia, solar radiation and delta temperature to support air quality dispersion modeling. This site is one of the required PM_{2.5} monitoring sites for North Dakota

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	Population Exposure	Urban
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	Population Exposure	Urban
Ozone	Instrumental Ultraviolet	Continuous	Population Exposure	Urban
Ozone	Instrumental Chemiluminescence	Continuous	Population Exposure	Urban
Ammonia	Instrumental Chemiluminescence	Continuous	General Background	Regional
PM _{2.5}	24-hour Gravimetric	1/6	Population Exposure	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Population Exposure	Urban
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	Population Exposure	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Delta Temperature	Elec. or Mach Avg.	Continuous	10 - 2 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban
Solar Radiation	Pyranometer	Continuous	2 meters	Urban

There are no plans to move or remove this site.

Site Pictures: **Beulah North**



North



South



East



West

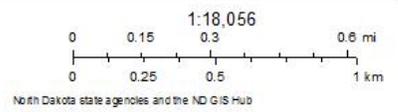


Looking Northeast



Looking Northwest

Beulah - North



Site Name: Bismarck Residential

Station Type: SLAMS

AQS#: 38-015-0003

MSA: 1010

Address: 1810 N 16th Street
Bismarck, ND

Latitude: +46.825425

Longitude: -100.768210

Site Description: This site is located in the second largest metropolitan area in the state. When two special purpose sites in Mandan were closed, this site was expanded from a particulates-only site to be a full site for gases, continuous particulates (inc. ambient pressure) and the basic meteorological parameters (wind speed, wind direction and temperature). Another key role this site plays is to field test new types of equipment and procedures isolated from the equipment used to report data to AQS.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	Population Exposure	Urban
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	Population Exposure	Urban
Ozone	Instrumental Ultraviolet	Continuous	Population Exposure	Urban
PM _{2.5}	24-hour Gravimetric	1/3	Population Exposure	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Population Exposure	Urban
PM ₁₀	PM ₁₀ BAM	Continuous	Population Exposure	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban

There are no plans to move or remove this site. This site will be designated the new NCore site upon completion of the relocation from Fargo.

Site Pictures: **Bismarck Residential**



North



East



West



Looking Northwest

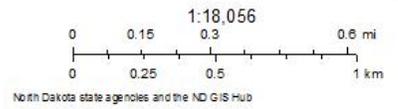


South



Looking Southeast

Bismarck Residential



Site Name: Dunn Center

Station Type: SLAMS

AQS#: 38-025-0003

MSA: 0000

Address: 9610 Seventh Street SW
Dunn Center, ND

Latitude: +47.313200

Longitude: -102.527300

Site Description: This site is located about midway between the oil development all along the North Dakota – Montana border and the seven coal conversion facilities to the east. The importance lies in the ability to monitor the transport of sulfur dioxide, nitrogen dioxide, and PM_{2.5} between these two areas. Also, this is a key site used in dispersion model calibration and validation.

Gas/Particulate parameters

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	General/Background	Urban
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	General/Background	Urban
Ozone	Instrumental Ultraviolet	Continuous	General/Background	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	General/Background	Urban
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	General/Background	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Delta Temperature	Elec. or Mach Avg.	Continuous	10 - 2 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban
Solar Radiation	Pyranometer	Continuous	2 meters	Urban

Changing site conditions have prompted the Department to evaluate the possibility of relocating this site. It is the Department's aim to continue to have the site meet appropriate siting criteria (including continued staff accessibility). Any relocation would maintain instrumental consistency. A new site location has been identified at Lake Ilo NWR. See section 3.2 of this annual report for discussion on the new site.

Site Pictures: **Dunn Center**



North



West



East



South

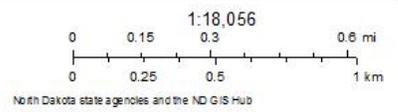


Looking Northwest



Looking Northeast

Dunn Center



Site Name: Fargo NW

Station Type: SLAMS (required)

AQS#: 38-017-1004

MSA: 2520

Address: 4266 40th Avenue North

Fargo, ND

Latitude: +46.933754

Longitude: -96.855350

Site Description: This site is located in the largest metropolitan area in North Dakota. Through 2015 it operated as one of EPA's 54 Speciation Trends Network sites and the state's required NCORE site. The data collected at this site are used in dispersion modeling for input, calibration and validation.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	Population Exposure	Urban
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	Population Exposure	Urban
Carbon Monoxide	Instrumental Gas Filter Correlation	Continuous	Population Exposure	Urban
NO _y	Instrumental Chemiluminescence	Continuous	Population Exposure	Urban
Ozone	Instrumental Ultraviolet	Continuous	Population Exposure	Urban
PM _{2.5}	24-hour Gravimetric	1/3	Population Exposure	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Population Exposure	Urban
PM ₁₀	PM ₁₀ BAM	Continuous	Population Exposure	Urban
PM _{10-2.5} Speciation	METOne SASS 24-hour Gravimetric	1/3	Population Exposure	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Delta Temperature	Elec. or Mach Avg.	Continuous	10 - 2 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban
Relative Humidity	Hygroscopic Plastic Film	Continuous	10 meters	Urban
Solar Radiation	Pyranometer	Continuous	2 meters	Urban

There are no plans to move or remove this site. Although the NCore designation for this site will end with the relocation to Bismarck, this site will remain a SLAMS site.

Site Pictures: **Fargo NW**



North



West



East



South

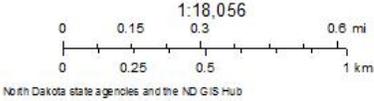


Looking Northeast



Looking West

Fargo NW



Site Name: Hannover

Station Type: SLAMS

AQS#: 38-065-0002

MSA: 0000

Address: 1575 Highway 31
Stanton, ND

Latitude: +47.185833

Longitude: -101.428056

Site Description: This site is centrally located to the power plants in the Oliver-Mercer-McLean county area. The data collected here are used to supplement ambient data collected at Beulah – North and TRNP – NU.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	Source Oriented	Urban
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	Source Oriented	Urban
Ozone	Instrumental Ultraviolet	Continuous	Source Oriented	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Source Oriented	Urban
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	Source Oriented	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban

There are no plans to move or remove this site.

Site Pictures: **Hannover**



North



East



South



West

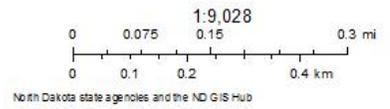


Looking Southwest



Looking Northeast

Hannover



Site Name: Lostwood NWR

Station Type: SLAMS

AQS#: 38-013-0004

MSA: 0000

Address: 8315 Highway 8

Kenmare, ND

Latitude: +48.641930

Longitude: -102.401800

Site Description: This site is located in a PSD Class I area. This site is downwind of two power plants near Estevan, SK, and located in the Souris River Airshed.

The site has an IMPROVE sampler operated by the US Fish and Wildlife Service. These data will be used with the other ambient data collected here to evaluate long-range transport of aerosols affecting regional haze/visibility.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	Regional Transport	Regional
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	Regional Transport	Regional
Ozone	Instrumental Ultraviolet	Continuous	Regional Transport	Regional
Ozone	Instrumental Chemiluminescence	Continuous	Regional Transport	Regional
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Regional Transport	Regional
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	Regional Transport	Regional

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Delta Temperature	Elec. or Mach Avg.	Continuous	10 - 2 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban
Solar Radiation	Pyranometer	Continuous	2 meters	Urban
Relative Humidity	Hygroscopic Plastic Film	Continuous	10 meters	Urban

There are no plans to move or remove this site.

Site Pictures: **Lostwood NWR**



North



South



East



West

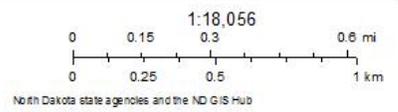


Looking Northwest



Looking North

Lostwood NWR



Site Name: Painted Canyon (TRNP – SU)

Station Type: SLAMS

AQS#: 38-007-0002

MSA: 0000

Address: Theodore Roosevelt National Park – South Unit
13881 I94 East

Latitude: +46.894300

Longitude: -103.378530

Site Description: Located in the South Unit of Theodore Roosevelt National Park, this Class I area site is operated in partnership with the National Park Service. As it is positioned south of the majority of oil and gas activity in the state, this station plays a key role in monitoring general background conditions and providing data for dispersion modeling input, calibration and validation.

The site has an IMPROVE sampler operated by the National Park Service. These data will be used with the other ambient data collected here to evaluate long-range transport of aerosols affecting regional haze/visibility.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	General/Background	Urban
Ozone	Instrumental Ultraviolet	Continuous	General/Background	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	General/Background	Urban
PM _{2.5}	24-hour Gravimetric	1/6	General/Background	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
*	*	*	*	*

* All meteorological parameters are monitored as part of the NPS network.

There are no plans to move or remove this site.

Site Pictures: **Painted Canyon**



North



East



South

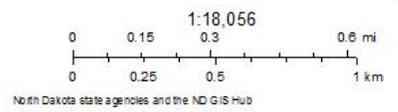


West



Looking Southwest

Painted Canyon



Site Name: TRNP-NU

Station Type: SLAMS (required)

AQS#: 38-053-0002

MSA: 0000

Address: 229 Service Road

Watford City, ND

Latitude: +47.581200

Longitude: -103.299500

Site Description: This site is located in Theodore Roosevelt National Park – North Unit and is one of three key sites in the Department’s ambient monitoring network to meet the six required monitoring objectives. The data collected are used for model calibration/validation.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous	General/Background	Regional
Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous	General/Background	Regional
Ozone	Instrumental Ultraviolet	Continuous	General/Background	Regional
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	General/Background Regional Transport	Regional
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	General/Background Regional Transport	Regional

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban
Relative Humidity	Hygroscopic Plastic Film	Continuous	10 meters	Urban

There are no plans to move or remove this site.

Site Pictures: **TRNP-NU**



North



South



East



West

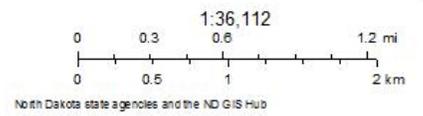
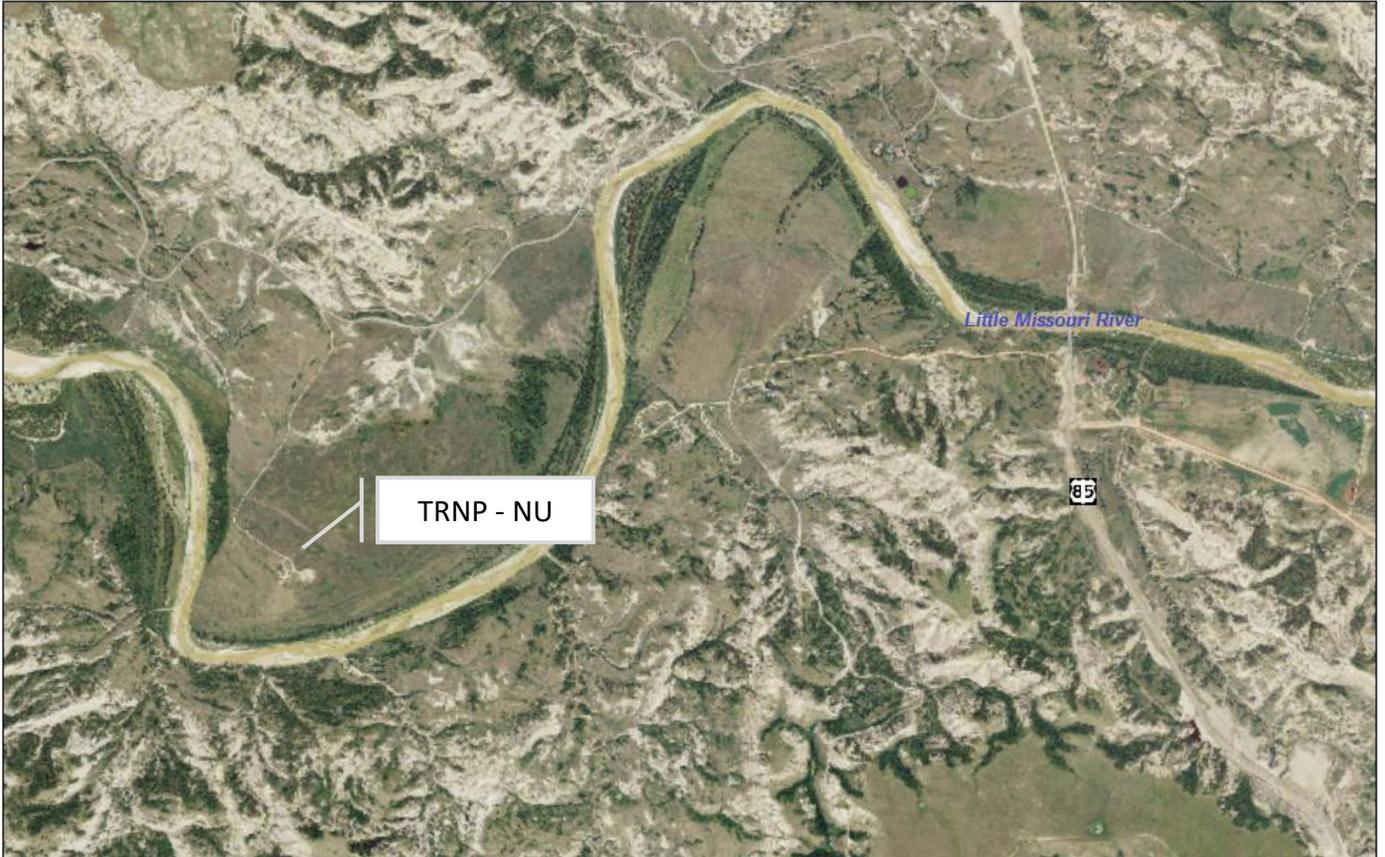


Looking Northwest



Looking Northeast

Theodore Roosevelt National Park - North Unit



Site Name: Williston

Station Type: SLAMS

AQS#: 38-105-0003

MSA: 0000

Address: 10th Street West

Williston, ND

Latitude: +48.152780

Longitude: -103.639510

Site Description: This site is located in the Williston Riverview Cemetery in downtown Williston. It is in the heart of the oil and gas development activity area and serves to meet the objective of monitoring population exposure to particulate matter and ozone.

Gas/Particulate parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Monitoring Objective	Spatial Scale
Ozone	Instrumental Ultraviolet	Continuous	Population Exposure	Urban
PM _{2.5}	FEM PM _{2.5} BAM	Continuous	Population Exposure	Urban
PM ₁₀	PM ₁₀ TEOM Gravimetric 50° Celsius	Continuous	Population Exposure	Urban

Meteorological parameters:

Parameter	Sampling & Analysis Method	Operating Schedule	Tower Height	Spatial Scale
Wind Speed	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Wind Direction	Elec. or Mach Avg. Level 1	Continuous	10 meters	Urban
Ambient Temperature	Elec. or Mach Avg.	Continuous	10 meters	Urban
Ambient Pressure	Barometric Pressure Transducer	Continuous	6 meters	Urban

There are no plans to move or remove this site.

Site Pictures: Williston



North



South



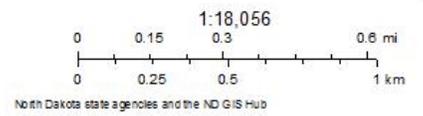
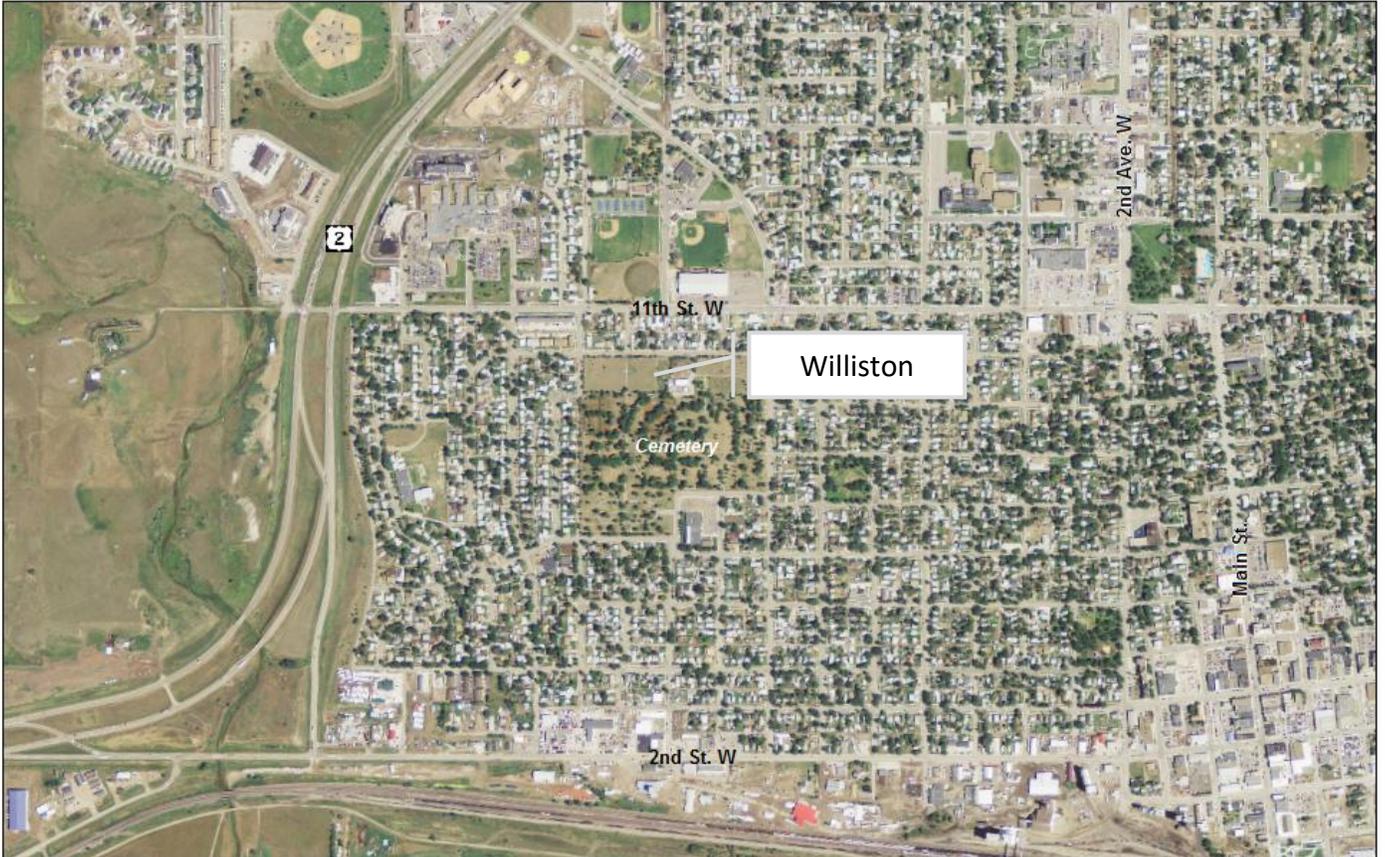
East



West



Williston



DRAFT

The figures in this appendix are organized with the site's wind rose presented at top, criteria pollutant roses follow in alphabetical order, and conclude with non-criteria (e.g. NH₃) monitored pollutant roses.

The pollution roses show the percentage of time a pollutant is detected when the wind is from a given direction and provide a total summary of detected concentrations in the legend.

DRAFT

Site Name: Beulah – North

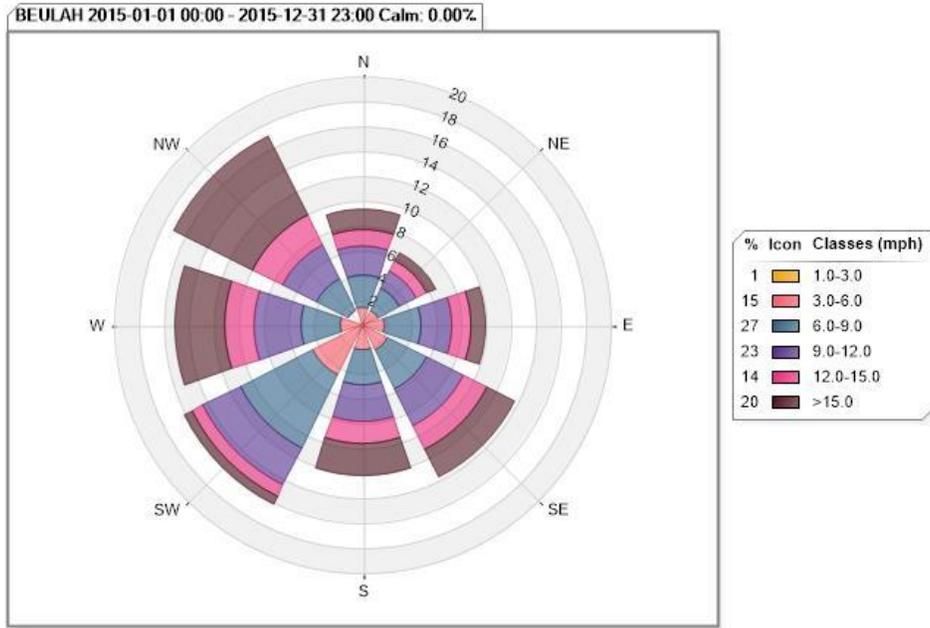


Figure 26. Beulah Wind Rose for 2015

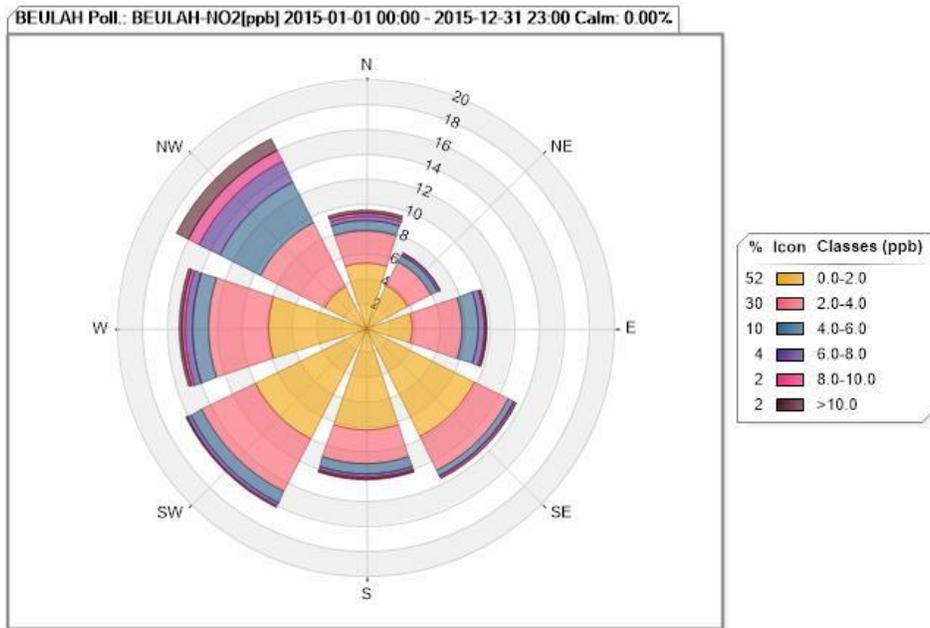


Figure 27. Beulah NO₂ Pollution Rose for 2015

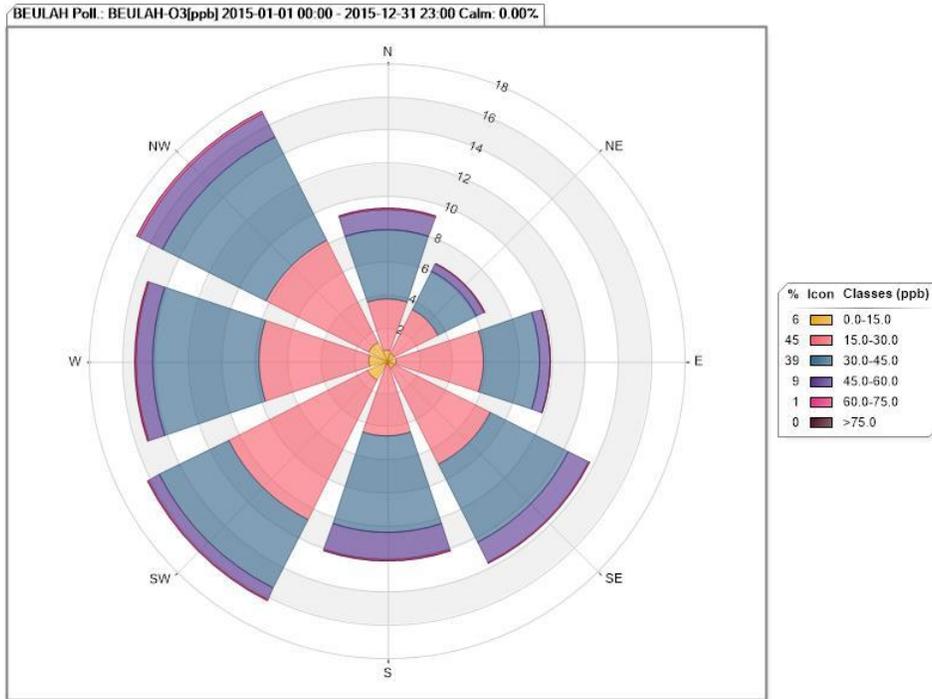


Figure 28. Beulah O₃ Pollution Rose for 2015

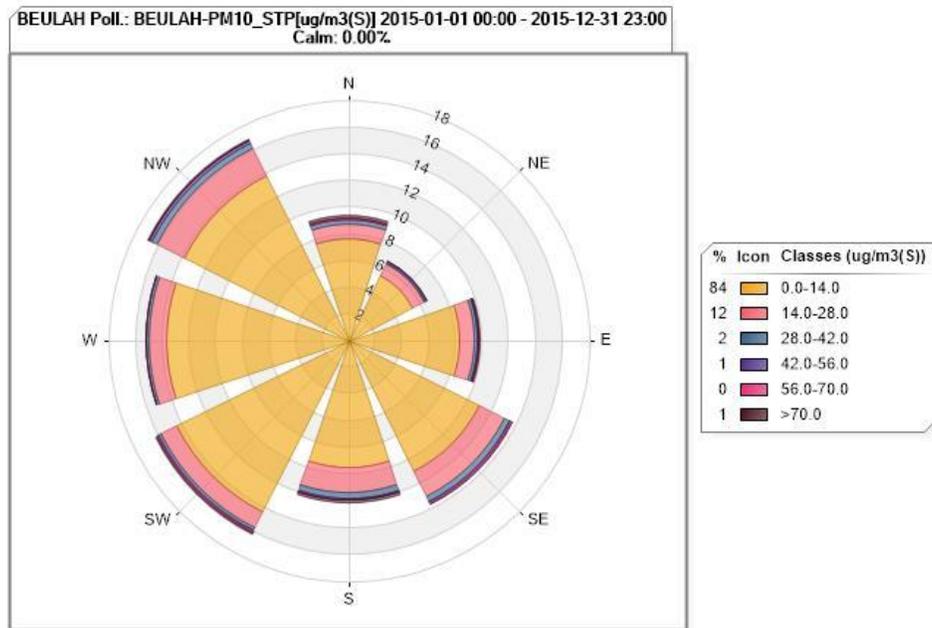


Figure 29. Beulah PM₁₀ Pollution Rose for 2015

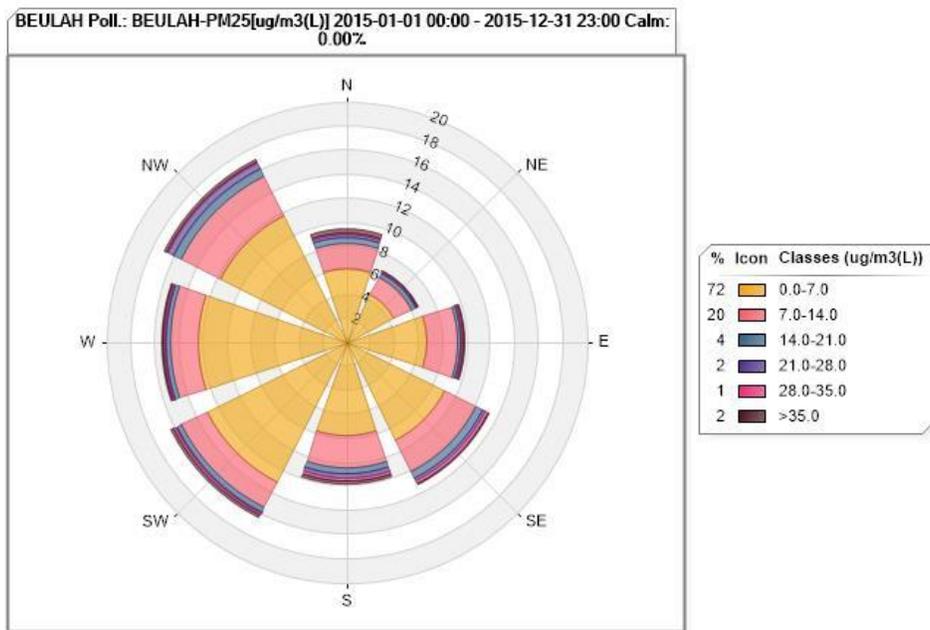


Figure 30. Beulah PM_{2.5} Pollution Rose for 2015

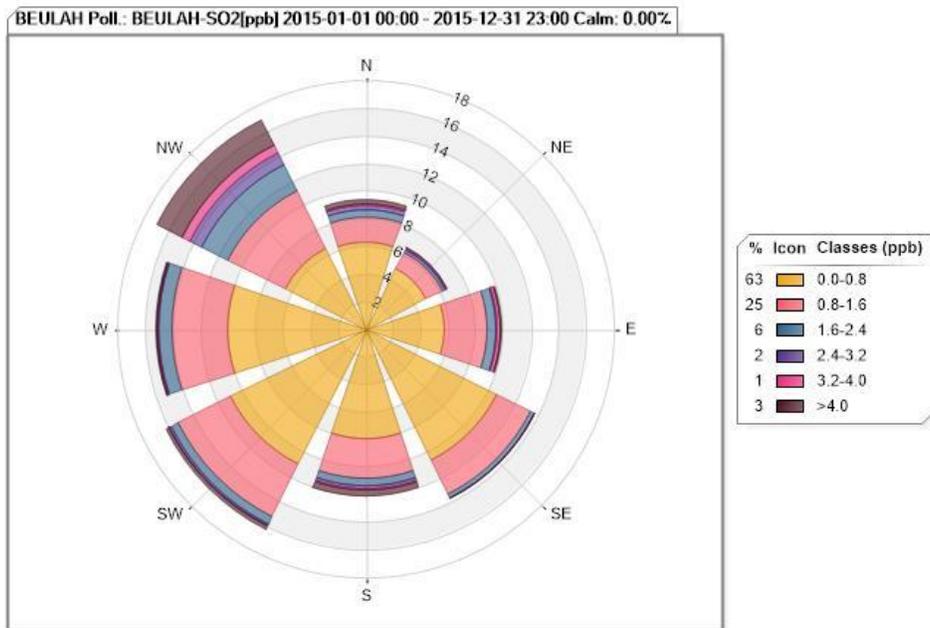


Figure 31. Beulah SO₂ Pollution Rose for 2015

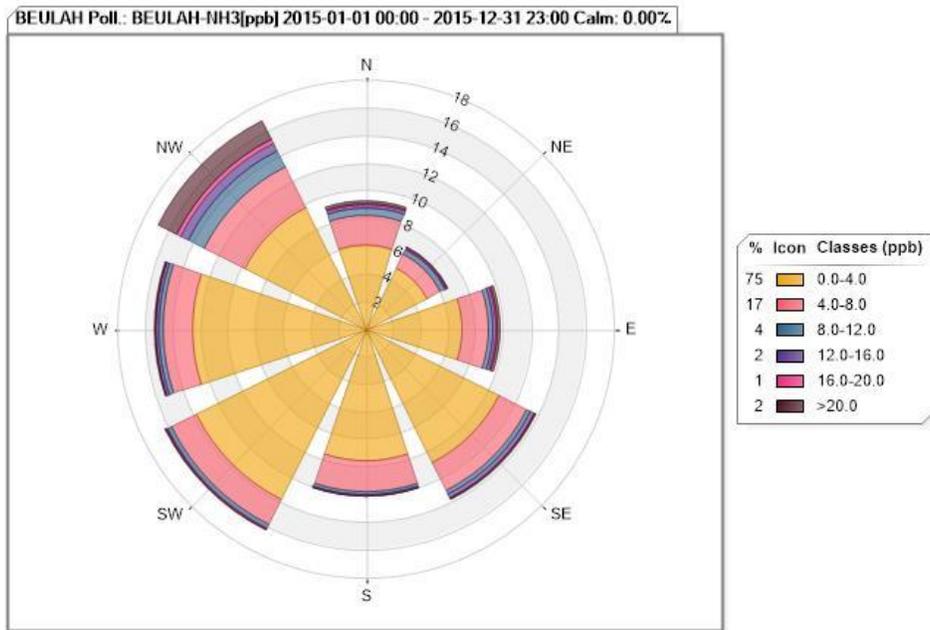


Figure 32. Beulah NH₃ Pollution Rose for 2015

DRAFT

Site Name: Bismarck Residential

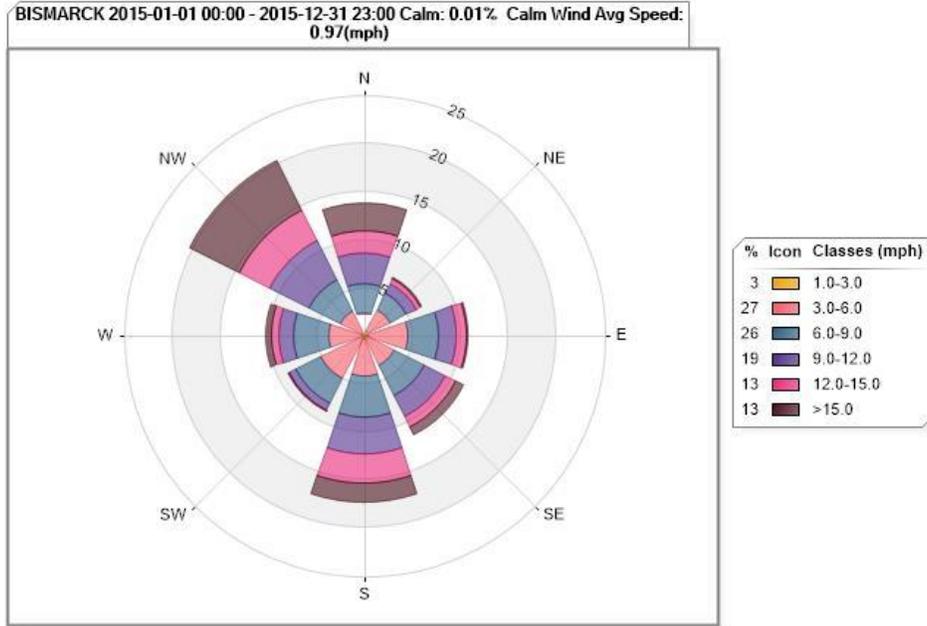


Figure 33. Bismarck Wind Rose for 2015

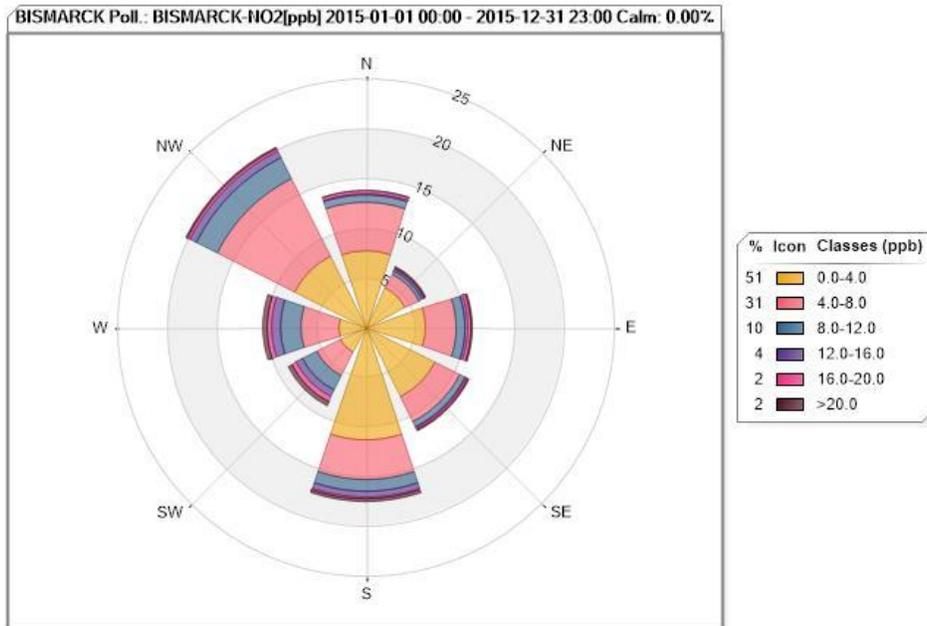


Figure 34. Bismarck NO₂ Pollution Rose for 2015

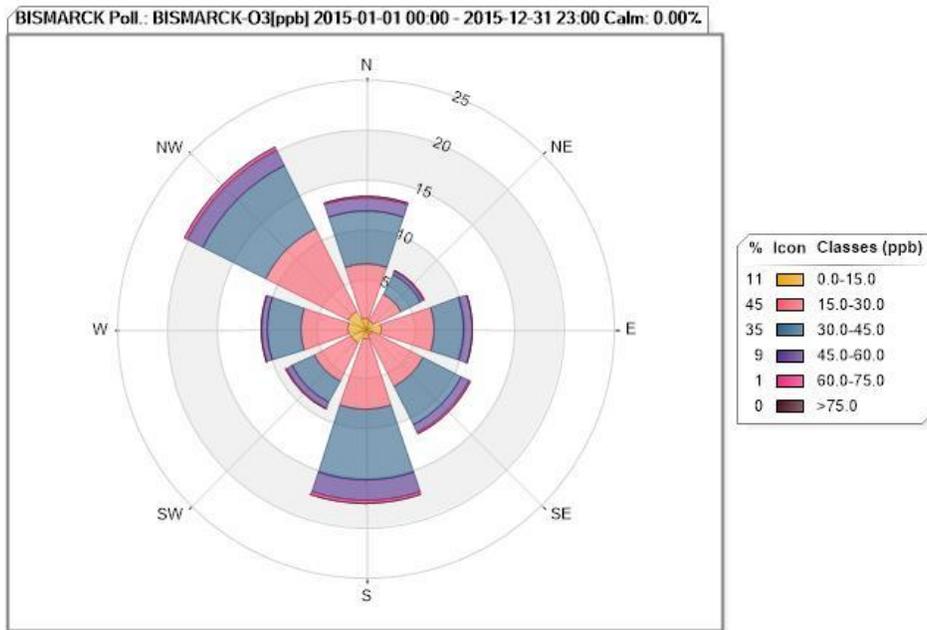


Figure 35. Bismarck O₃ Pollution Rose for 2015

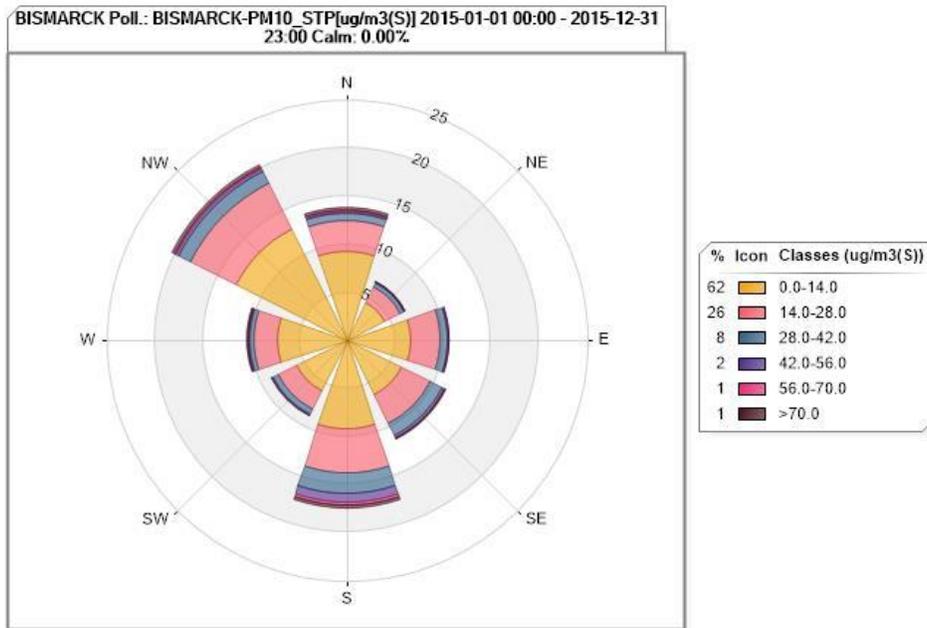


Figure 36. Bismarck PM₁₀ Pollution Rose for 2015

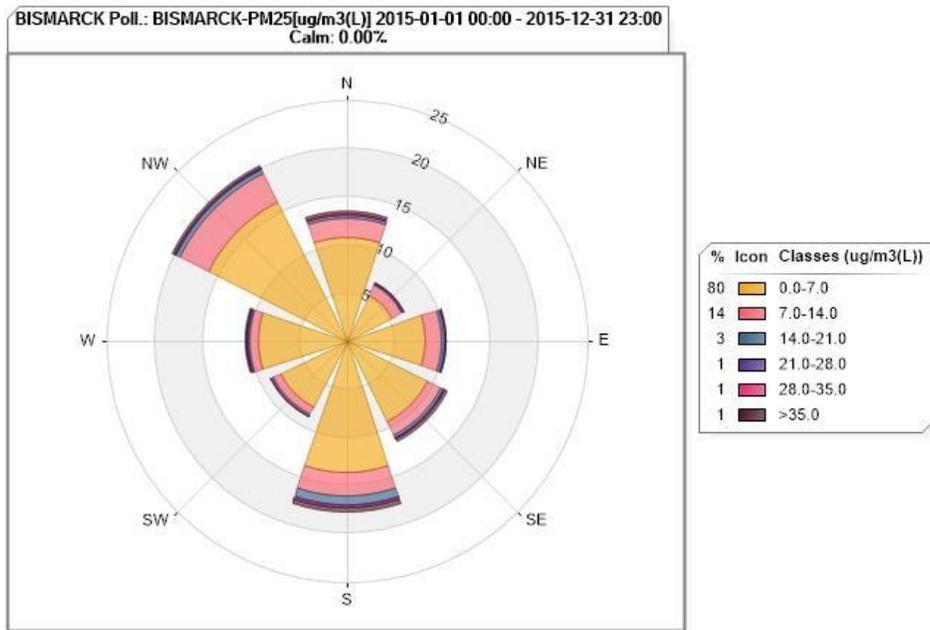


Figure 37. Bismarck PM_{2.5} Pollution Rose for 2015

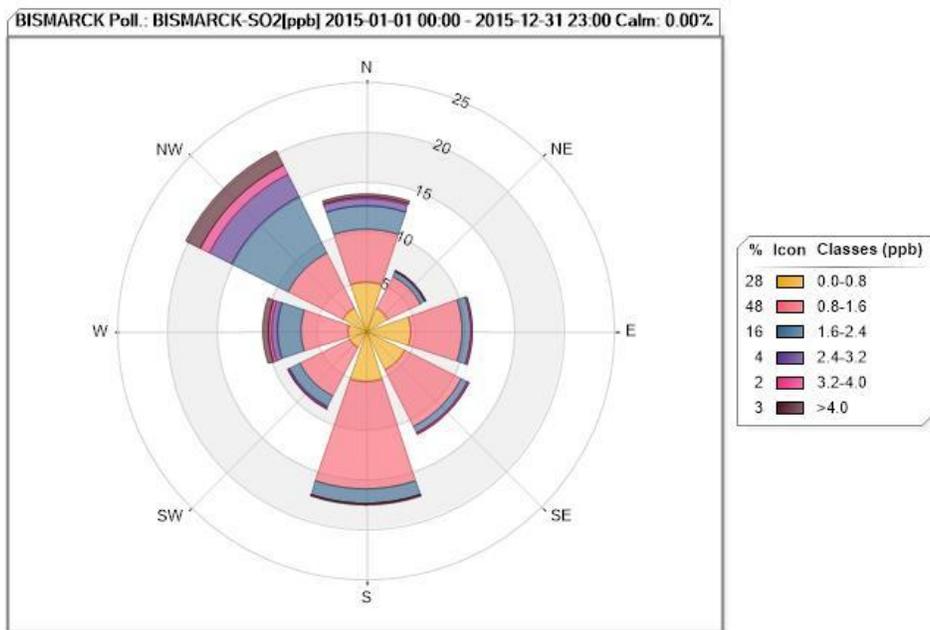


Figure 38. Bismarck SO₂ Pollution Rose for 2015

Site Name: Dunn Center

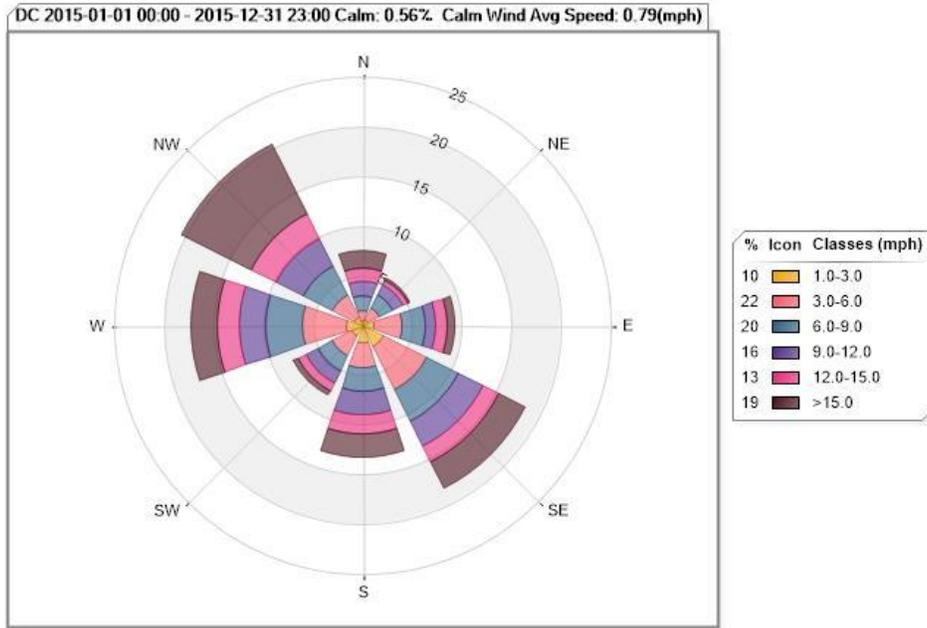


Figure 39. Dunn Center Wind Rose for 2015

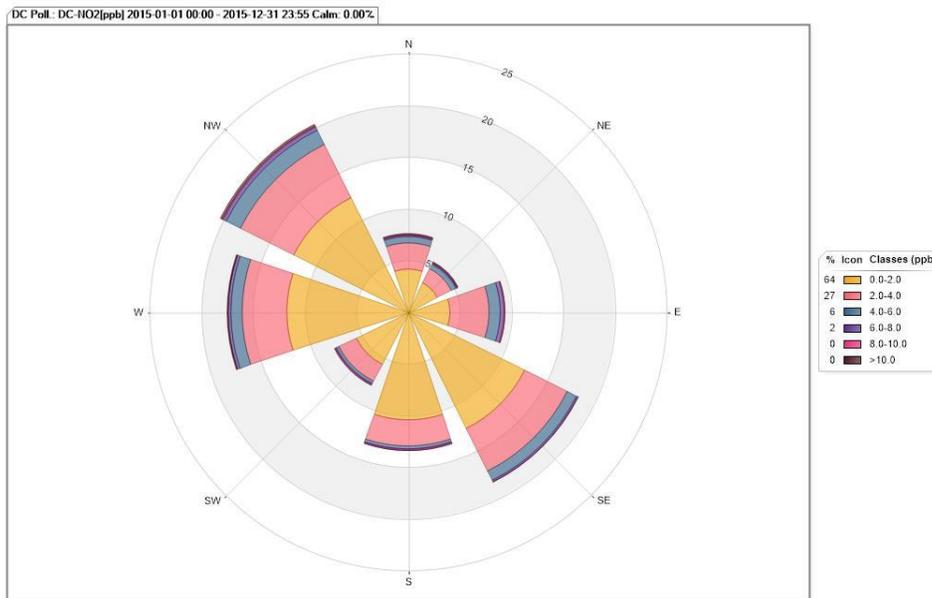


Figure 40. Dunn Center NO₂ Pollution Rose for 2015

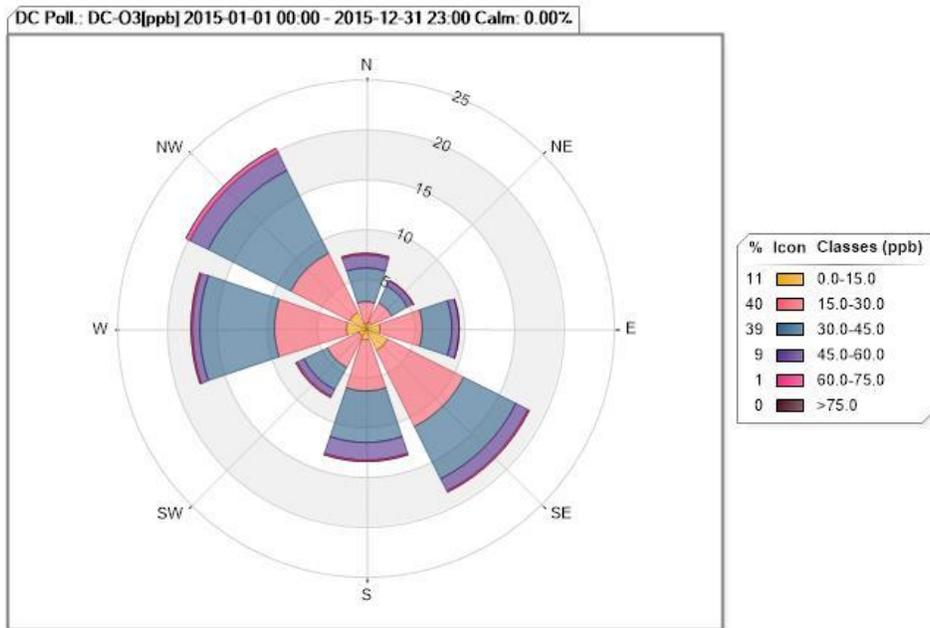


Figure 41. Dunn Center O₃ Pollution Rose for 2015

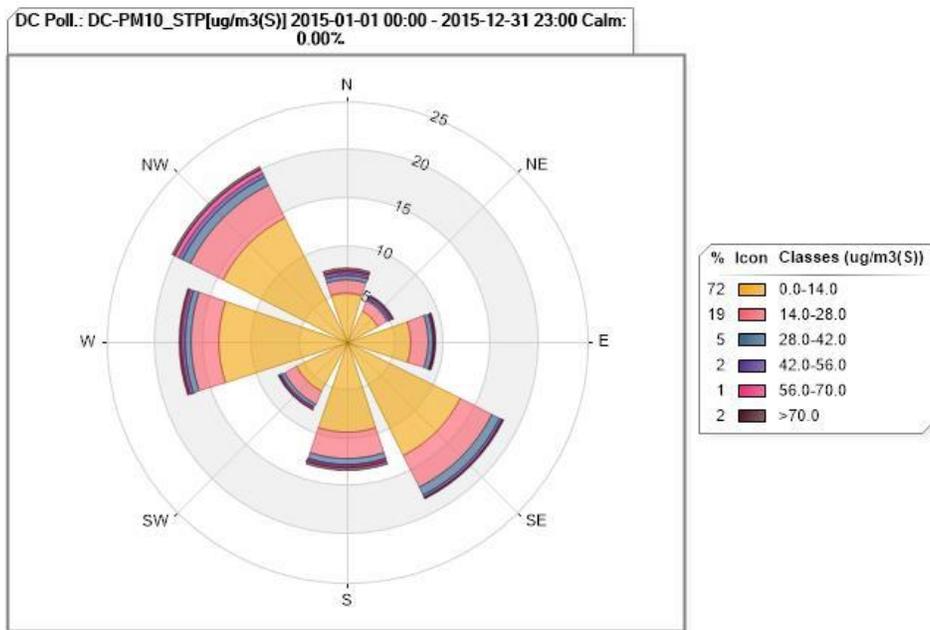


Figure 42. Dunn Center PM₁₀ Pollution Rose for 2015

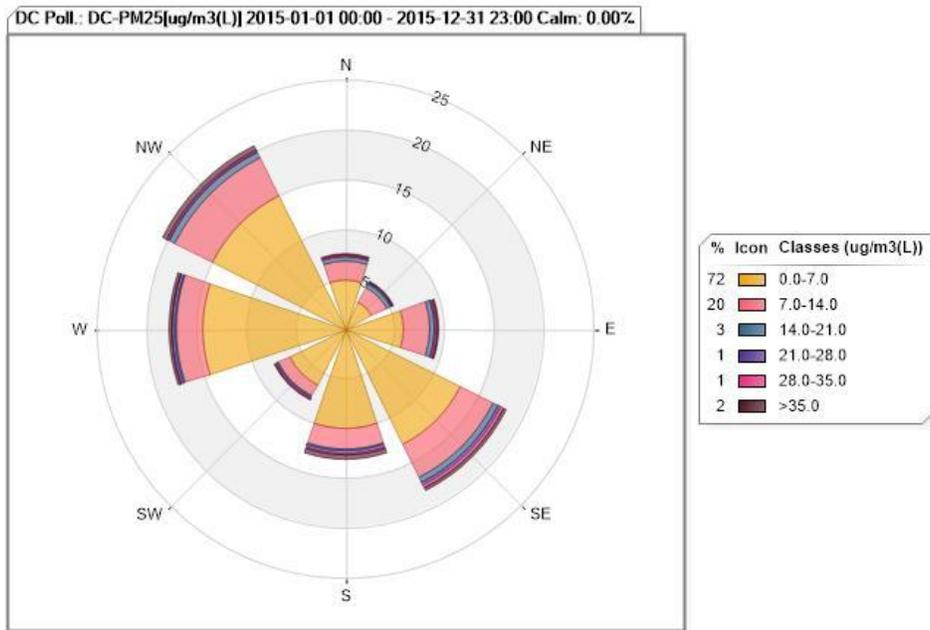


Figure 43. Dunn Center PM_{2.5} Pollution Rose for 2015

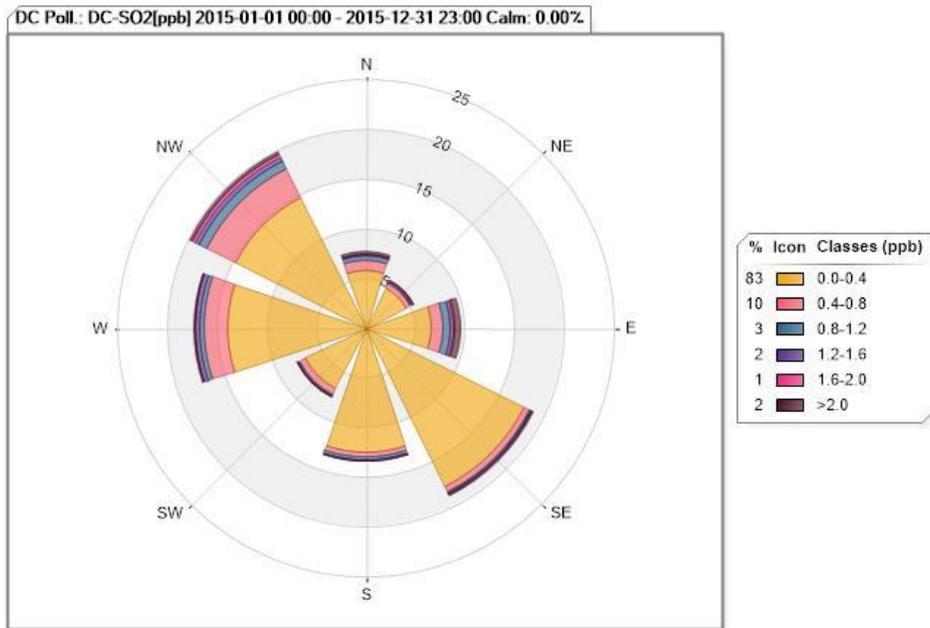


Figure 44. Dunn Center SO₂ Pollution Rose for 2015

Site Name: Fargo NW

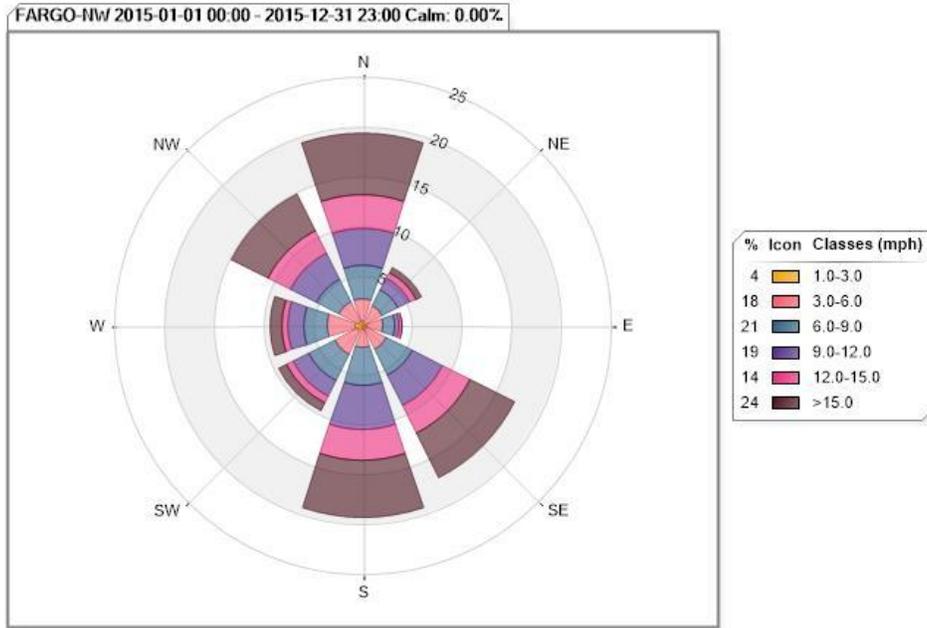


Figure 45. Fargo Wind Rose for 2015

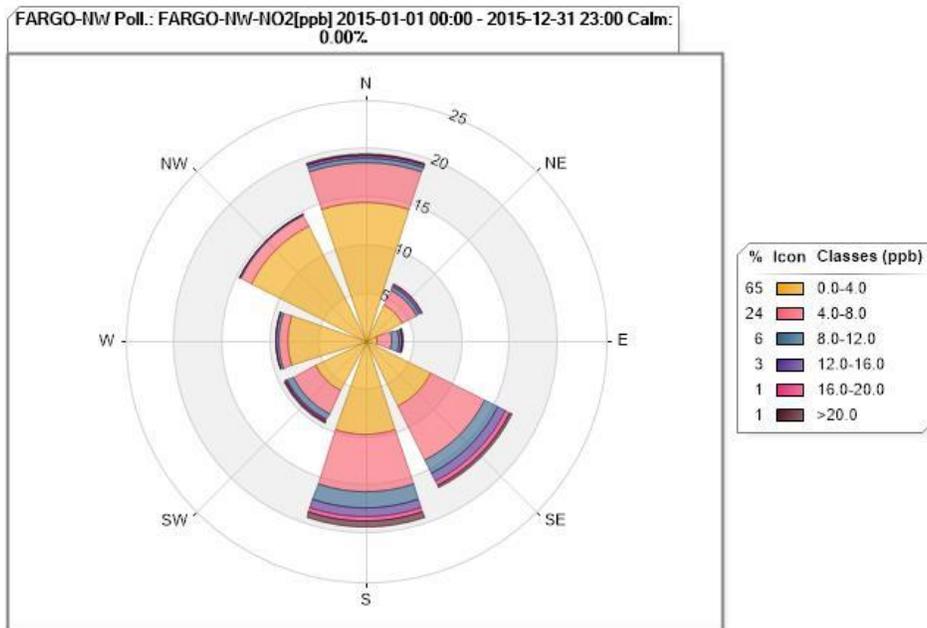


Figure 46. Fargo NO₂ Pollution Rose for 2015

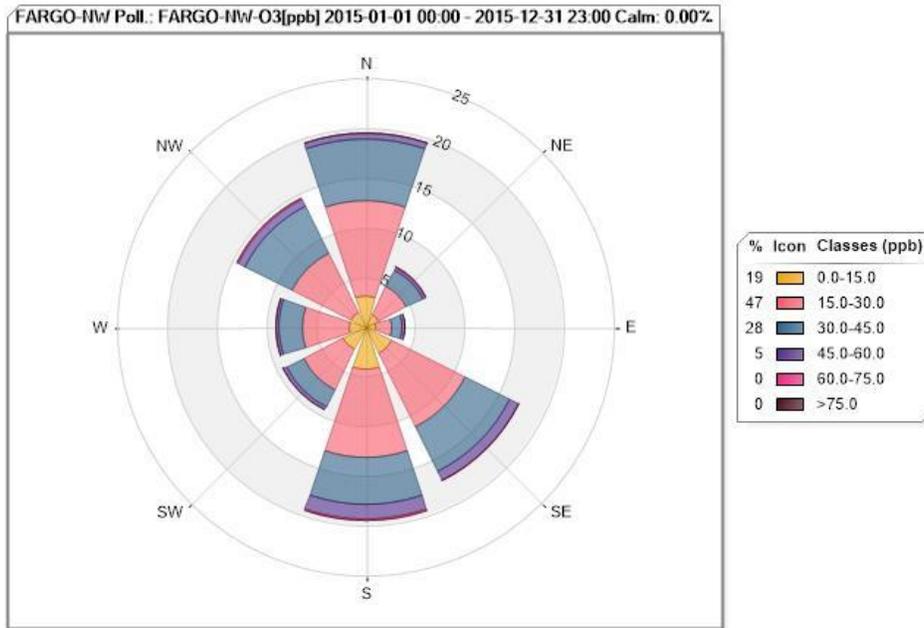


Figure 47. Fargo O₃ Pollution Rose for 2015

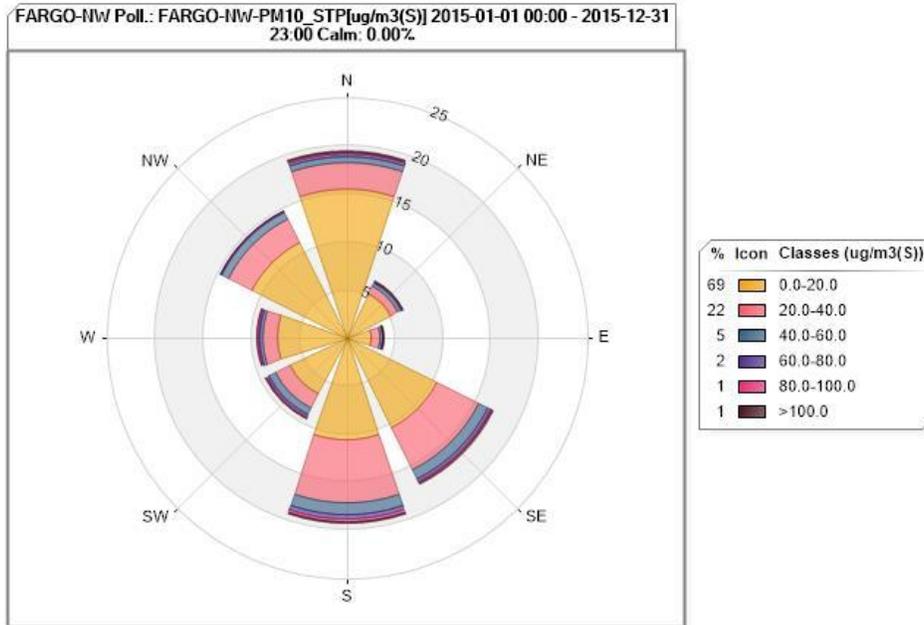


Figure 48. Fargo PM₁₀ Pollution Rose for 2015

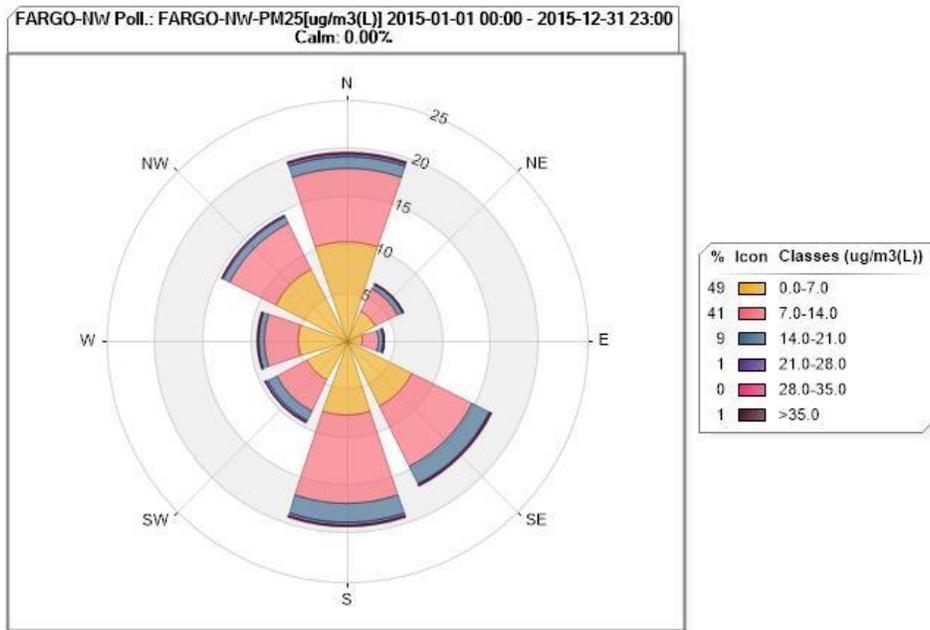


Figure 49. Fargo PM_{2.5} Pollution Rose for 2015

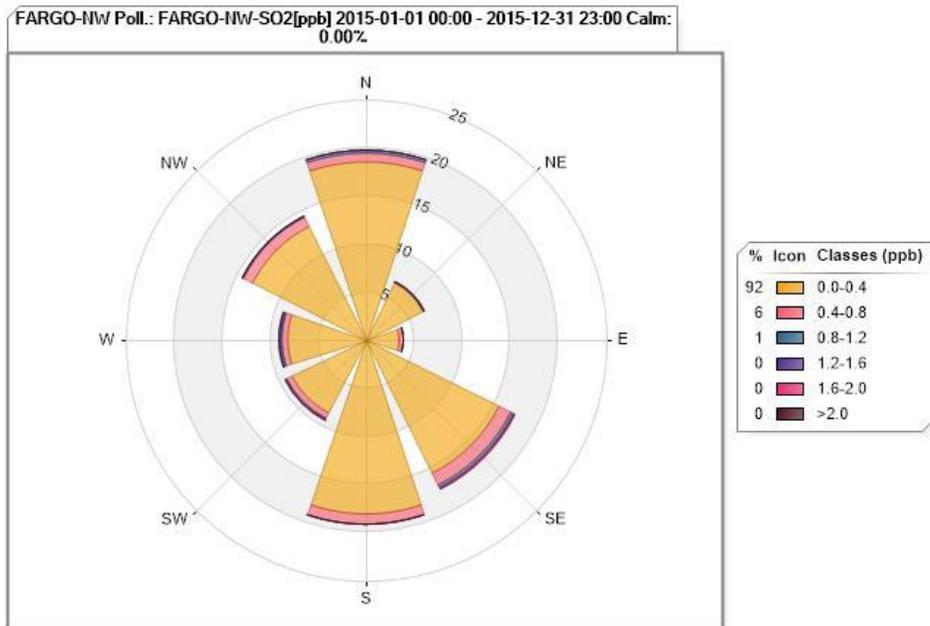


Figure 50. Fargo SO₂ Pollution Rose for 2015

Site Name: Hannover

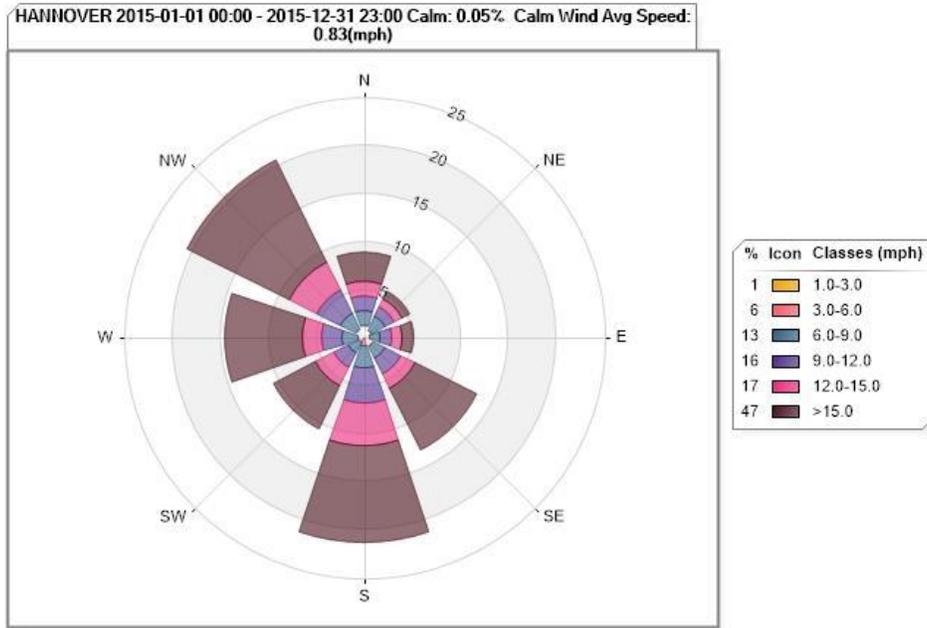


Figure 51. Hannover Wind Rose for 2015

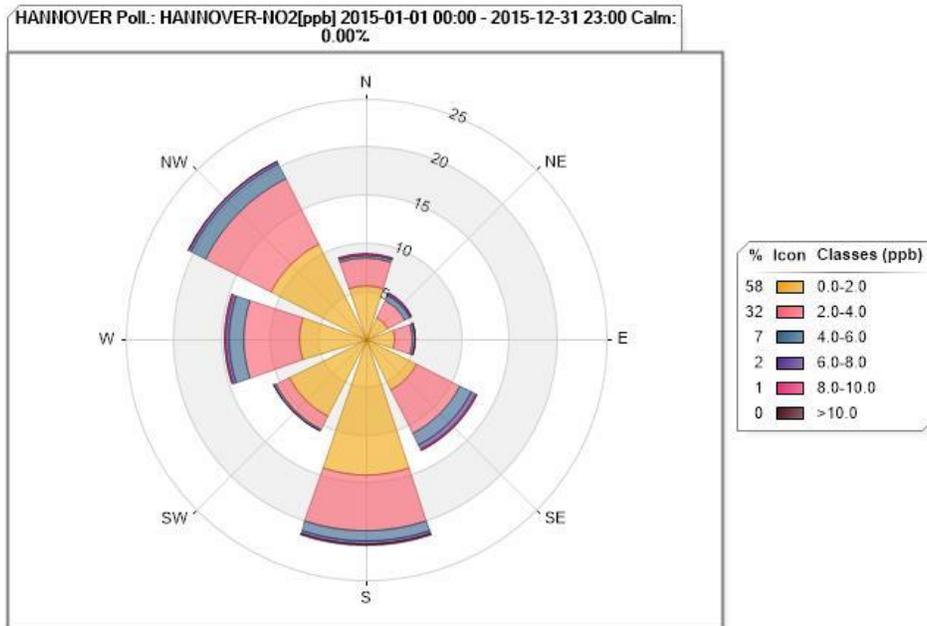


Figure 52. Hannover NO₂ Pollution Rose for 2015

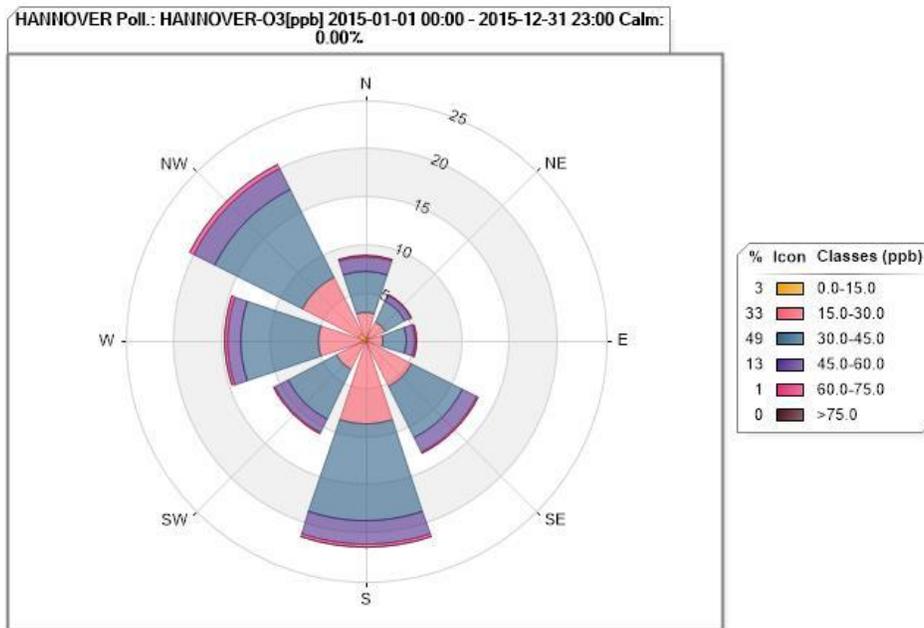


Figure 53. Hannover O₃ Pollution Rose for 2015

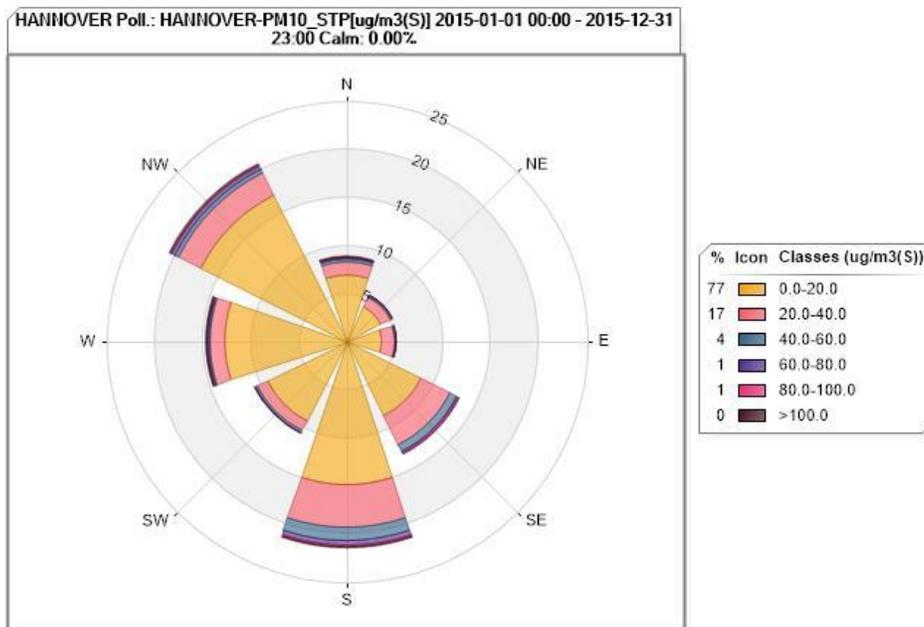


Figure 54. Hannover PM₁₀ Pollution Rose for 2015

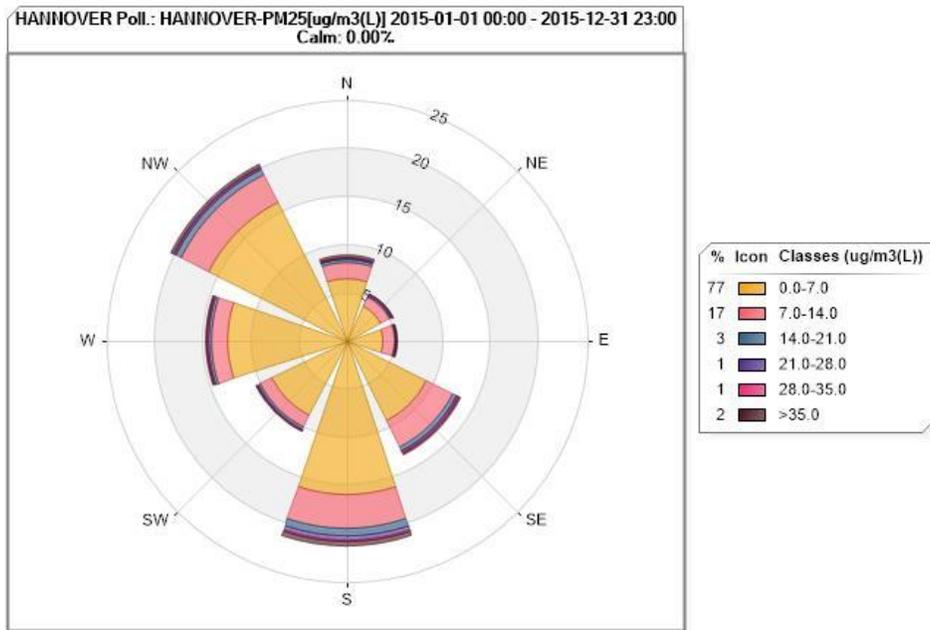


Figure 55. Hannover PM_{2.5} Pollution Rose for 2015

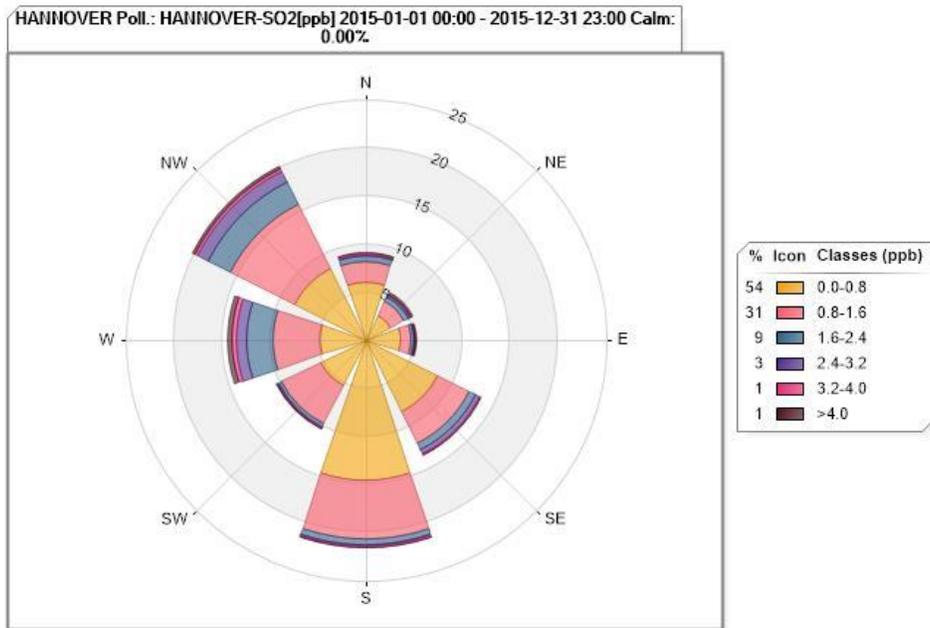


Figure 56. Hannover SO₂ Pollution Rose for 2015

Site Name: Lostwood NWR

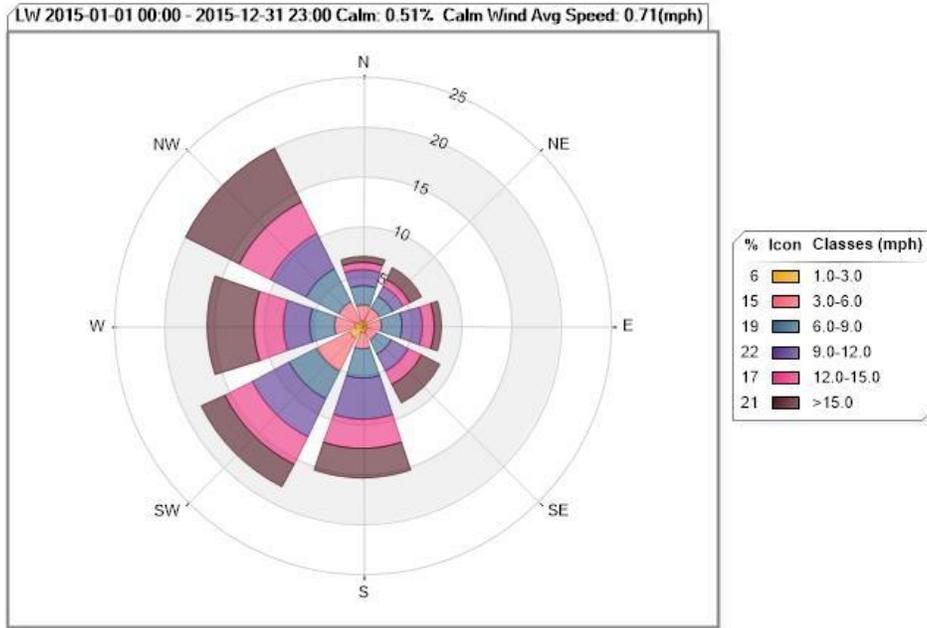


Figure 57. Lostwood Wind Rose for 2015

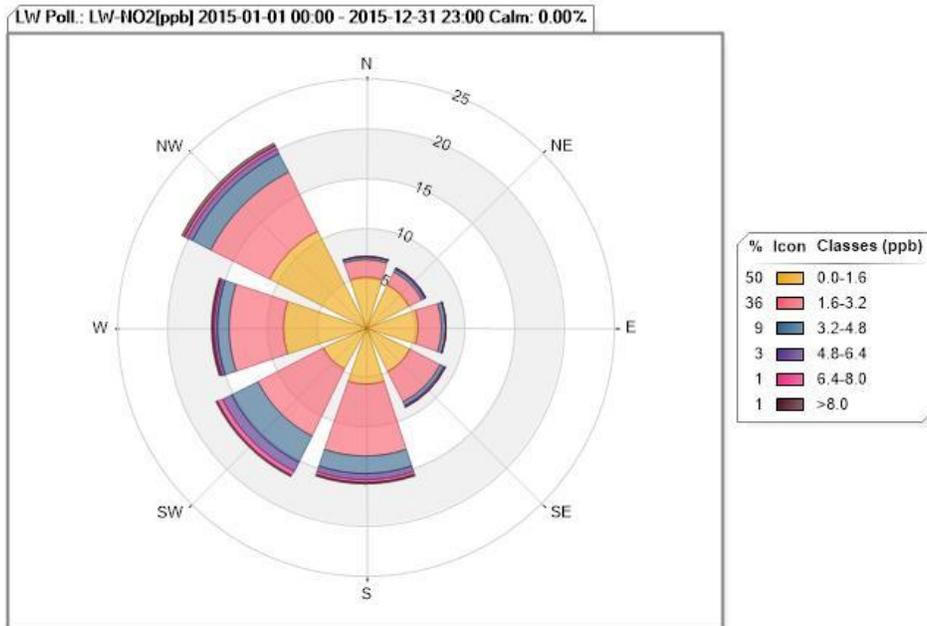


Figure 58. Lostwood NO₂ Pollution Rose for 2015

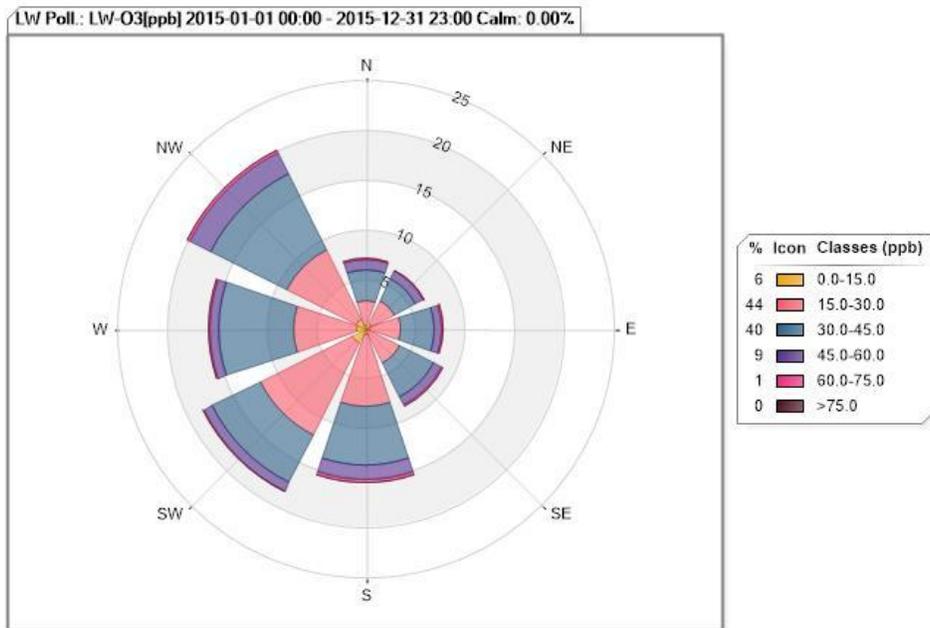


Figure 59. Lostwood O₃ Pollution Rose for 2015

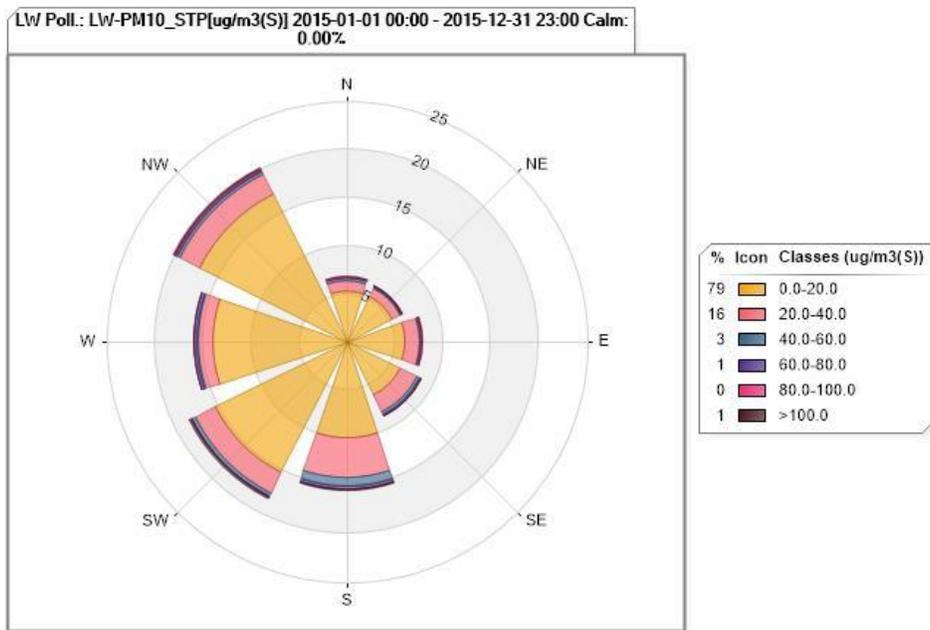


Figure 60. Lostwood PM₁₀ Pollution Rose for 2015

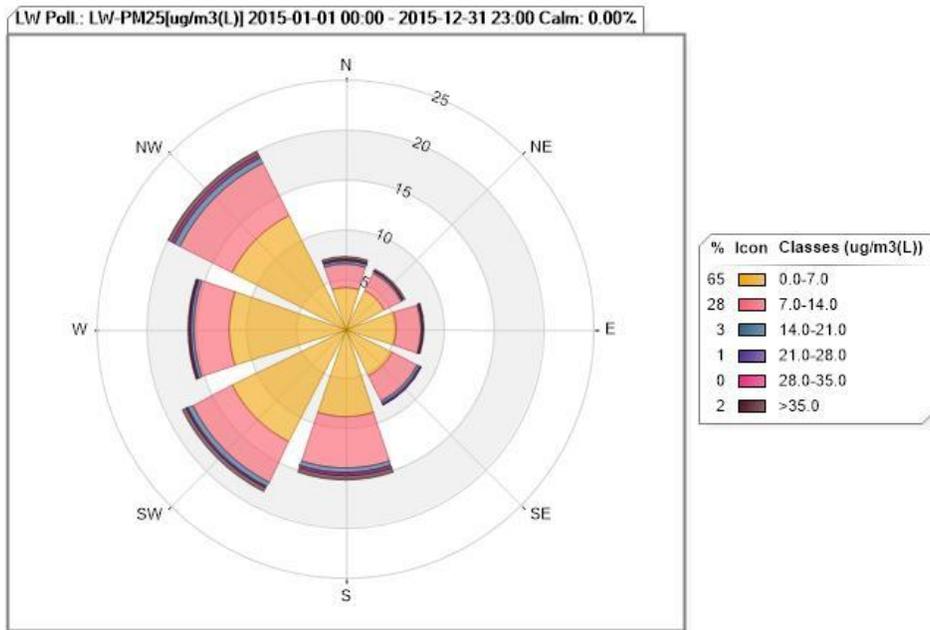


Figure 61. Lostwood PM_{2.5} Pollution Rose for 2015

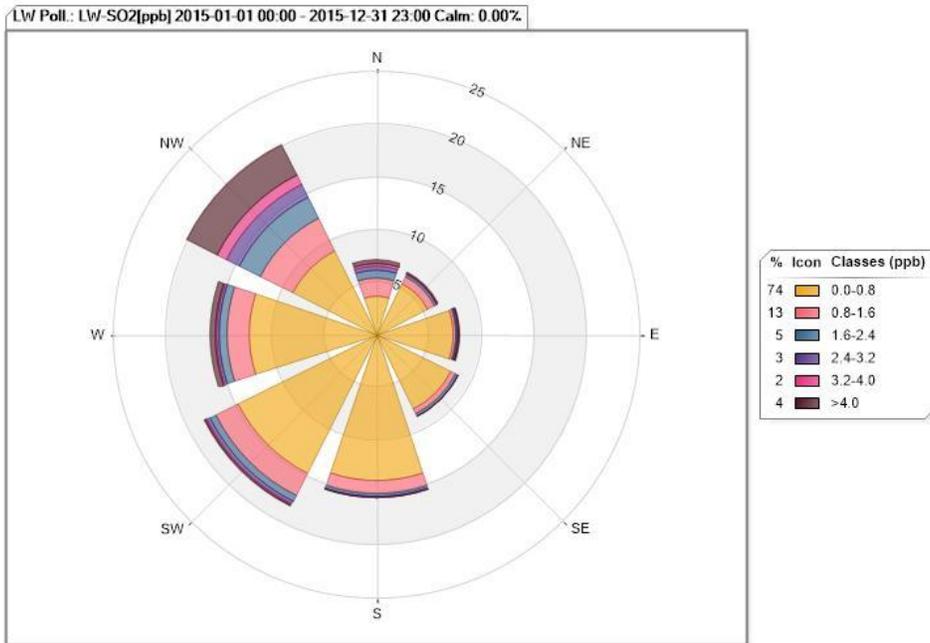


Figure 62. Lostwood SO₂ Pollution Rose for 2015

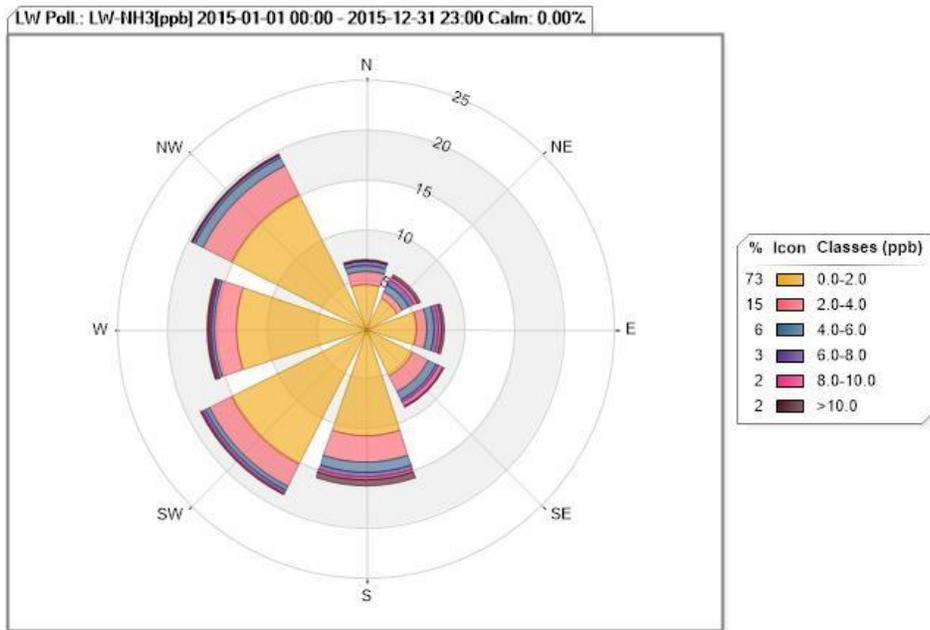
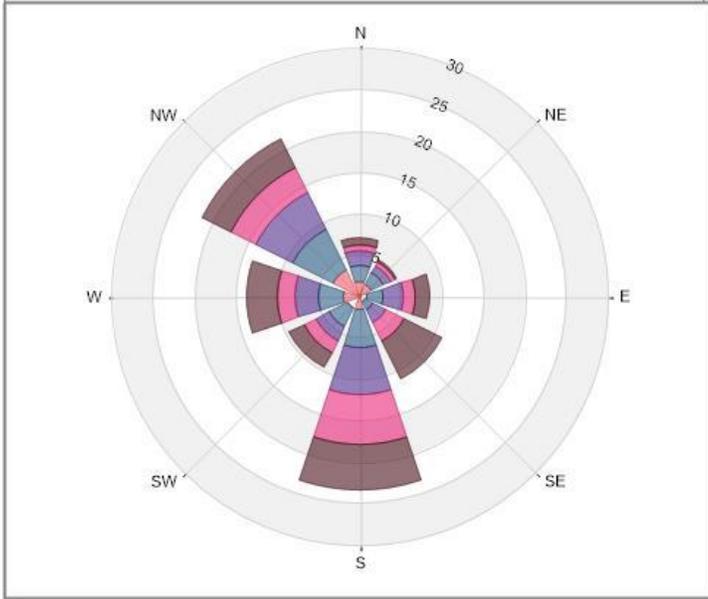


Figure 63. Lostwood NH₃ Pollution Rose for 2015

DRAFT

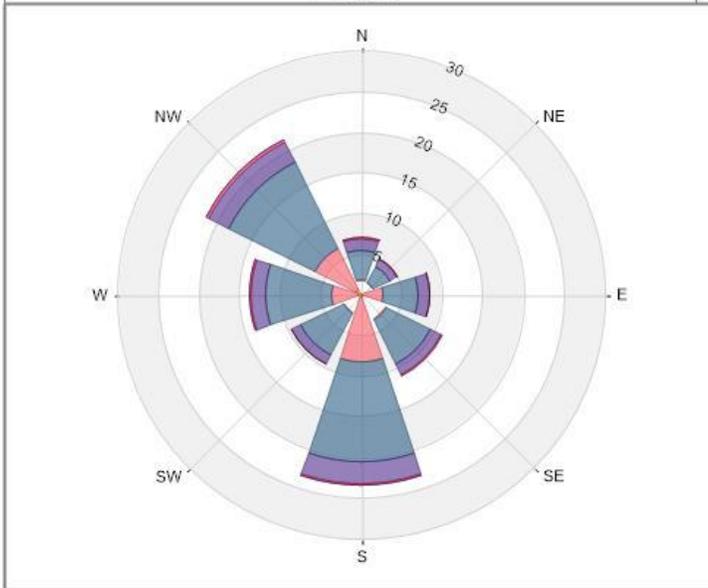
Site Name: Painted Canyon (TRNP - SU)

PC 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 0.31% Calm Wind Avg Speed: 0.63(mph)



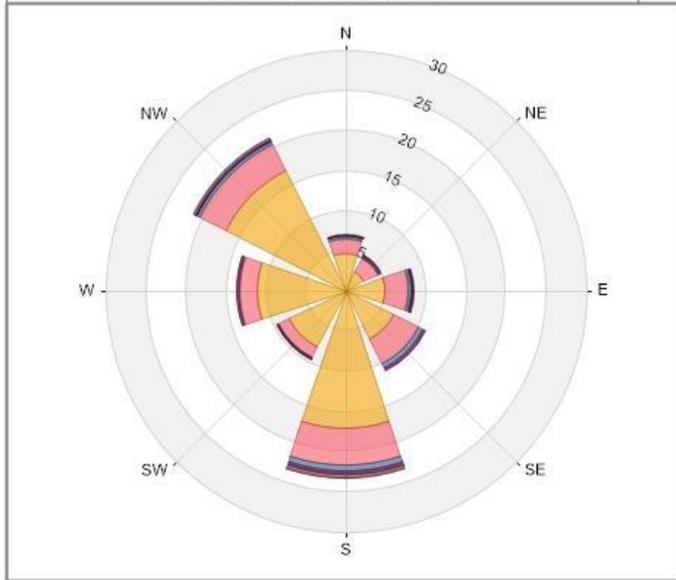
% Icon Classes (mph)	
2	1.0-3.0
12	3.0-6.0
22	6.0-9.0
22	9.0-12.0
18	12.0-15.0
23	>15.0

PC Poll.: PC-O3[ppb] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 0.10% Calm Poll Avg: 37.31[ppb]



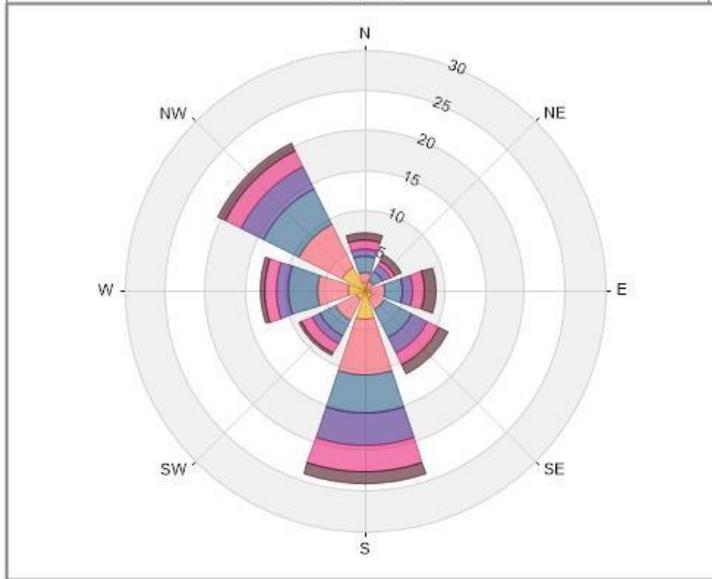
% Icon Classes (ppb)	
2	0.0-15.0
28	15.0-30.0
55	30.0-45.0
14	45.0-60.0
1	60.0-75.0
0	>75.0

PC Poll.: PC-PM25[ug/m3(L)] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 0.10%
 Calm Poll Avg: 6.49[ug/m3(L)]



% Icon	Classes (ug/m3(L))
72	0.0-7.0
22	7.0-14.0
3	14.0-21.0
1	21.0-28.0
1	28.0-35.0
2	>35.0

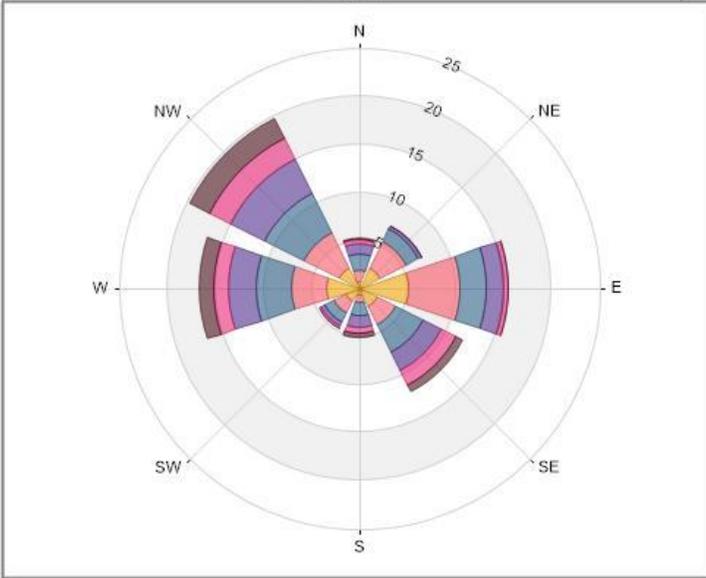
PC Poll.: PC-SO2[ppb] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 0.11% Calm Poll Avg: 0.78[ppb]



% Icon	Classes (ppb)
13	0.0-0.4
26	0.4-0.8
24	0.8-1.2
15	1.2-1.6
14	1.6-2.0
8	>2.0

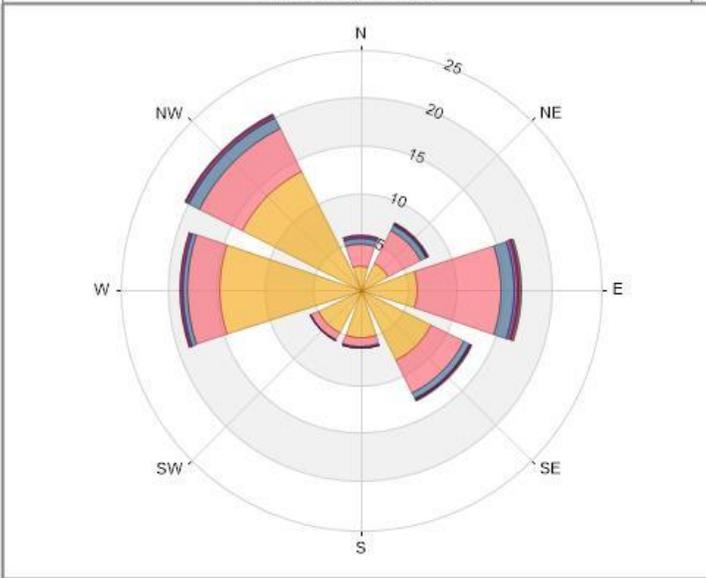
Site Name: TRNP-NU

TRNP-NU 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 13.47% Calm Wind Avg Speed: 0.57(mph)



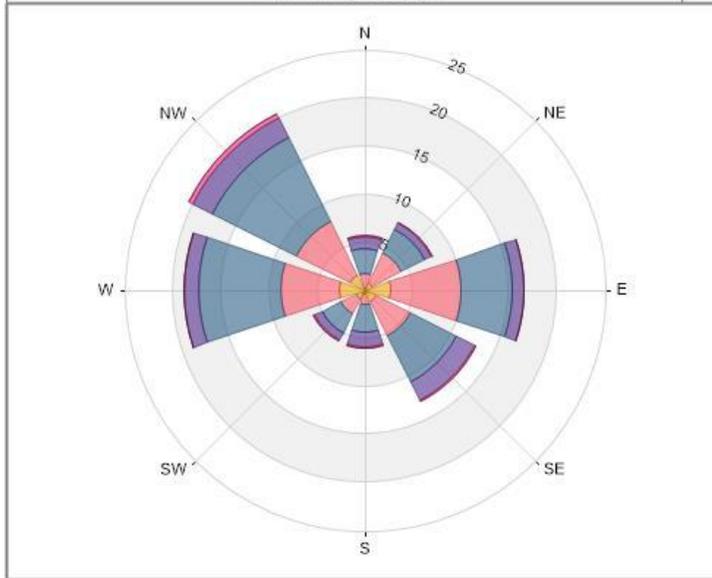
% Icon Classes (mph)	
18	1.0-3.0
22	3.0-6.0
20	6.0-9.0
14	9.0-12.0
8	12.0-15.0
5	>15.0

TRNP-NU Poll.: TRNP-NU-NO2[ppb] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 5.37% Calm Poll Avg. 1.68[ppb]

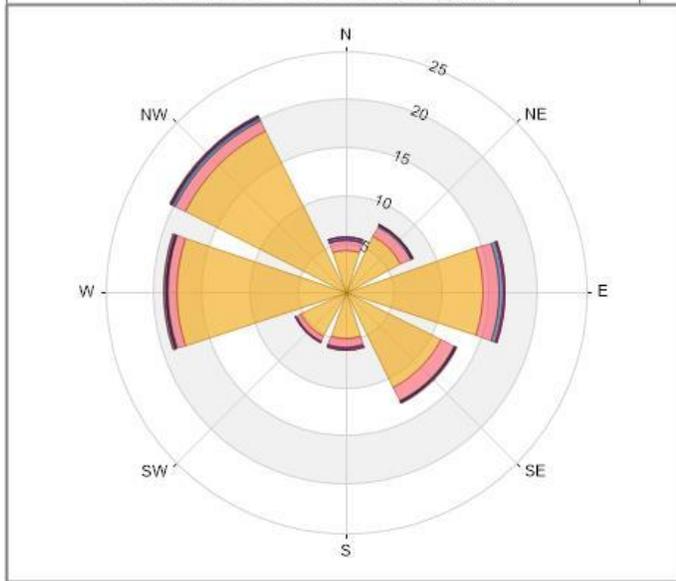


% Icon Classes (ppb)	
58	0.0-1.6
29	1.6-3.2
5	3.2-4.8
1	4.8-6.4
1	6.4-8.0
1	>8.0

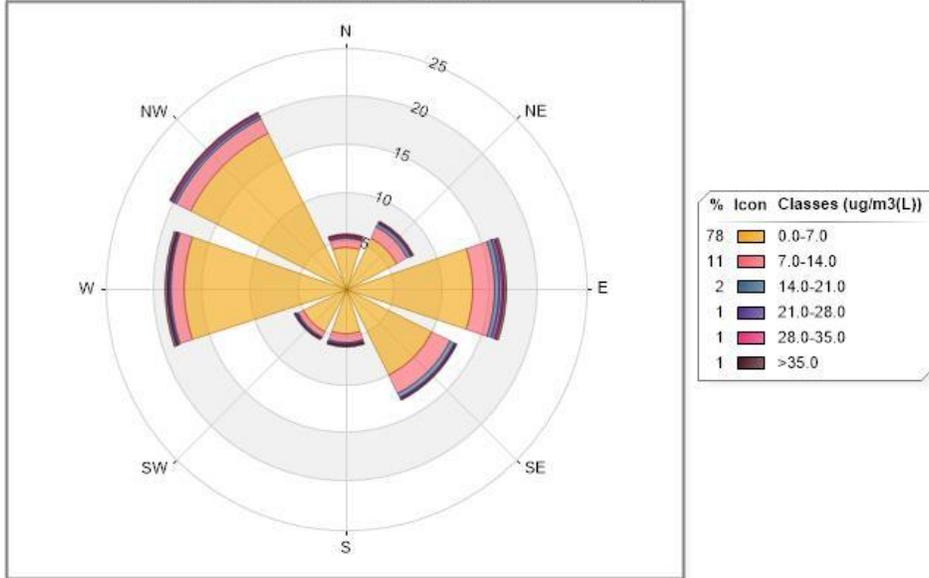
TRNP-NU Poll.: TRNP-NU-O3[ppb] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 5.37%
Calm Poll Avg: 14.88[ppb]



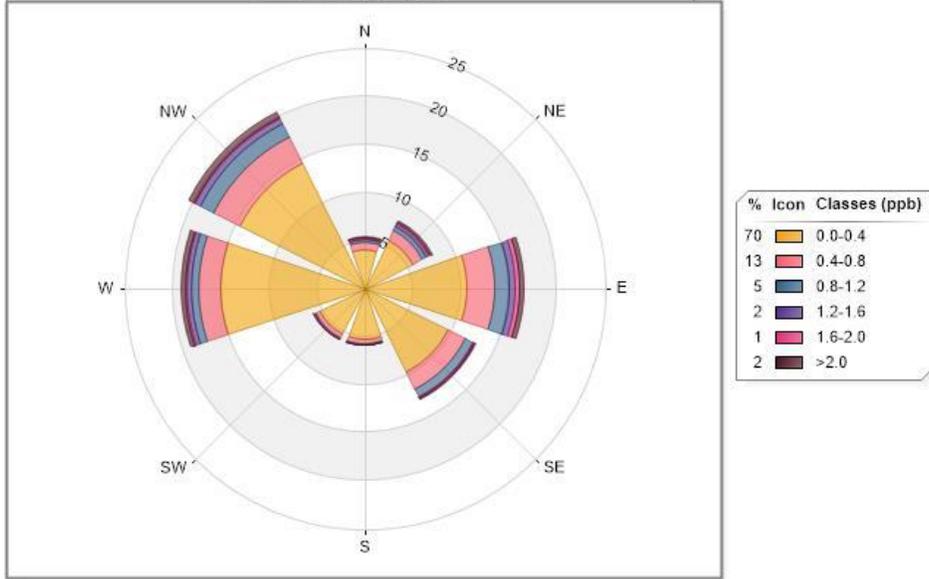
TRNP-NU Poll.: TRNP-NU-PM10_STP[ug/m3(S)] 2015-01-01 00:00 - 2015-12-31
23:00 Calm: 5.38% Calm Poll Avg: 6.55[ug/m3(S)]



TRNP-NU Poll.: TRNP-NU-PM25[ug/m3(L)] 2015-01-01 00:00 - 2015-12-31 23:00
 Calm: 5.38% Calm Poll Avg: 2.53[ug/m3(L)]

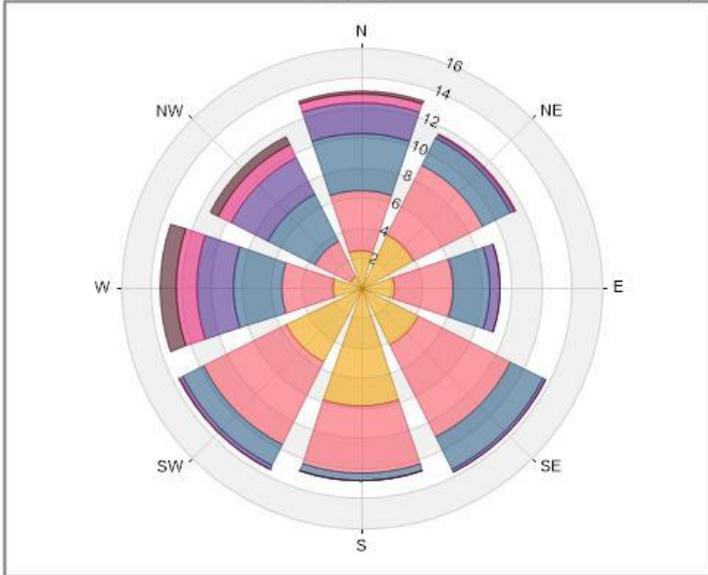


TRNP-NU Poll.: TRNP-NU-SO2[ppb] 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 5.36%
 Calm Poll Avg: 0.19[ppb]



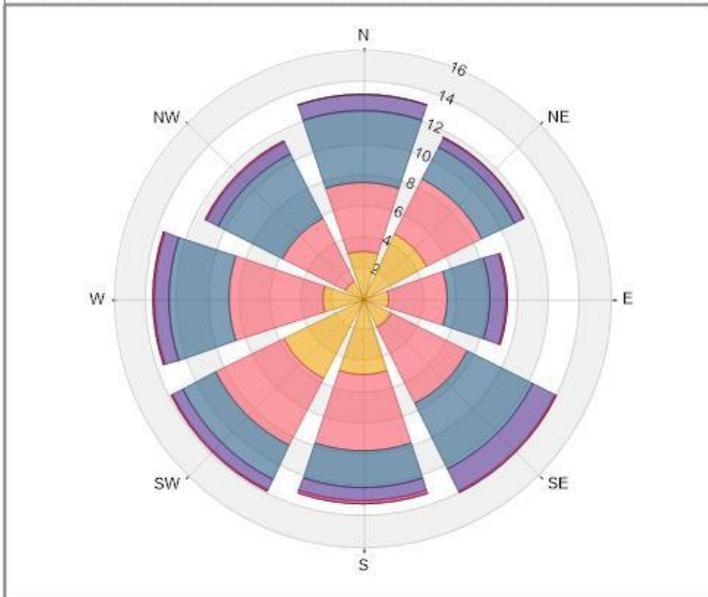
Site Name: Williston

WILLISTON 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 1.12% Calm Wind Avg Speed: 0.86(mph)



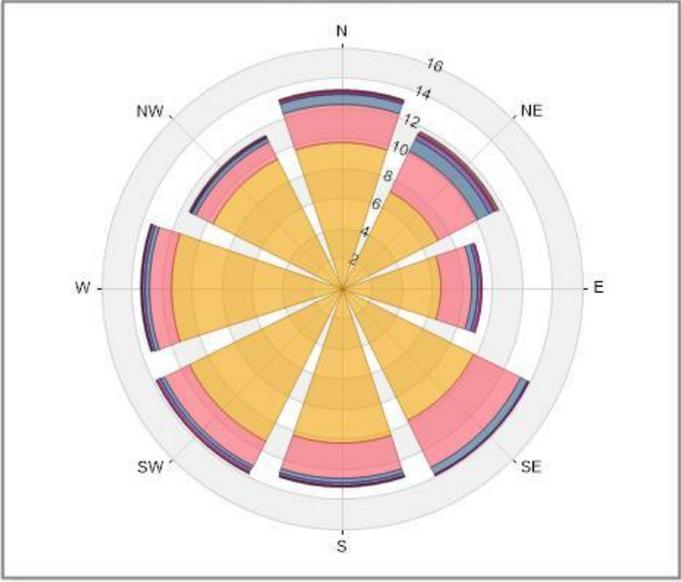
% Icon	Classes (mph)
29	1.0-3.0
37	3.0-6.0
20	6.0-9.0
9	9.0-12.0
3	12.0-15.0
2	>15.0

WILLISTON Poll.: WILLISTON-O3(ppb) 2015-01-01 00:00 - 2015-12-31 23:00 Calm: 0.00%



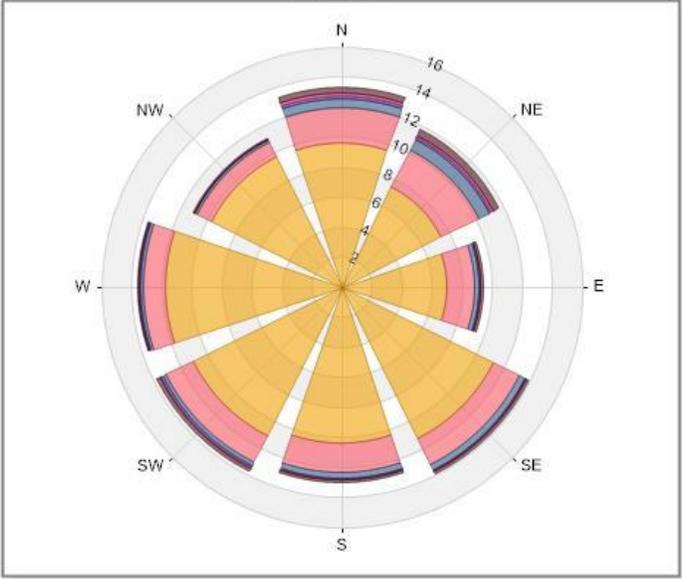
% Icon	Classes (ppb)
26	0.0-15.0
38	15.0-30.0
28	30.0-45.0
8	45.0-60.0
1	60.0-75.0
0	>75.0

WILLISTON Poll.: WILLISTON-PM10_STP[ug/m3(S)] 2015-01-01 00:00 - 2015-12-31
23.00 Calm: 0.00%



% Icon	Classes (ug/m3(S))
76	0.0-30.0
18	30.0-60.0
4	60.0-90.0
1	90.0-120.0
0	120.0-150.0
1	>150.0

WILLISTON Poll.: WILLISTON-PM25[ug/m3(L)] 2015-01-01 00:00 - 2015-12-31 23:00
Calm: 0.00%



% Icon	Classes (ug/m3(L))
78	0.0-7.0
16	7.0-14.0
3	14.0-21.0
1	21.0-28.0
0	28.0-35.0
2	>35.0

DRAFT

Introduction:

The Department requested that the Hess Corporation (Hess) prepare a comprehensive air dispersion modeling analysis for the Tioga Gas Plant. This analysis was submitted on May 20, 2016 and is titled: *SO₂ Ambient Monitor Site Selection Implementation of Data Requirements Rule (40 CFR 51.1200 et seq.)*²⁴. This analysis was conducted to inform siting of SO₂ ambient air quality monitors which will allow for the characterization of the ambient air quality with respect to applicable state and federal ambient air quality standards.

This memorandum serves as a summary of the Department's findings based on a thorough review of this analysis.

Background:

Hess operates a natural gas processing facility in Williams County North Dakota. The facility, called the Tioga Gas Plant, consists of gas sweetening operations, gas separation and dehydration, sulfur recover, and tail gas incineration. The facility currently operates under Title V Permit to Operate No. T5-O82002 and is designated a major source for Title V because it emits more than 100 tons per year of the criteria pollutants: Oxides of Nitrogen (NO_x), Carbon Monoxide (CO), and Sulfur Dioxide (SO₂).

Hess currently operates two industrial ambient SO₂ monitoring stations near the Tioga Gas Plant called Site #1 (AQS# 38-105-0103 - located ~0.8 miles north of the facility) and Site #3 (AQS# 38-105-0150 - located ~0.5 miles to the southeast of the facility). These two stations are not considered regulatory; however, Site #3 has suggested excessive ambient concentrations of SO₂.

Effective September 21, 2015, EPA promulgated the Data Requirements Rule (DRR) for the 2010 1-hour SO₂ standard which requires state air agencies to characterize air quality in areas with large sources of SO₂ emissions. The Hess Tioga Gas Plant is subject to this rule as an applicable source due to concerns expressed by EPA over the concentrations seen at the two Hess monitoring sites. This applicability is outlined in the March 18, 2016 DRR Response letter from EPA²⁵.

One of the pathways for a state agency to characterize air quality is to use ambient air quality monitoring by use of SLAMS or SLAMS-like²⁶ monitors. The decision to use monitoring for air quality characterization must be communicated to EPA by July 1, 2016. It is the intent of the Department to use air quality monitors for this purpose.

²⁴ A copy of the analysis is attached at the end of this memorandum.

²⁵ Available at <https://www3.epa.gov/airquality/sulfurdioxide/drr/nd-response.pdf>

²⁶ Monitors operated in a manner equivalent to SLAMS as to meet all applicable requirements of 40 CFR 58, appendices A, C, and E, and subject to the data certification and reporting requirements of 40 CFR 58.15 and 58.16.

The Department conducted preliminary screening air dispersion computer modeling to identify locations of maximum impact due to SO₂ emissions from the Hess facility. The results of this exercise suggested that the existing monitor sites may not represent areas of maximum concentration. Based on these preliminary findings, the Department requested that Hess prepare a comprehensive air dispersion modeling analysis for the Tioga Gas Plant to aid in monitor siting.

Hess conducted the analysis in accordance with applicable sections of the *Guideline on Air Quality Models* (40 CFR 51, Appendix W; Guideline) and recommendations of the *SO₂ NAAQS Designations Source-oriented Monitoring Technical Assistance Document* (TAD²⁷).

Method:

Model:

The U.S. Environmental Protection Agency (EPA) has created a Guideline on air quality models wherein they list preferred models, as well as guidance on selecting appropriate model inputs, for permitting review. Additionally, EPA has published a draft technical document, or TAD, with recommendations for characterizing air quality with respect to SO₂ by use of ambient monitoring. That document references the *SO₂ NAAQS Designations Modeling Technical Assistance Document*²⁸ for those agencies that use modeling to inform monitor placement. For the type of analysis required for the Hess Tioga facility monitor siting, these documents suggest that the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) should be used unless an alternative model can be justified. AERMOD was used for this analysis

In addition to the AERMOD (core) dispersion model which is used to estimate ambient concentrations of a given pollutant, the AERMOD system contains the following pre- and post-processors: AERMET, a meteorological data preprocessor; AERMAP, a terrain data preprocessor which generates elevation inputs for receptors; AERSURFACE, a surface land cover characteristics preprocessor; and BPIP-PRIME, a building profile input and downwash calculation pre-processor. For their analysis, Hess utilized the following versions:

AERMOD	-	15181
AERMET	-	15181
AERMAP	-	11103
AERSURFACE	-	13016
BPIP-PRIME	-	04274

The versions noted are the current versions of each processor. In addition, AERSURFACE

²⁷ In Draft. Updated February, 2016 and available online at <https://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf>

²⁸ In Draft. Updated February, 2016 and available online at <https://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2ModelingTAD.pdf>

parameters were applied using files from the 1992 National Land Cover Database (NLCD1992). The Department finds that AERMOD and the associated pre-processors as noted are appropriate for the analysis of the project as described.

Meteorological Data:

Surface and upper-air data are pre-processed by AERMET to generate the boundary layer parameters required by AERMOD to calculate plume dispersion. Per 8.3.1.2 of the Guideline, a minimum of one year of site-specific data, or five years of representative National Weather Service (NWS) data should be used to ensure a sufficiently conservative result which addresses the worst-case atmospheric conditions. The TAD amends this requirement by suggesting that the use of three complete years of meteorological data is appropriate for monitor siting.

If site specific data is not available, the Department provides representative National Weather Service (NWS) data from various stations throughout the state. For use in this analysis, the Department processed three years of data (2011-2013) from the Williston, ND, NWS station.

1. Surface:

Surface roughness length, albedo, and Bowen ratio are required values used by AERMET to pre-process meteorological data for AERMOD. AERSURFACE allows the user to develop these values using inputs based on set seasonal variability in the vegetative landscape (land cover). Hess utilized seasonally and directionally varying data in the form of land cover data files from NLCD1992 for the AERSURFACE pre-processor inputs.

AERMET uses hourly surface observations of wind speed and direction, ambient temperature, sky cover (opacity), and (optionally) local air pressure, in addition to the AERSURFACE output, to compile the appropriate surface meteorological inputs for AERMOD. Hess used the files for the Williston, ND station (NWS Station 94014) provided by the Department for the hourly surface observations. The Williston station is the nearest suitable NWS station to the facility and is located approximately 35 miles from the site.

2. Upper-Air:

Mixing heights used by AERMOD to determine plume dispersion are calculated based on upper-air data collected by Radiosonde at a NWS upper-air observation station. Hess used the Glasgow, MT upper-air station (NWS Station 94008) as the source for the upper-air data used in their analysis. The Glasgow station is located approximately 170 miles from the site and was determined to be an acceptable choice for the analysis.

Emission Source Data:

In air dispersion modeling, pollutant emission releases can be configured as point, volume, or area sources. Point sources are typically used to represent conventional stacks, flares, and cooling towers. Area sources are often used to represent vents and other emission surfaces which

can be defined as two-dimensional sources of emissions (often fugitive). Volume sources are used to simulate fugitive emissions from haul roads, piles, and other potential three-dimensional sources.

Source data required by AERMOD includes the type and location for each emission point, the base elevation of a given stack, emission height and rate, and gas exit velocity and temperature. The units at the Hess Tioga Gas Plant that are associated with SO₂ emissions are the Sulfur Recovery Unit (SRU) and flare. The SRU is designed to handle up to 220 long tons of sulfur per day. The flare is designed to operate during upset conditions that may occur and is fed from the SRU or the acid gas system. The Hess analysis shows that over the past 10 years, the flare has contributed approximately 6%, on average, of total SO₂ emissions at the facility. Additionally, flare emissions were approximately zero for 98% of all hours, suggesting that emissions from the flare are concentrated over a small number of hours. This is consistent with an upset relief system.

The Department conducted preliminary screening modeling using conservative assumptions whereby the flare and SRU operate concurrently all modeled hours. It was found that at a resolution meaningful to monitoring, emissions from the flare are not likely to significantly impact the location of the modeled maximum concentrations when compared to modeling the SRU alone. Because of this, the flare was not considered in the modeling analysis.

Hess has outlined specific emission point parameters and rates used in their analysis (reproduced as Table 1 below). Stack exit velocity and temperature have been determined from Continuous Emissions Monitoring System (CEMS) data. The TAD suggests using normalized actual emission rates for a modeling analysis. Because of changes to the operations at the facility and non-representativeness of actual emissions during the 2011-2013 modeled time period, Hess proposed to use a more conservative single emission value of 1 pound per hour for all 8,760 hours for each of the three modeled years. This unitary emission rate was justified in the analysis by stating that emissions are from a single source and modeling results are not intended for use as a compliance tool. Rather, the modeling analysis is used solely to locate an ambient monitoring site. The Department agrees with this approach.

Table 10. Values utilized in air dispersion modeling input files: Hess Tioga Gas Plant Parameters

Stack ID	Description	Emissions Rate ²⁹ lb/hr	Stack Parameters			
			Diameter m	Height m	Temperature °C (K)	Velocity m/s
SRU	Sulfur Recovery Unit	1.00	0.89	50.3	305 (578)	22.8

²⁹ Because this analysis was designed to inform monitoring site placement and not to quantify maximum impact or serve as a compliance tool, a unitary emissions rate was used.

Ambient Air Boundary:

Ambient air refers to the air to which the general public can reasonably be expected to have access. Typically this refers to air located outside a boundary (fence, wall, etc.) which restricts access to a facility or source. Because this analysis was conducted in order to locate an ambient air quality monitor, only locations outside the ambient air boundary were evaluated.

The Hess analysis indicates that the existing facility fence line will constitute the ambient air boundary.

Receptor Grid:

Receptors are the locations where a dispersion model calculates ground-level pollutant concentrations. Receptor spacing was set as follows:

- 100-meter (m) spacing for receptor placement along the property ambient air boundary.
- 100-m spacing out to 1 km
- 250-m spacing from 1 km to 2 km
- 500-m spacing from 2 km to 7 km
- 1000-m spacing from 7 km to 20 km
- “Hot spot” receptors were placed at 100-m spacing around the highest design value receptors.

A total of 8,010 receptors were defined.

The Department has determined that this spacing is acceptable based on the topographical profile for the project area guaranteeing a reasonable probability that the location of the highest pollutant impact has been represented. Receptor elevations were based on 1/3 arc-second GeoTIFF files.

Off-Site Impacts, Nearby Sources, and Background Concentrations:

Within the 50 km domain of the model, the Tioga Gas Plant is the significant contributor of SO₂ emissions. Other nearby sources are minor and the Department, based on historical modeling and permitting actions, has determined that they are not likely to either cause a significant concentration gradient of SO₂ in the vicinity of the subject source, or emit SO₂ at a significant level.

Because modeling for monitor siting is based on unitary emission rates and is not designed to identify a specific modeled maximum concentration *value*, but rather the *location* of maximum concentration, the addition of a uniform background concentration to all locations is superfluous and was not done for this analysis.

Building Downwash:

Downwash is the result of the interference of buildings or other nearby structures with plume dispersion. Downwash is assumed to occur when stack heights are below Good Engineering

Practice (GEP) heights³⁰. Hess has indicated that stacks at the facility may be below GEP heights. Downwash was simulated for nearby buildings by use of the Building Profile Input Program with the PRIME downwash algorithm (BPIP-PRIME).

Output:

The model was executed with the standard pollutant ID parameter of “SO2” to allow for an output comparable to the ambient standard (i.e. in the form of the design value – not a concentration comparison). The MAXDAILY option was applied which outputs the maximum 2-hour value for each receptor. This allows for a frequency analysis of peak values as recommended in the TAD.

Results and Discussion:

Maximum Concentration Location:

The AERMOD model was executed using the source, receptor, and meteorological data, as described above, in order to obtain “design value” form SO₂ maximums³¹. In their analysis, Hess identified the top 20 receptors with maximum modeled concentrations based on the unitary emission rate (Table 11). Figure 64 plots the location of the high value receptors as isopleths (greater than 0.7 µg/m³) and shows the highest concentration (primary isopleth) located approximately 7 km NNE of the Tioga Gas Plant facility. Hess also identified two secondary locations of high concentration within 5 km of the primary isopleth, but noted their small geographical extent. For monitor siting, the analysis suggested that the probability of collecting maximum concentration monitoring data is increased with an increased geographical area of high modeled concentration. The larger primary isopleth (which includes the maximum receptor design values) provides for more flexibility in land acquisition, securing utility access, etc. for a future monitoring station while still remaining within the maximum concentration area. The Department concurs with this assessment.

Table 11. Receptor Rank Order - Maximum Modeled Value (Data taken from Table 9 of Hess analysis report)

Rank Order	UTM Easting (meters)	UTM Northing (meters)	Receptor Design Value (µg/m ³)
1	656,200	5,369,900	0.91
2	655,800	5,370,300	0.88
3	656,100	5,370,000	0.87
4	655,500	5,370,200	0.87
5	656,200	5,370,000	0.86
6	655,300	5,370,500	0.86
7	655,400	5,370,300	0.86
8	655,800	5,370,400	0.86

³⁰ GEP = H + 1.5L where H is the height of nearby structure(s) and L is the lesser dimension, height or projected width, of nearby structure(s); from EPA’s *Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document For the Stack Height Regulations)(Revised)(June 1985)*

³¹ Three year average of the 99th percentile of the daily hourly maximum (40 CFR 50).

9	655,800	5,370,200	0.86
10	655,300	5,370,400	0.85
11	655,400	5,370,400	0.85
12	655,800	5,370,100	0.85
13	655,300	5,370,300	0.84
14	655,400	5,370,200	0.84
15	655,700	5,370,200	0.84
16	655,500	5,370,500	0.83
17	653,000	5,368,300	0.83
18	655,600	5,370,300	0.83
19	656,100	5,370,100	0.82
20	655,600	5,370,700	0.82

DRAFT

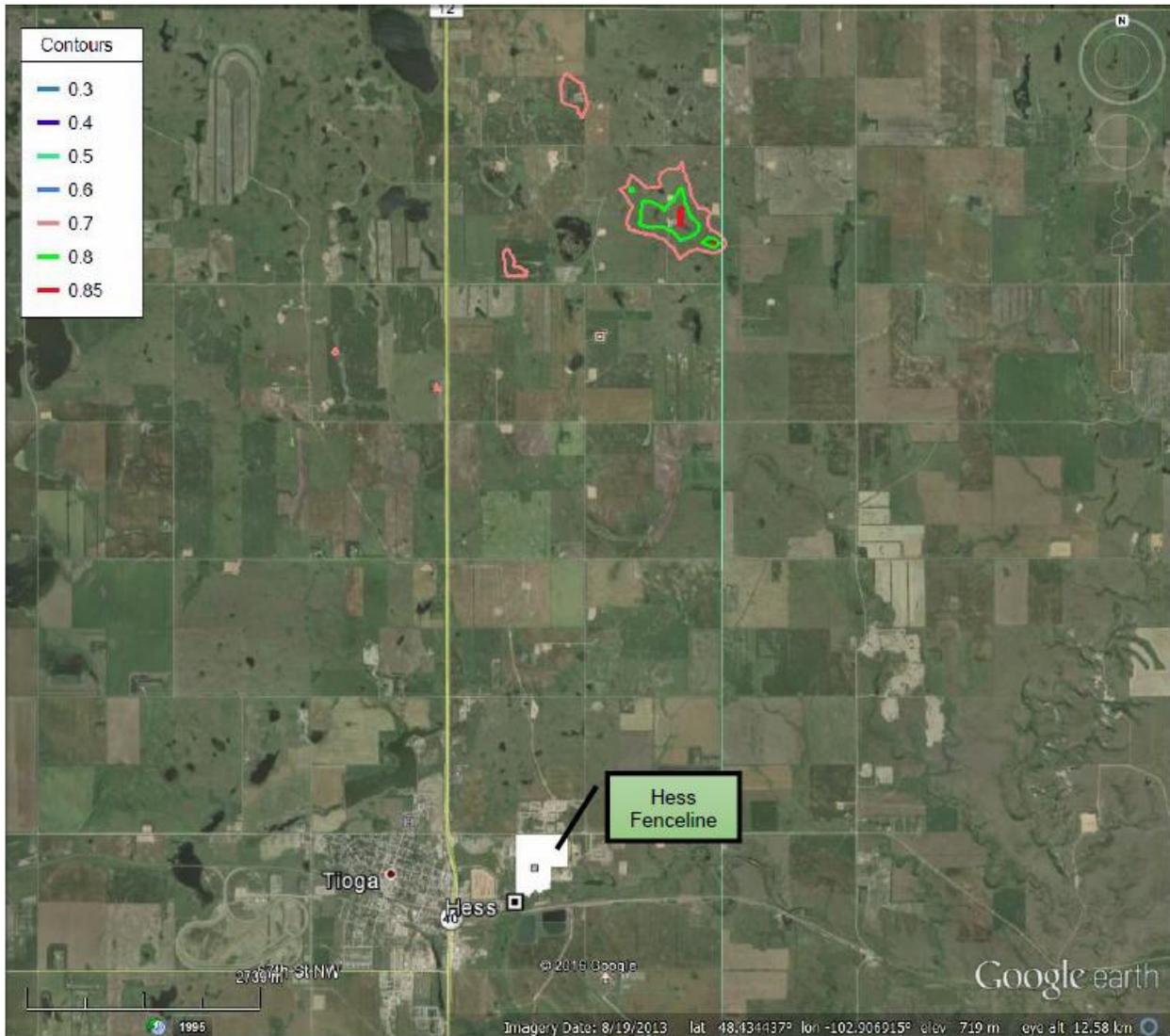


Figure 64. Design Value Isopleths (Reproduced from Figure 15 of the Hess analysis report).

Frequency of High Concentrations:

Hess also evaluated the frequency of high concentrations in accordance with the recommendations of the TAD (p. A-6). The MAXDAILY option was used to output the maximum 1-hour concentration for each receptor for each day. Hess limited the dataset by eliminating those values with a maximum concentration less than 1/2 of the single highest value.

The receptors were then ordered by the number of days each receptor had the highest 1-hour concentration for the day over the 3 modeled years. Table 12 shows the top 25 ranked receptors. The analysis shows that there are some minor differences in frequency of occurrences among the top ranked receptors. However, the majority of the receptors are clustered within the area identified by the primary isopleth (Figure 65). The Department determined that 56% of the daily

Table 12. Receptor Rank Order – Daily Max Frequency (Data taken from Table 10 of Hess analysis report)

Rank Order	Rank	Receptor #	Count (# of Daily Max)	UTM Easting (meters)	UTM Northing (meters)
1	1	201	25	653,000	5,368,300
2	2	990	18	653,900	5,369,600
3	2	1,193	18	656,200	5,369,900
4	2	1,602	18	655,100	5,370,600
5	3	1,309	11	655,800	5,370,100
6	4	991	9	654,000	5,369,600
7	4	1,252	9	656,100	5,370,000
8	4	1,368	9	655,700	5,370,200
9	4	1,603	9	655,200	5,370,600
10	5	140	8	652,900	5,368,200
11	5	1,311	8	656,000	5,370,100
12	6	368	7	651,800	5,368,600
13	6	2,315	7	654,400	5,371,800
14	7	369	6	651,800	5,368,600
15	7	1,425	6	655,400	5,370,300
16	7	1,485	6	655,400	5,370,400
17	8	202	5	653,100	5,368,300
18	8	429	5	651,800	5,368,700
19	8	430	5	651,900	5,368,700
20	8	1,109	5	653,800	5,369,800
21	8	1,192	5	656,100	5,369,900
22	8	1,195	5	656,400	5,369,900
23	8	1,365	5	655,400	5,370,200
24	8	1,427	5	655,600	5,370,300
25	9	61	4	651,000	5,368,100

Table 13. Percentage of Total Daily Maximums per Isoleth

Isopleths (Identified by Top 25 Receptor Rank)	Count (Sum)	Percentage of Total
All	218	100%
Primary Isopleth*	121	56%
1, 10, & 17	38	17%
2, 6, & 20	32	15%
12, 14, 18 & 19	23	11%
13	7	3%
25**	4	2%
* 3, 4, 5, 7, 8, 9, 11, 15, 16, 21, 22, 23, & 24		
** Does not represent an isopleth illustrated in Figure 64.		

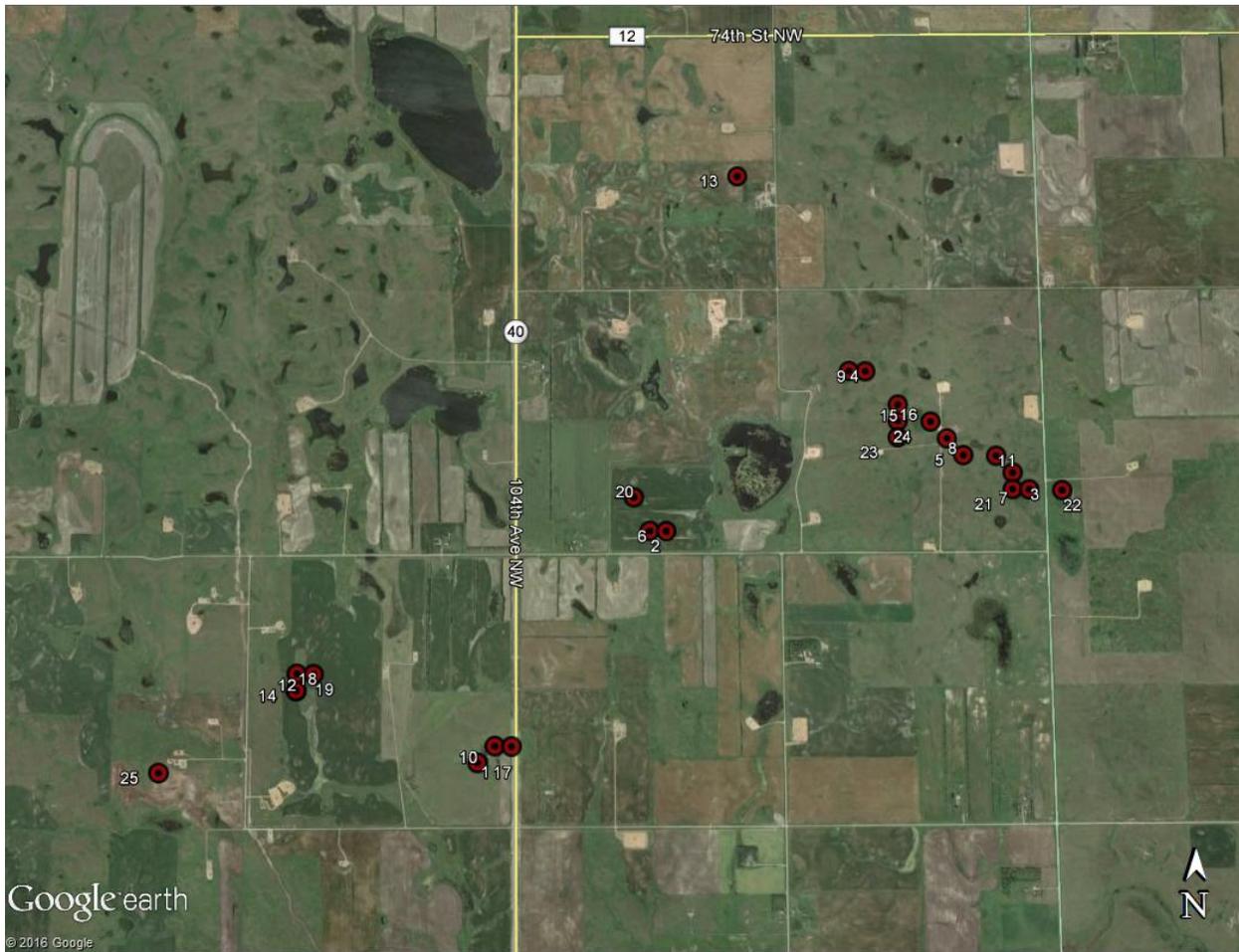


Figure 65. Plot of Top 25 Receptors Ranked by Daily Maximum Frequency (Rank Order ID)

maximums recorded for the top 25 receptors were accounted for by the primary isopleth, whereas the next most frequent isopleth only accounted for 17% of the daily maximums (Table 13).

Model Score:

Hess continued the analysis with additional receptor scoring by determining the sum of the design value rank for each receptor and the frequency count rank. Hess identified the three top scored receptors, all which were located in the primary isopleth. The Department re-ran this analysis using different ranking scores for the frequency count rank whereby those receptors with equal counts were ranked equally. The results of the Department’s analysis are presented in Table 14. Those receptors located in within the general vicinity of the primary isopleth again scored highest, including the top three ranked receptors, indicating that a monitor located in that area would provide data adequate to characterize the ambient air quality by resolving maximum impact.

Site Selection:

Based on the above described modeling analysis, a location approximately five miles NNE of the

SRU stack is proposed, within the area identified as the primary isopleth. This location has been identified by both a maximum design value analysis and a frequency analysis as one most likely to allow for the characterization of air quality due to maximum SO₂ impact from the Hass Tioga Gas Plant facility. Specific siting location information will be provided in a future supplement to this report.

Table 14. Receptor Score Rank

Receptor #	UTM Easting (meters)	UTM Northing (meters)	Design Value Rank (Table 11)	Frequency Day Count (Table 12)	Frequency Rank ³²	Score (sum of Rank)	Score Rank
1193	656,100	5,369,900	1	18	2	3	1
1602	655,500	5,370,200	4	18	2	6	2
1252	655,800	5,370,100	3	9	4	7	3
1429	655,500	5,370,200	2	3	10	12	4
1366	656,200	5,370,000	4	3	10	14	5
1425	656,100	5,370,100	7	6	7	14	6
1253	655,700	5,370,000	5	1	12	17	7
201	653,000	5,368,300	17	25	1	18	8
1485	655,700	5,370,200	11	6	7	18	9
1368	655,800	5,370,100	15	9	4	19	10
1484	655,500	5,370,200	10	1	12	22	11
1365	656,100	5,370,000	14	5	8	22	12
1424	656,000	5,370,100	13	2	11	24	13
1427	656,200	5,370,100	18	5	8	26	14
1603	655,600	5,370,300	28	9	4	32	15
1192	565,100	5,369,900	24	5	8	32	16
1367	655,700	5,370,100	21	1	12	33	17
1428	655,400	5,370,200	31	1	12	43	18
1488	655,900	5,370,200	39	1	12	51	19
990	654,200	5,368,700	74	18	2	76	20

As is noted in the introduction to this report, there are two historical ambient air quality monitoring site locations in the vicinity of the facility as well. Data collected at one of these (Site #3 - Southeast) was the primary impetus for including the Tioga Gas Plant in the list of facilities subject to the DRR, as it included values above the 75 ppb (Table 15). Site #3 has been in operation for more than 25 years.

³² The Department chose to use a different frequency rank method from Hess whereby rank is listed sequentially for the top 25 receptors and those receptors with equal counts were ranked equally. This did not change the overall conclusions based on the score rank.

Table 15. Ambient Monitoring Data Summary: 2010 – 2015 (Data from Table 4 of Hess analysis report)

Year	99 th Percentile (ppb)		Annual Average (ppb)	
	Site #1 (N)	Site #3 (SE)	Site #1 (N)	Site #3 (SE)
2010	27	77	0.5	2.2
2011	75	68	1.1	1.6
2012*	35	161	0.6	3.1
2013	44	264	0.5	3.2
2014	16	180	0.3	1.6
2015	17	74	0.4	1.4

* The 75 ppb standard became effective in August 2012

Because of existing ambient monitoring data suggesting that this site is the location of significant impacts due to a SO₂ plume originating from the facility, the Department proposes to continue monitoring at this site. This will allow for data continuity and evaluation of trends with respect to SO₂ impacts in this area.

In their analysis, Hess suggests further justification for continued monitoring at Site #3:

- Wind Direction** – Site #3 is at a 320° direction measured to the SRU unit, inside the most frequent wind direction quadrant measured over the past three years. Figure 66 shows that wind predominantly blows from the SRU to the SE over the combined three year period of 2013-2015. Individual years show the same trend. Hess also calculated a resultant wind vector based on a unit wind speed for each hour of the year. When combined with observed wind direction, the resultant wind vector shows the values in Table 16.

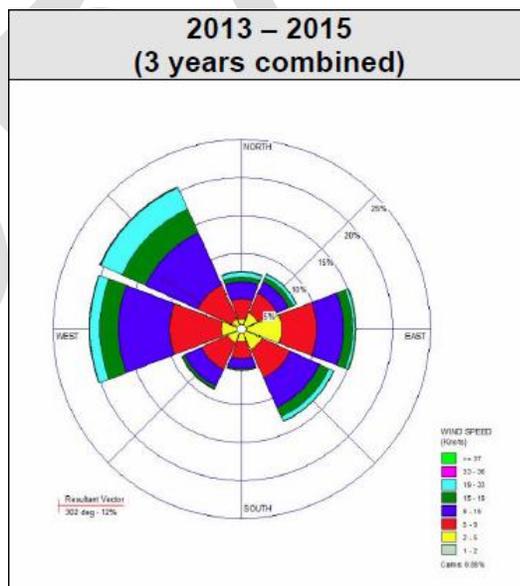


Figure 66. Tioga Gas Plant Wind Rose – Three Year Summary (reproduced from Figure 14 of Hess analysis report)

Table 16. Resultant Wind Vectors at Hess Tioga Gas Plant

Year	Resultant Vector
2013	322
2014	300
2015	290
2013-2015	302

They suggest that the current Site #3 location is well within the demonstrated range of wind vectors and represents an appropriate location.

- Wind Speed** – Hess evaluated wind speed with the aim of determining plume travel. The expectation was that lower wind speeds would allow a buoyant plume (identified by the average stack exit temperature of 520° F) to rise to a greater height and cause impacts farther from the facility than high wind speeds which would limit plume rise. To resolve the most favorable wind speed for current monitor site detection, Hess examined historical wind speeds when compared to SO₂ concentration. The results are reproduced in Figure 67. The analysis shows that high concentrations (>75 ppb) have occurred at a wide range of wind speeds including those considered “low”, “medium”, and “high”. Therefore the existing location is at a distance from the facility suitable to resolve high concentration impacts at a variety of representative wind speeds.

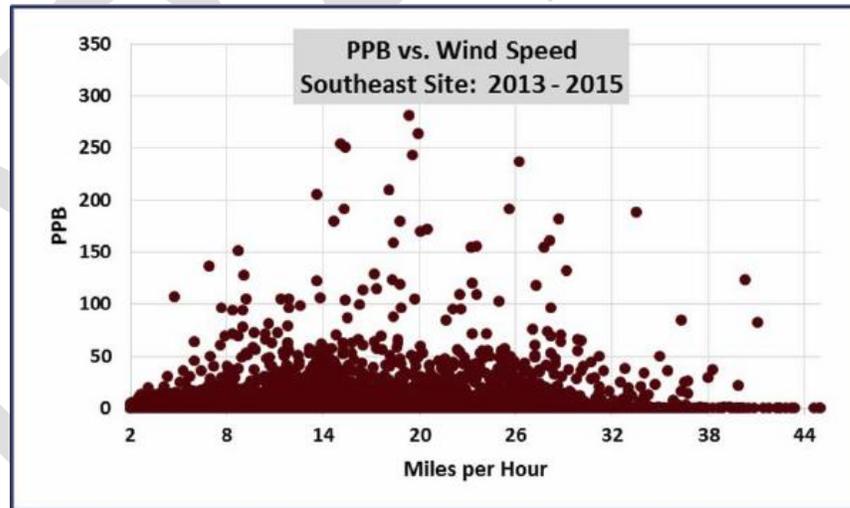


Figure 67. Concentration (ppb) as Compared to Wind Speed at Tioga Gas Plant Monitoring Site #3 (SE) – (reproduced from Figure 18 of Hess analysis report)

The Department concurs that both the wind speed and wind direction analyses provide additional compelling arguments for continued monitoring at Site #3.

Conclusions:

The Department has completed review of the modeling analysis submitted by Hess. Based on this review, the following is concluded:

1. Based on the March 18, 2016 DRR Response letter from EPA, the Hess Tioga Gas Plant is subject to the DRR. This determination was triggered, in part, due to high SO₂ readings at a non-regulatory monitor located in the area around the Tioga Gas Plant.
2. The DRR requires the characterization of the ambient air quality in areas with significant SO₂ emissions sources. One method of achieving this is through ambient air quality monitoring. In response to a request by the Department, Hess conducted an air dispersion modeling analysis to inform potential monitor placement. This analysis has been completed in accordance with applicable sections of the EPA modeling Guideline document and the TAD.
3. Hess has adequately demonstrated via modeling an appropriate general location for a monitor in order to identify peak SO₂ concentrations that occur in the area around the Tioga Gas Plant.
4. Historical data review suggests that continued monitoring at the existing high reading monitor site (Site #3) will provide additional confidence in the ability to correctly characterize the air quality in the vicinity of the Tioga Gas Plant.

The Department therefore proposes that source-oriented SO₂ monitoring be used to create data for comparison to the SO₂ National Ambient Air Quality Standard. Two monitors will be used to characterize ambient air quality around the Hess Tioga Gas Plant: one in the general area identified via the modeling analysis discussed in this report as the location of peak SO₂ concentration, and one at the current location of the non-regulatory monitor that collected data that resulted in the facility being subject to the DRR (Site #3). These monitors will operate in a “SLAMS-like” manner. Specifics on the location and site characteristics will be addressed in a future addendum to this report.

DRAFT

A 30-day public comment period for a draft of this document will be held from July 1, 2016 through August 1, 2016.

Notice for the comment period and a link to an electronic version of the document will be placed on the North Dakota Department of Health Air Quality Monitoring web page at: <http://www.ndhealth.gov/AQ/Ambient.aspx>, on the Division of Air Quality Public Comments & Notices web page at: <http://www.ndhealth.gov/AQ/PublicCom.aspx>, and the Calendar & Events page at: <http://www.ndhealth.gov/AQ/PublicCom.aspx>; as well as on the ND Department of Health Public Notices/Public Comment system which includes the webpage at <http://www.ndhealth.gov/DoH/PublicNotices.aspx>, an e-mail notification, and an RSS feed.

In order to meet the July 1, 2016 date³³ for submitting to the EPA Regional Administrator the Department's selection of ambient monitoring to characterize SO₂ concentrations in the area around the subject Hess Tioga Gas Plant, a pre-public comment version of this report will be provided to EPA Region 8. This will be followed by a second copy of this report after the public comment period has ended which will specifically address any comments received. Additionally, an applicable addendum addressing specifics of monitor siting (also subject to public comment) is anticipated and will be submitted to the Regional Administrator upon completion.

³³ "For each source on the list, the air agency will be required to indicate by July 1, 2016, whether it will characterize air quality through ambient monitoring or through air quality modeling... If the air agency chooses the first option, ambient monitoring for a source, the air agency must include information about the planned new monitor(s) in the annual monitoring plan that the air agency must submit to the EPA by July 1, 2016..." *Data Requirements Rule for the 2010 1-hour Sulfur Dioxide (SO₂) Primary National Ambient Air Quality Standard (NAAQS)*. Available at: www.gpo.gov/fdsys/pkg/FR-2015-08-21/pdf/2015-20367.pdf



May 20, 2016

NEXT DAY DELIVERY

Mr. Terry L. O'Clair, P.E.
Director, Division of Air Quality
North Dakota Department of Health
918 East Divide Avenue, 2nd Floor
Bismarck, North Dakota 58501-1947

**Re: SO₂ AMBIENT MONITOR SITE SELECTION
IMPLEMENTATION OF DATA REQUIREMENTS
RULE - HESS TIOGA GAS PLANT**

Dear Mr. O'Clair:

As we have previously discussed, please find enclosed the sulfur dioxide (SO₂) Ambient Monitor Site Selection analysis report, prepared by Bison Engineering on behalf of Hess Corporation, containing an in-depth analysis of SO₂ monitor siting considerations for the area in the vicinity of the Hess Tioga Gas Plant.

The report is designed to assist the North Dakota Department of Health (NDDH) in fulfilling, in part, its obligations contained in 40 CFR 51.1203(a) and (b) concerning characterization of 1-hour SO₂ concentrations in the subject area. Additionally the document also serves the purpose of providing a response to the U.S. Environmental Protection Agency's (EPA) "120-day" letter regarding the (lack of a) designation for the Tioga area.

The analysis concludes that one of the existing Hess-operated ambient monitoring sites, coupled with a new ambient monitoring station as identified in the modeling study, fulfill Data Requirements Rule (DRR) and NDDH obligations to establish an air quality monitoring network for the purpose of determining an appropriate designation for the area.

If you should have any questions regarding this information, please contact me at (713) 496-5031.

Sincerely,

Tony R. St. Clair
Senior EHS Specialist

TRS:Monitoring SO2 DRR Report Cvr Ltr

Enclosure

**SO₂ Ambient Monitor Site Selection
Implementation of
Data Requirements Rule**
(40 CFR 51.1200 *et seq.*)

Presented to:
North Dakota Department of Health
Environmental Health Section
918 E. Divide Ave.
Bismarck, ND 58501-1947

Prepared for:
Hess Corporation
Tioga Gas Plant
1340 66th Street NW
Tioga, ND 58852

Prepared by:
Bison Engineering, Inc.
1400 11th Avenue
Helena, MT 59601
(406) 442-5768
www.bison-eng.com



Helena 406.442.5768
Billings 406.896.1716

May 19, 2016

TABLE OF CONTENTS

1. Introduction	1
2. Purpose	2
3. Methodology	3
4. Analysis	4
4.1. Introduction and Approach	4
4.2. Data Gathering.....	4
4.2.1. Emission Source.....	4
4.2.2. Existing Ambient Air Quality Data	12
4.2.3. Existing Dispersion Modeling.....	17
4.2.4. Meteorological Data.....	17
4.2.5. Geographical Influences	29
5. Monitor Siting	31
5.1. Introduction	31
5.2. “New” Dispersion Modeling	31
5.2.1. Design Value Analysis.....	33
5.2.2. Frequency Analysis	36
5.2.3. Receptor Ranking – Model Score.....	38
5.2.4. Near Fenceline vs. Model Receptor	39
5.3. Exploratory Monitoring	41
5.4. Monitor Siting Based on Existing Data	42
6. Monitor Site Selection	43
6.1. Site Selection #1 – Southeast – Existing Data	44
6.2. Site Selection #2 – North – Modeling Data.....	47
6.3. Conclusion	49

LIST OF FIGURES

Figure 1: Annual SO ₂ Emissions - Tioga Gas Plant.....	6
Figure 2: Hourly SO ₂ Emissions: 2013 - 2015	7
Figure 3: Hourly SO ₂ Flare Emissions: 2013 - 2015	7
Figure 4: Histogram Hourly SO ₂ SRU Emissions: 2013 - 2015	9
Figure 5: Average Emissions by Hour of the Day: 2013 - 2015.....	9
Figure 6: Hourly Flare Emissions Distribution: 2013 – 2015.....	11

Figure 7:	Hess Ambient Monitoring Sites.....	13
Figure 8:	Hess Ambient Monitoring Sites - Historical Data Summary.....	14
Figure 9:	Hess Ambient Monitoring Sites – Average PP by Hour.....	15
Figure 10:	Emissions vs. Ambient Data (Southeast Site): 2006 - 2015.....	16
Figure 11:	Hourly Temperature: 2013 - 2015.....	20
Figure 12:	Histogram of Hourly Wind Speeds: 2013 - 2015.....	22
Figure 13:	Wind Rose by Quarter: 2013 - 2015.....	23
Figure 14:	Annual Wind Roses: 2013 - 2015.....	27
Figure 15:	Design Value Isopleths.....	35
Figure 16:	Top 25 Frequently Occurring Receptors.....	38
Figure 17:	Selected Monitoring Locations.....	44
Figure 18:	PPB vs. Wind Speed: 2013 – 2015.....	47

LIST OF TABLES

Table 1:	SRU Descriptive Statistics: Hourly Emissions: 2013 - 2015.....	8
Table 2:	Flare-to-Total Annual Emissions Ratio.....	10
Table 3:	SO ₂ Ambient Monitoring Site Details.....	13
Table 4:	Ambient Monitoring Data Summary: 2006 – 2015.....	14
Table 5:	Meteorological Monitoring Site Details.....	18
Table 6:	Ambient Monitoring Temperature Summary: 2013 – 2015.....	19
Table 7:	Ambient Monitoring Wind Speed Summary: 2013 – 2015.....	21
Table 8:	Dispersion Modeling Elements Summary.....	32
Table 9:	Rank Order - Top 20 Receptors.....	34
Table 10:	Receptor Rank Order - Daily Max Frequency.....	37
Table 11:	Receptor Scoring - Modeling.....	39
Table 12:	North vs. Fenceline Area Frequency Ranking.....	41
Table 13:	Selected SO ₂ Ambient Monitoring Program.....	43

1. Introduction

In 2010, the U.S. Environmental Protection Agency (EPA) promulgated a new ambient standard for sulfur dioxide (75 FR 35520). This new standard was not implemented in traditional fashion. In particular, EPA did not designate all of the U.S. within three years of promulgation.

Instead, EPA designated only a few areas as nonattainment based on available ambient monitoring data.¹ EPA chose to address the remainder of the U.S. by the adoption of the Data Requirements Rule (DRR) on August 21, 2015 (80 FR 51052). The rule became effective on September 21, 2015, and requires (primarily) state agencies to submit air quality data to EPA for purposes of characterizing the maximum 1-hour concentrations of SO₂ in various areas of interest. This “characterization”² is to be accomplished using either ambient monitoring or air quality dispersion modeling as the analysis vehicle. The decision regarding which methodology (monitoring or modeling) is left to the state agency³, the North Dakota Department of Health in this case.

For purposes of implementing the DRR rule, it has been decided to use monitoring in order to characterize ambient air quality in the Tioga area of North Dakota. This method was chosen for several reasons including comments from EPA and the wealth of information already available in the Tioga area. The remainder of this document will consist of various analyses that collectively will define an ambient monitoring network to be used to “characterize” future ambient air quality data as required by the DRR.

¹ The designations were published on August 5, 2013 (78 FR 47191) based primarily on ambient monitoring data from 2009 through 2011. There were no areas in North Dakota included in this nonattainment designation.

² The DRR rule (40 CFR 51.1200 – 1205) frequently uses the term “characterize” (or a derivative thereof) in describing the study or data purpose. The term is important so as not to be confused with enforcement, compliance, or other more traditional regulatory terms. The data is eventually to be used to determine an air quality status of an area; not “compliance.”

³ 40 CFR 51.1203(b).

2. Purpose

The purpose of this document is to provide an analysis and justification for the selection of an ambient monitoring station location for the Tioga, North Dakota, area. The analysis is designed to assist the North Dakota Department of Health (NDDH) in fulfilling, in part, their obligations contained in 40 CFR 51.1203(a) and (b). Additionally the document also serves the purpose of providing a response to EPA's "120-day" letter⁴ regarding the (lack of a) designation for the Tioga area.

On December 21, 2015, NDDH submitted a letter to Region 8 EPA Administrator Shawn McGrath identifying those sources/areas in which a 'characterization' study should be conducted in accordance with the DRR. That notification did not include Tioga as an area of study for DRR. EPA responded on March 18, 2016, adding the Tioga area for purposes of DRR as a result of ambient air quality data collected at one of two ambient monitoring stations operated by Hess in accordance with their air quality permit.⁵

The analysis that is contained in this document concludes one of the existing ambient monitoring sites (Southeast Site) coupled with a new ambient monitoring station⁶ fulfill DRR and NDDH obligations to establish an air quality monitoring network for the purpose of determining an appropriate designation⁷ for the area.

⁴ The "120-day letter is an EPA obligation when it disagrees with the Governor's recommendation as to an area's designation for an ambient air quality standard. (Section 107, Clean Air Act.) The EPA letter may be found here:

https://www3.epa.gov/airquality/sulfurdioxide/designations/round2/08_ND_resp.pdf

⁵ Both letters are available at the following EPA web site:

<https://www3.epa.gov/airquality/sulfurdioxide/drr.html>

⁶ The new monitoring station is sited using dispersion modeling. As a practical matter, one of the existing stations (Northeast) will be moved to this new monitoring site to complete the ambient monitoring network.

⁷ The designation categories are: "attainment," "nonattainment" or "unclassifiable." EPA staff have indicated that they will also publish an "unclassifiable/attainment" designation for some areas.

3. Methodology

The primary methodology used in this document to identify candidate monitoring sites is that recommended by EPA's "SO₂ NAAQS Designations Source-Oriented Monitoring Technical Assistance Document" (TAD) to provide assistance to state agencies in developing an appropriate ambient network. The TAD was first issued in December 2013 several months prior to publishing the draft DRR. Following the issuance of the final DRR, EPA has recently updated the TAD (February, 2016) to reflect the final rule.⁸ Although the document provides information about how one might determine the location and size of a monitoring network, EPA was quite clear that the document is not binding. In fact, the document itself continues to include a "draft" watermark.

Both the DRR preamble and the TAD emphasize that the TAD is designed to assist agencies in developing the network but that the document is not binding in any way. The following are representative quotes to that effect:

*"The EPA reiterates that the TADs provide recommendations but are **not binding** or enforceable and **create no obligations on any person.**" (Section IV.D.2.c; 80 FR 51073); [Emphasis added.]*

*"The EPA has issued separate **non-binding** draft technical assistance documents recommending how air agencies should conduct such monitoring or modeling." (Summary: 80 FR 51053);*

*"In the preamble of the proposed rulemaking, the EPA noted that the Agency has produced draft, **non-binding** Monitoring and Modeling TADs that discuss options, suggested approaches and methods ..." (Section IV.D.1.A, 80 FR 51071).*

Although not binding, the principles found in the TAD were used to select an appropriate monitoring program for the Tioga area.

⁸ "SO₂ NAAQS Designations Source-Oriented Monitoring Technical Assistance Document," February 2016, DRAFT. The document may be found here: <https://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf>

4. Analysis

4.1. Introduction and Approach

The analysis begins by considering the methods described primarily in the TAD. The guideline suggests that as much available information as possible should be used to determine the number and site locations of a monitoring network. The document may be boiled down to the following steps:

- 1) **Data Gathering**
 - a) Emission Source
 - i) Description
 - ii) Emissions and CEM Data
 - iii) Trends and Analysis
 - b) Existing Air Quality Data
 - i) Description
 - ii) Ambient Data
 - iii) Trends and Analysis
 - c) Existing Modeling
 - d) Meteorological Data
 - e) Geographic Influences
- 2) **Monitor Siting**
 - a) "New" Modeling
 - b) Exploratory Monitoring
 - c) Siting Based on Existing Data
- 3) **Monitor Site Selection**

The remainder of this analysis generally follows the outline above in selecting a monitoring network.

4.2. Data Gathering

Prior to any analysis of site location, the TAD recommends that one must first obtain and peruse all reasonably available data that could influence an eventual site location. This section of the report provides a summary of the available data that may be used to identify good candidate monitoring locations. All material raw or original data was previously provided to NDDH as part of Hess's ongoing monitoring and reporting requirements and is available upon request.

4.2.1. Emission Source

The area of interest in this study is in the vicinity of Tioga, ND. A quick review of the area indicates the Tioga Gas Plant as the largest SO₂-emitting source in this general vicinity. Also in the general area are a number of gas wells. Flaring and other activities relating to these wells might also contribute slightly to ambient concentrations near Tioga.

For purposes of this analysis, the Tioga Gas Plant is the emission source of interest. There are only two emitting units within the facility of interest: the sulfur recovery unit (SRU) and flare.

4.2.1.1. Emission Source Description

The Tioga Gas Plant is permitted to “Hess Tioga Gas Plant LLC.” The facility operates in accordance with Title V Permit T5-O82002. The facility was constructed in 1954 under different ownership. The plant was originally designed to handle about 120×10^6 scf of sour gas. A sulfur recovery unit (SRU) was added in 1967 (105 long tons/day). This unit was replaced/upgraded to handle up to 220 long tons of sulfur per day in 1991. Finally, several other upgrades and improvements to operations were made from 2013 to 2015.

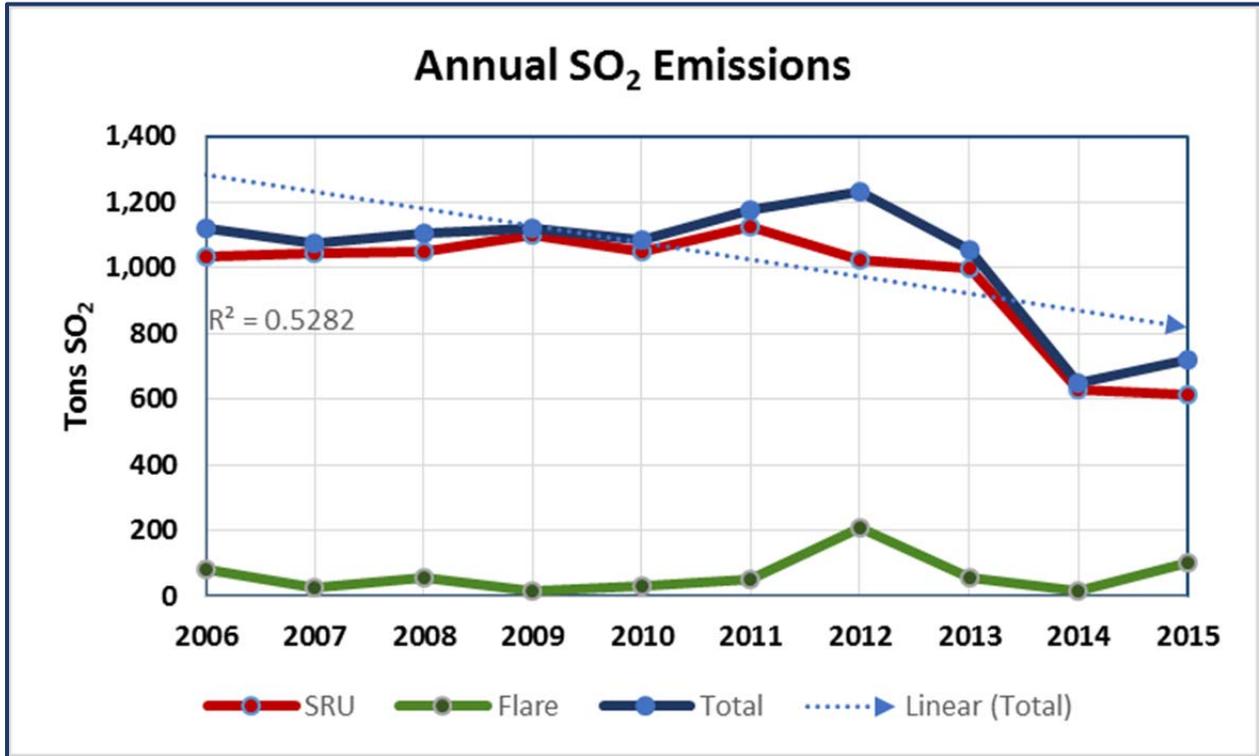
In addition to the SRU, the Tioga Gas Plant also has a flaring system. The flare is primarily used to handle various upsets that may occur during operation. The streams that feed the flare during these events are either from the SRU unit or the acid gas system.

4.2.1.1.1. Emissions Data

The emissions from the Tioga Gas Plant have been measured routinely for the past 10+ years. The facility operates a continuous emissions monitoring system (CEMS) as noted in 4.2.1.3 below. Therefore, it is possible to review, in detail, the hourly, quarterly or annual emissions over that period.

To begin, the figure below is a summary of the annual emissions for the past 10 years.

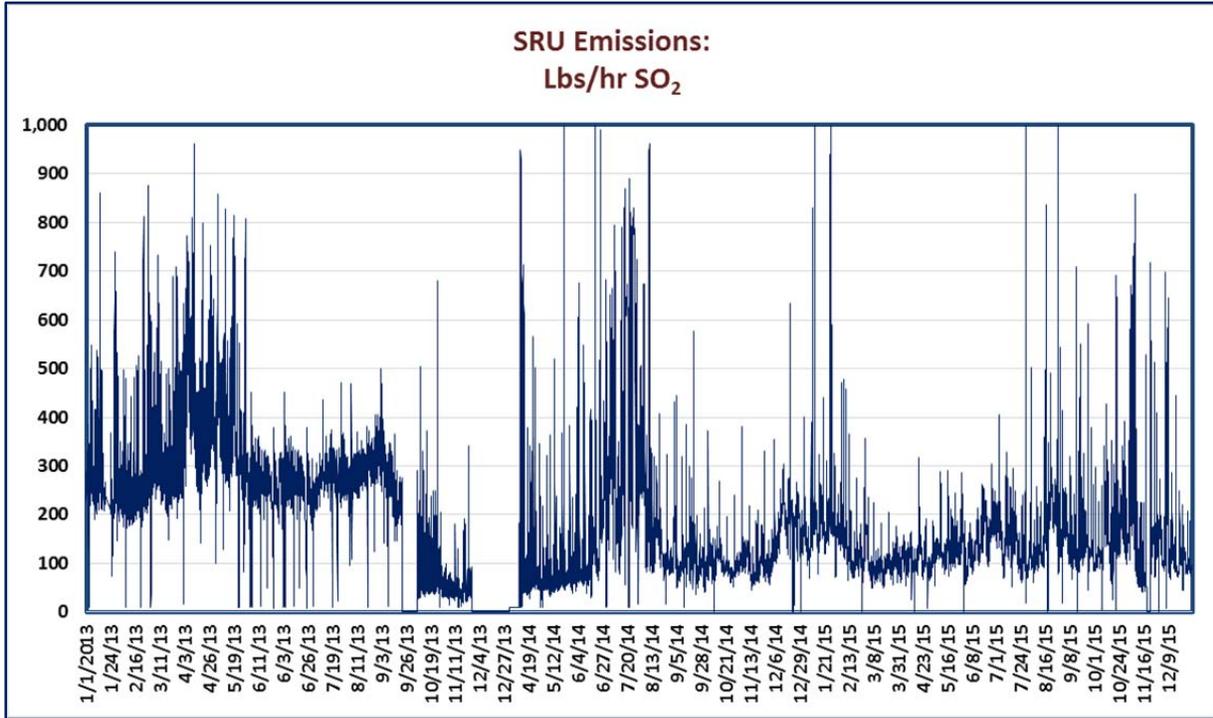
Figure 1: Annual SO₂ Emissions - Tioga Gas Plant



The figure is instructive in that it indicates a clear downward trend in emissions.

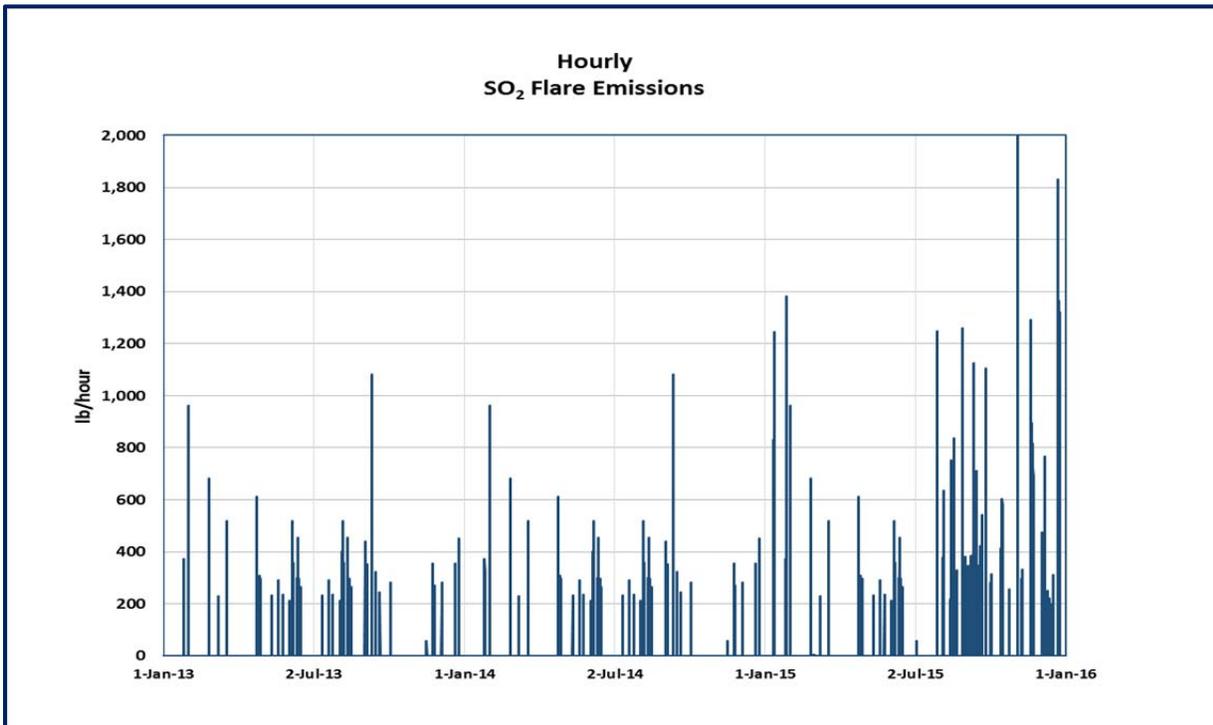
The most relevant period for review is, of course, the past 3+ years of operation as that forms the basis of this SO₂ 1-hour ambient standard analysis. Data from previous years is also available. It was decided not to use earlier data, primarily because the emissions from prior years are greater than the past few years (as demonstrated in Figure 1 above and figures to follow.) Since it is the purpose of this review to determine a future monitoring site (2017 and beyond), it is appropriate to use the most recent data for ambient monitoring site selection.

Figure 2: Hourly SO₂ SRU Emissions: 2013 - 2015



In addition to the SRU data, the flare emissions data is also of interest. The data for the past three years is plotted in Figure 3 below.

Figure 3: Hourly SO₂ Flare Emissions: 2013 - 2015



An analysis of the data is provided below.

4.2.1.2. Trends and Analysis (Emissions)

A review of the emissions data yields the following observations. The first is that the emissions from the facility have undergone a significant reduction for several years especially in the past two to three years. Though nonlinear, the trend downward is statistically significant. The calculated R^2 [Pearson correlation coefficient]⁹ for this data is 0.53, meaning that 53% of the variance in SO₂ emissions is linearly correlated with the progression of time (as a downward trend). This indicates that the downward trend is, from a statistics point of view, not likely the result of random variation in the data.

Regardless of the trend over time, it is worth investigating the distribution of the hourly SRU data. Table 1 below provides general descriptive statistics of the hourly data. The distribution of the data may also be shown via a histogram provided in Figure 4. The histogram shows the frequency of occurrence (# of hours) of various short-term (pound per hour) emission rates from 2013 through 2015. The data appears to have a near normal¹⁰ distribution.

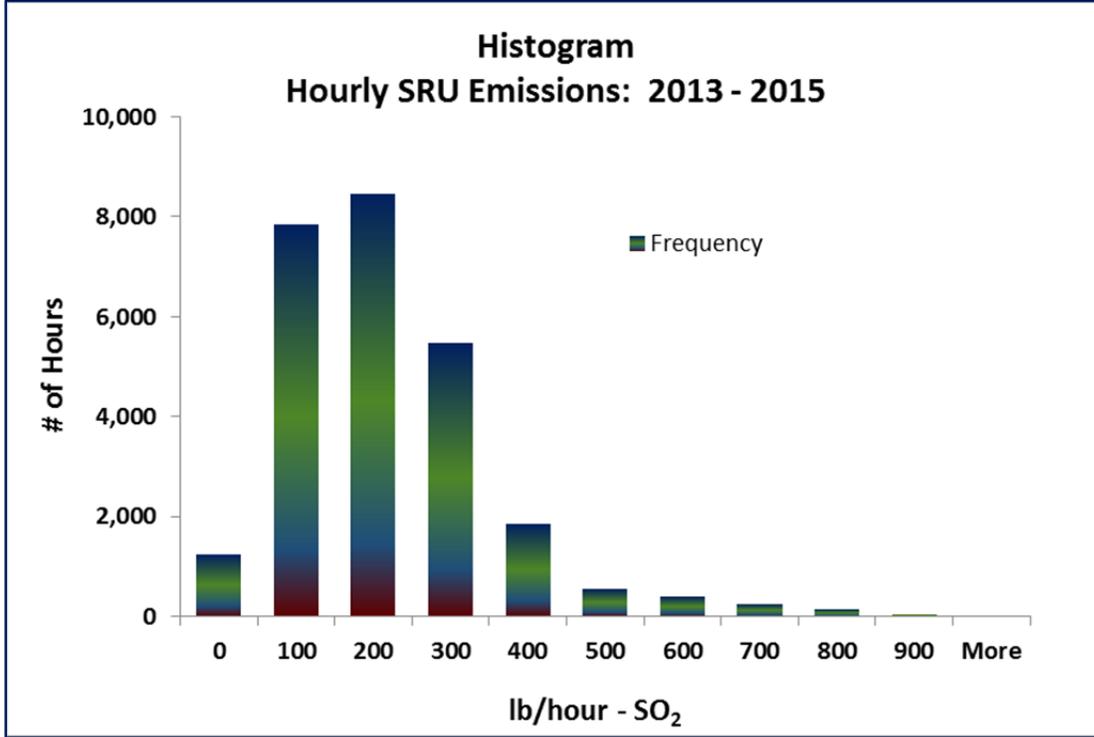
Table 1: SRU Descriptive Statistics: Hourly Emissions: 2013 - 2015

Parameter	Data
Mean	171
Median	132
Standard Deviation	135
N	26,280
95% Confidence Level (of the mean)	1.63

⁹ If a set of data indicates an R^2 at, or at least not statistically different from zero, then this implies that the two variables (emissions and time in this case) are independent of each other. Since there is enough statistical evidence to deny this null hypothesis (that the R^2 is zero), then it is reasonable to conclude that there is a relationship between emissions and time.

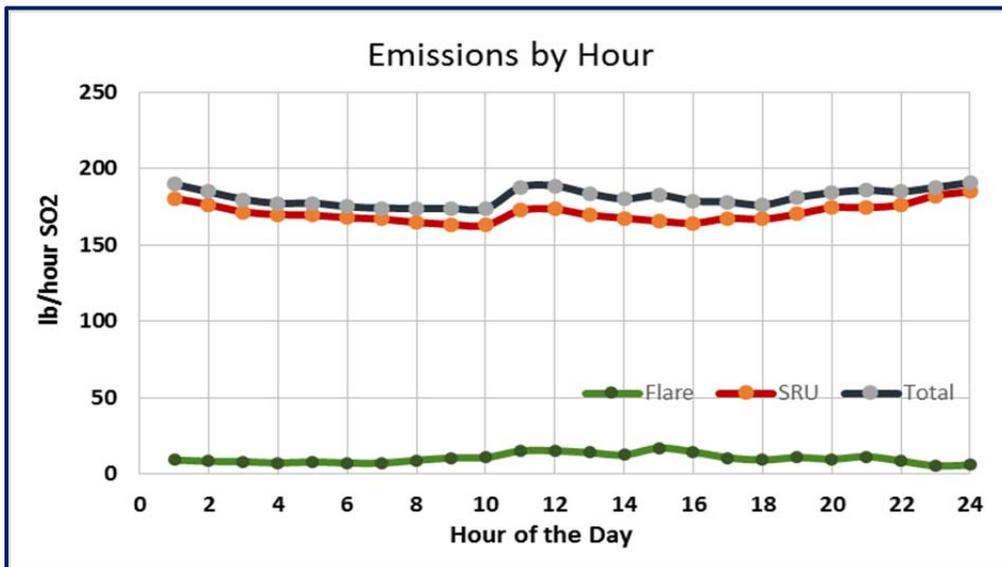
¹⁰ The term “normal” is used in a statistical context of a “normal” (or Gaussian) distribution.

Figure 4: Histogram Hourly SO₂ SRU Emissions: 2013 - 2015



Another method of reviewing the data is to consider any diurnal pattern in the data. The figure below shows the average emissions for the flare, SRU and total (flare + SRU) by each hour of the day.

Figure 5: Average Emissions by Hour of the Day: 2013 - 2015



The figure indicates no discernable diurnal pattern in the data. This is a reasonable observation as the facility operates 24 hours per day and is not, it appears, subject to hourly swings in production or processing that affects emissions.

Next, it is of interest to compare the flare data and the emissions from the SRU. It is clear from the data in Figure 1, for example, that the emissions from the SRU exceed those from the flare by roughly an order of magnitude. On an annual basis the ratio of flare emissions to total emissions is shown in Table 2 below for the past 10 years.

Table 2: Flare-to-Total Annual Emissions Ratio

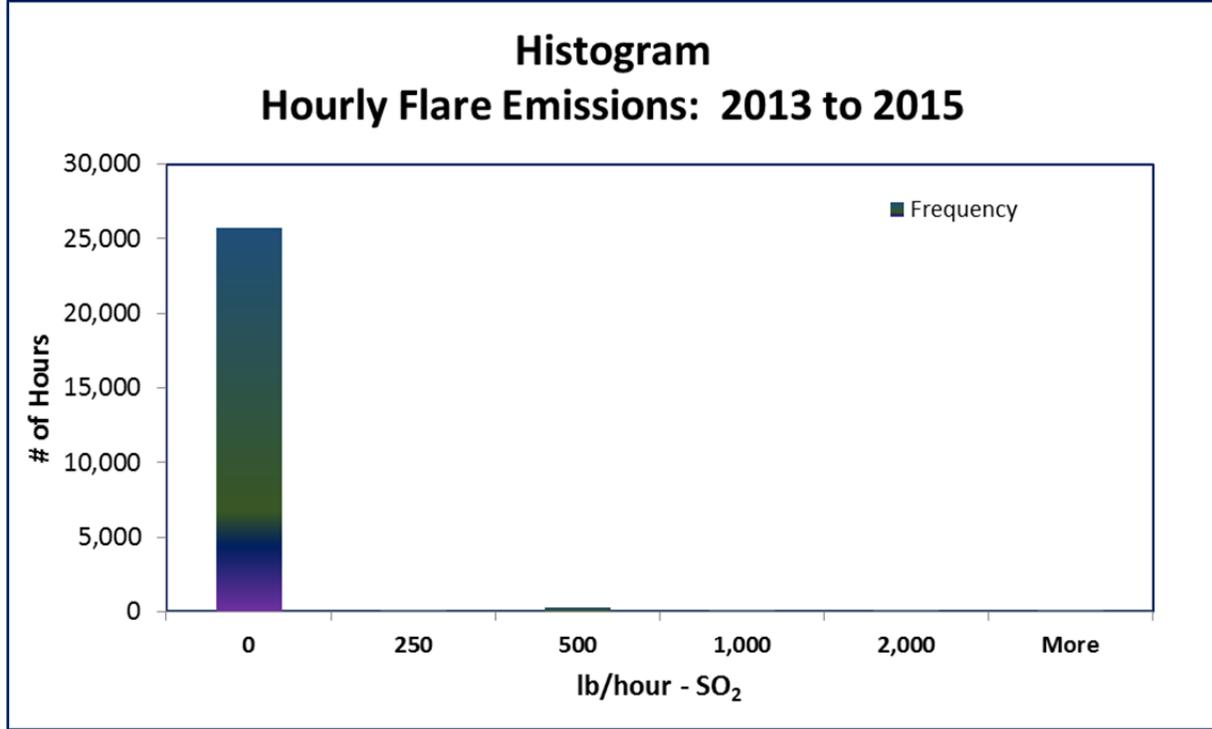
Year	Ratio: Annual Flare /Total
2006	8%
2007	3%
2008	5%
2009	2%
2010	3%
2011	4%
2012	17%
2013	5%
2014	2%
2015	14%
10-Year Average	6%

With the exception of 2012 and 2015, the data is fairly consistent.

The fact that the flare data only composes a small fraction of the total emissions picture is reasonable. The flare is primarily a safety device and handles (combusts) gases that arise from an upset at the plant itself. When the SRU unit, for example, is not able to process the inlet gas, those sulfur-bearing gases must be vented to the flare as a matter of safety.

A review of the annual emissions mix (Figure 3) indicates that the emissions from the flare are concentrated over a small number of hours. This is the nature of an emergency release safety system. For example, in the past three years, flare emissions were “zero” 98% of all hours. Figure 6 provides a frequency distribution of the emissions profile from this unit.

Figure 6: Hourly Flare Emissions Distribution: 2013 – 2015



The likely reasons for the overall decrease in annual emissions and the spikes in the hourly emissions data are discussed below.

Recall that the gas plant has been in operation (by multiple owners) since the 1950s. It currently has a design rate of about 250×10^6 standard cubic feet per day (scf/day) of gas. However, there have been a number of changes in the past few years. The first is that the plant has and continues to process a significant amount of gas from the Bakken. This gas has a lower H₂S content than the sour gas processed in its earlier years of operation. Thus, the amount of sulfur processed for a given quantity of gas is less than prior years. However, it also led to operational problems.

Starting in early 2012, the plant experienced a series of malfunctions that were linked to low sulfur content spikes. In order to solve that problem, Hess undertook a series of actions to reduce the number of spikes in the future. Coupled with that effort, Hess entered into an “Administrative Consent Agreement” (ACA). The SRU had been originally designed to handle the more historic sour gas streams. This “new” gas stream led to the malfunctions observed in December of 2013.¹¹ The ACA required Hess to make some operational changes in order to reduce emissions and limit or prevent some of the spikes recorded in the earlier data.¹²

¹¹ Administrative Consent Agreement: Case No. 13-001 APC, N.D.C.C. Ch 23-25: State Department of Health State of North Dakota and Hess Corporation.

¹² The modifications and procedures implemented by Hess as a result of the spikes and the ACA are extensive and thus not listed here for the sake of brevity. A complete list is available upon request.

Although the sulfur content of the processed gas has decreased historically, leading to lower annual emissions, that same fact created operational problems in the gas processing unit itself which caused more frequent spiking of the data than might otherwise occur.

Of interest here is what to expect in the future insofar as the selection of an ambient monitoring station is concerned. It seems reasonable to presume that the emissions variability will improve in the near future. Significant effort and cost are being expended to improve the emission profile before January, 2017, the date by which the ambient monitoring station must be operational.

4.2.2. Existing Ambient Air Quality Data

We turn our discussion to a review of the ambient air quality data in or near the area of interest. A review of the area indicates two sulfur dioxide ambient monitoring stations located near the Hess facility. The next nearest monitors are at the Lostwood National Wildlife Refuge, about 30 miles from Tioga.

4.2.2.1. Monitoring Station Description

The two ambient stations near Tioga are operated by Hess. They are designated as Site #1 (Northeast) and Site #3 (Southeast). They were constructed and continue to operate in accordance with Air Quality Permit #T5-O82002. The stations have been in operation since 1987, thus offering a plethora of information regarding ambient air quality in the study area.¹³ The location of the two monitoring stations is shown in Figure 7 below. In addition Table 3 provides the particulars of the station descriptive data.

¹³ EPA and to some extent NDDH have expressed concern about the quality of this data for 'regulatory' purposes. That is not to say that the data from the site is invalid or inconsistent with the air quality permit. Nonetheless, EPA chose not to use this for the designation purposes since certain QA procedures were either not known or not verifiable. Using the data for site selection is an entirely different matter. It is appropriate to use this long history of information for siting purposes, especially considering that this ambient data is the sole reason that this area is subject to a "characterization" study at all. Had it not been for this data, the Tioga area does not meet any of the criteria for any analysis. Therefore, this data will be used extensively in this report to assist in the selection of an appropriate ambient monitoring network for DRR purposes.

Figure 7: Hess Ambient Monitoring Sites

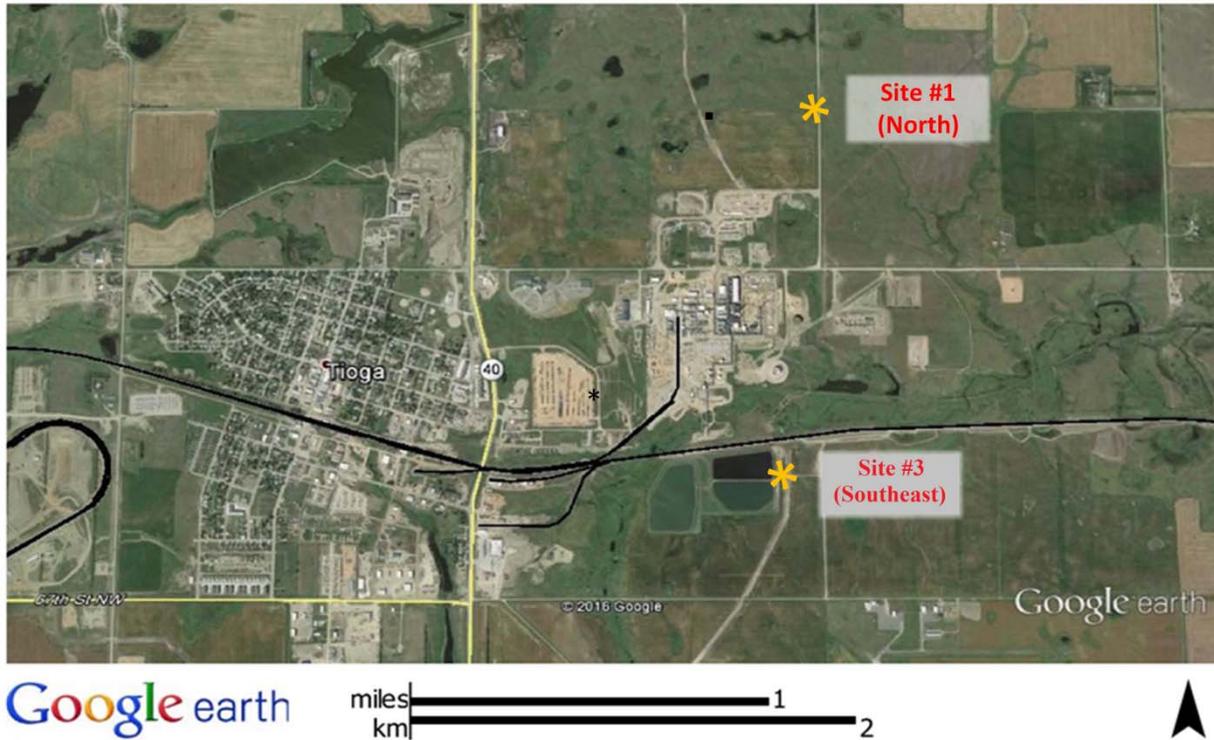


Table 3: SO₂ Ambient Monitoring Site Details

Parameter	Site #1 (North)	Site #3 (Southeast)	Units
AQS #	38-105-0103	38-105-0150	n/a
Elevation	713	675	Meters
Latitude	48.4088	48.3926	Degrees
Longitude	-102.9077	-102.9102	Degrees
Start Date	7/1/87	11/5/87	n/a
Direction (Site to Gas Plant SRU stack)	210	320	Degrees
Distance (Site to Gas Plant SRU stack)	1.34	0.82	Kilometers

4.2.2.1.1. Monitoring Station Data

Hourly ambient data is available from the two Hess monitoring stations for the past 25+ years. Similar to the emissions data, the more recent data is of most interest. Table 4 below provides a few summary statistics for the past 10 years.

Table 4: Ambient Monitoring Data Summary: 2006 – 2015

Year***	99 th Percentile*		Annual Average*	
	Site #1 (North)**	Site #3 (Southeast)**	Site #1 (North)**	Site #3 (Southeast)**
2006	20	48	0.7	1.7
2007	25	49	0.7	2.0
2008	37	50	0.6	2.0
2009	34	65	0.6	2.4
2010	27	77	0.5	2.2
2011	75	68	1.1	1.6
2012	35	161	0.6	3.1
2013	44	264	0.5	3.2
2014	16	180	0.3	1.6
2015	17	74	0.4	1.4

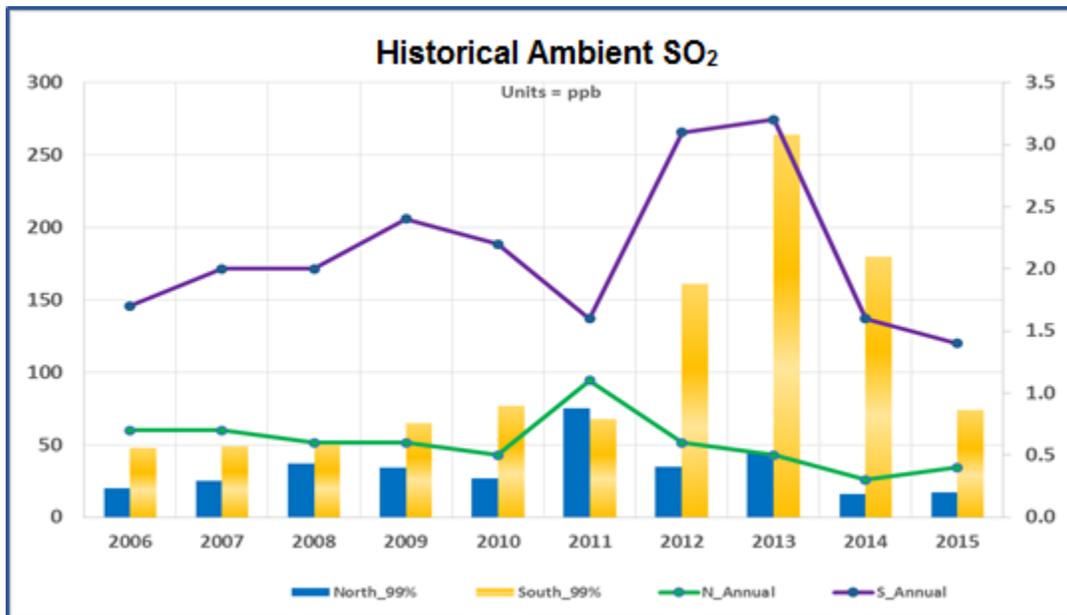
* 99% percentile of daily hourly maximum: Units = parts per billion

** Units = parts per billion

*** The 75 ppb standard became effective in August 2012.

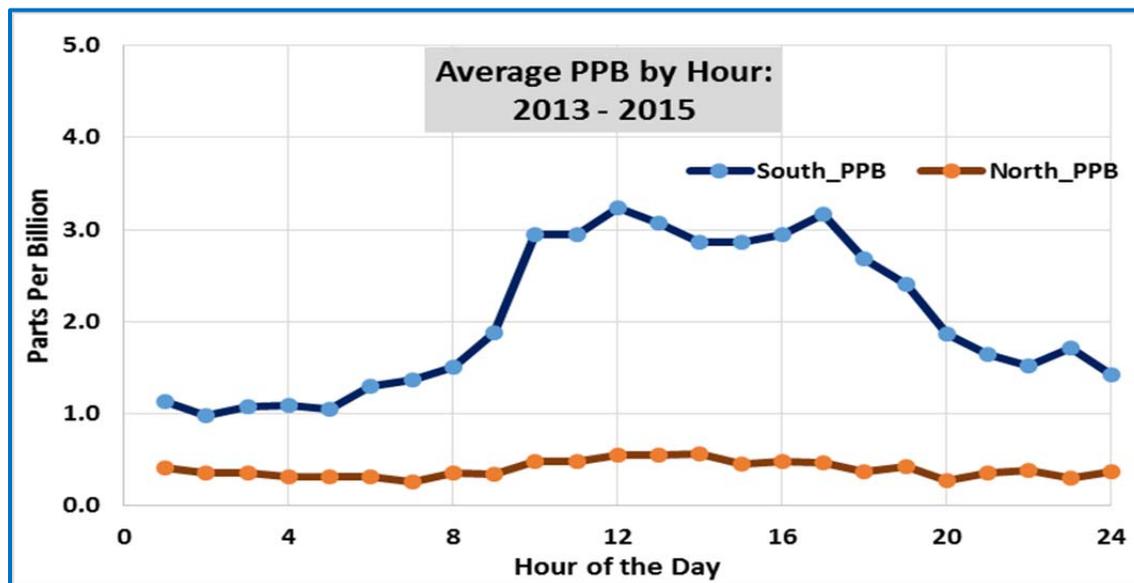
The same information is plotted on Figure 8.

Figure 8: Hess Ambient Monitoring Sites - Historical Data Summary



Another parameter of interest which may affect the monitor location selection is how the ambient data changes diurnally. That information is displayed in Figure 9 below and covers the period of 2013 through 2015.

Figure 9: Hess Ambient Monitoring Sites – Average PPB by Hour



The results of this review show a marked difference in ambient SO₂ concentrations at the Southeast site. The Northeast site shows only a modest difference based on the hour of the day.

4.2.2.2. Trends and Analysis (Ambient Monitoring)

A cursory review of the ambient data yields several geographic and temporal observations. The geographical difference in the data is, for the most part, clear. The Southeast site consistently records higher data than the Northeast site. This seems to occur both in the short term (expressed in the same manner as the 1-hour ambient standard) and long term (as an annual average). In fact, with the exception of one data point (2011 – 99% percentile), the Southeast site always exceeds the value of the Northeast site; short term and long term. Clearly the Southeast site is more likely to record higher values than the Northeast site a large percentage of the time.

This conclusion presumes, of course, that the primary sources of SO₂ remain consistent with the past. This view is reasonable because the emission sources are known (SRU and flare) and no significant new SO₂ emissions sources are foreseen in the surrounding area.¹⁴

The temporal distribution of the data shows relatively consistent data up until about 2011. The years 2011 through 2014 stand out as unusual. This observation is strikingly similar to the emissions data presented in Figures 1 and to some extent Figures 2 and 3. Those years of emissions were also, for the most part, different from the norm. The reason for the difference in emissions is discussed in Section 4.1.2.3. The reader will recall that the facility was experiencing operational difficulties which caused more

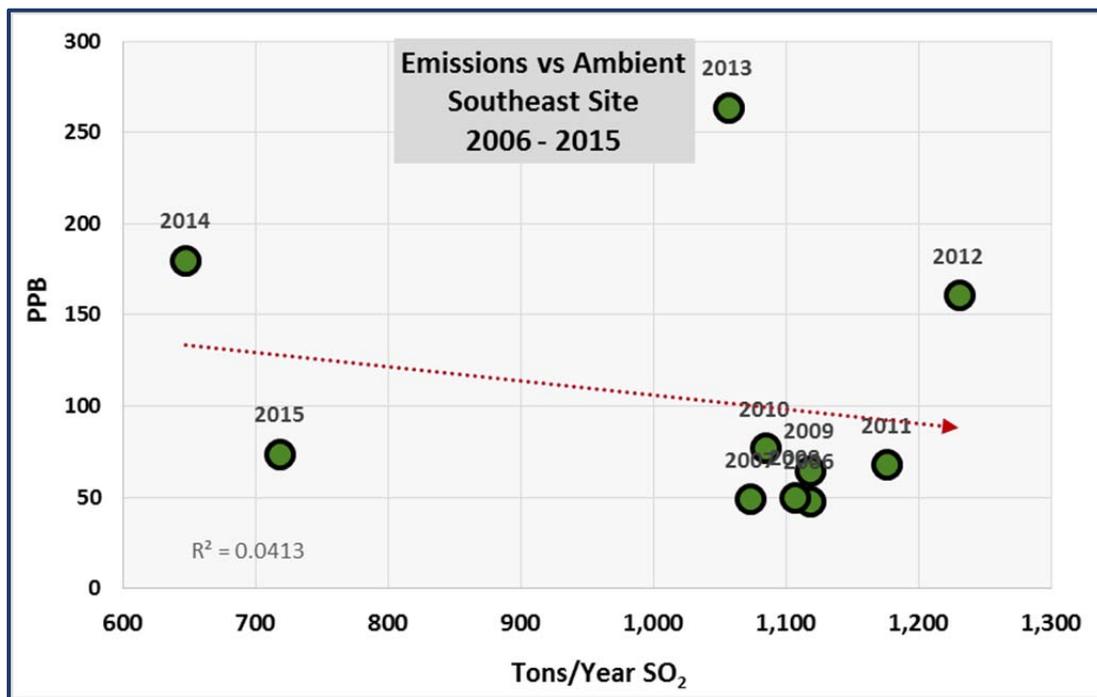
¹⁴ That is not to say that there will not be, or are not, other SO₂ sources in the area. However, it is presumed that those sources will not have a measurable impact on these ambient monitoring sites.

emissions than usual, particularly on a short-term (upset) basis. (See Figures 2 and 3.) During this time, Hess entered into an “Administrative Consent Agreement” (ACA) in December, 2013¹⁵ that required the facility to make operational changes. Those operational changes have, for the most part, been completed. A few lingering problems remain, but it is anticipated that they too will fade in the near future.

These observations tend to indicate that many of the excessive ambient data found throughout the past three years are likely caused by the large number of spikes in emissions data. This is confirmed by information in the ACA itself along with other documents provided to and by NDDH.

The result may also be demonstrated via statistics and in Figure 10 below.

Figure 10: Emissions vs. Ambient Data (Southeast Site): 2006 - 2015



The figure shows the annual emissions versus the ambient concentrations (99th percentile of the daily 1-hour max) for the 10-year period 2006 through 2015. The figure makes it fairly clear that the annual emission rate during this period does not reflect the ambient data observed at the Southeast site. In fact the slope of the line is negative (although not statistically different from zero)¹⁶ which indicates that, as emissions rise, the ambient concentration decreases (or remains independent of emissions).

¹⁵ Administrative Consent Agreement: Case No. 13-001 APC, N.D.C.C. Ch 23-25: State Department of Health State of North Dakota and Hess Corporation.

¹⁶ A statistical test was applied to the slope to determine if there was enough evidence to deny the null hypothesis that the slope is zero. The statistical test did not provide such evidence thus concluding that

Along the same lines, the correlation coefficient (R^2) equals 0.04. This further indicates no predictable relationship between annual emissions and the Southeast ambient monitor as measured by the 99th percentile.

The data in this section indicates that the selection of the ambient monitoring station should not take into strict account the recent variable (spike) emissions data as a significant factor.

4.2.3. Existing Dispersion Modeling

The data gathering task would not be complete without a review of any existing dispersion modeling results that could be applied to site selection. It was decided to conduct new air quality dispersion modeling specifically for this project. Thus, data could be obtained following suggestions of the TAD and NDDH dispersion modeling staff. A discussion of the modeling conducted for this project is found in Section 5.2. Details of the modeling input and output parameters are contained in Appendix A.

4.2.4. Meteorological Data

An understanding of the meteorology (and climatology) is critical to identifying potential maximum concentration.¹⁷

There is a set of meteorological data available for this project. On-site meteorological data has been gathered at the Northeast site for well over 20 years. The subsections below provide a summary and analysis of the data as it applies to establishing a reasonable ambient monitoring station. From a climatological point of view, the Tioga area is dominated by continental air masses. Tioga typically has cold winters and hot summers. In addition to the temperature differences by season, diurnal temperature changes are also dramatic compared to many other states. The climate is generally semi-arid and has less precipitation and humidity than the eastern half of the state. Annual precipitation is generally less than 17 inches. Specific meteorological data for the area is provided in following sections of this document.

4.2.4.1. Meteorological Station Description

The meteorological station operates as an integral part of the Northeast site (SO_2) described in some detail in Section 4.2.2.1. In addition, Figure 7 shows the location on a Google Earth© map. For the purposes of completeness, the table below was also created to provide a general description of the site location. In addition to the description, the meteorological parameters recorded at the site are also presented.

the slope is likely not any different than zero which would indicate that ambient concentrations are independent of the emission rate for this analysis.

¹⁷ This paragraph is paraphrased from section 2.4 of the TAD.

Table 5: Meteorological Monitoring Site Details

Parameter	Site #1 (North)	Units
AQS #	38-105-0103	n/a
Elevation	713	Meters
Latitude	48.4088	Degrees
Longitude	-102.9077	Degrees
Start Date	7/1/87	n/a
Direction (Site to Gas Plant SRU stack)	210	Degrees
Distance (Site to Gas Plant SRU stack)	1.34	Kilometers
Meteorological Parameters		
• Wind Speed	Hourly	Meters/sec
• Wind Direction	Hourly	Degrees
• Wind Sigma	Hourly	Degrees
• Temperature	Hourly	Degrees F

It should be clear from the site location and other information that the data from this station is well suited for site selection purposes. The station has been collecting hourly data for many years. The data has been reported to the NDDH on a quarterly basis. The site undergoes routine calibrations and audits in conformance with the Quality Assurance Project Plan (QAPP).

4.2.4.2. Meteorological Station Data

This section of the document provides a summary of the meteorological data collected at the site. Since this is meant as an overview, the information will be presented as a series of tables and figures. Only the most recent three years of data will be reviewed since that is the period of most interest. With that in mind, the following data is presented.

Temperature

It is presumed that temperature alone does not play a notable role in site selection. Temperature, and its related parameters such as vertical profiles (and thus atmospheric stability), are not nearly as important in identifying a site as wind speed and direction. The following table is a breakdown of temperature data for the past three years.¹⁸

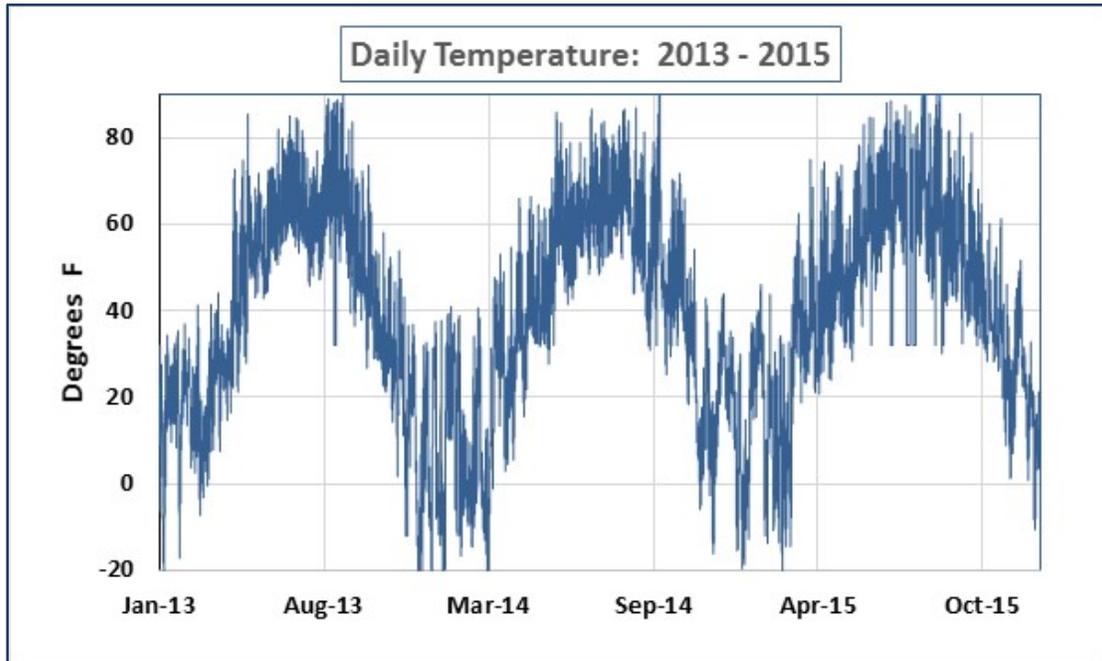
¹⁸ The same three-year period as presented in the ambient and emissions data was used for convenience.

Table 6: Ambient Monitoring Temperature Summary: 2013 – 2015

Parameter	Value	Data (°F)	Parameter	Value	Data (°F)
By Month	Jan	13	By Hour	1	36
	Feb	11		2	36
	Mar	24		3	35
	Apr	37		4	34
	May	53		5	34
	June	62		6	33
	July	64		7	34
	Aug	65		8	35
	Sept	59		9	36
	Oct	44		10	39
	Nov	25		11	41
	Dec	15		12	43
				13	44
By Year	2013	38		14	46
	2014	39		15	46
	2015	42		16	47
				17	46
				18	45
				19	44
				20	42
				21	40
				22	39
				23	38
				24	37

An hourly plot of the temperatures from this station is found in Figure 11.

Figure 11: Hourly Temperature: 2013 - 2015



Wind Speed

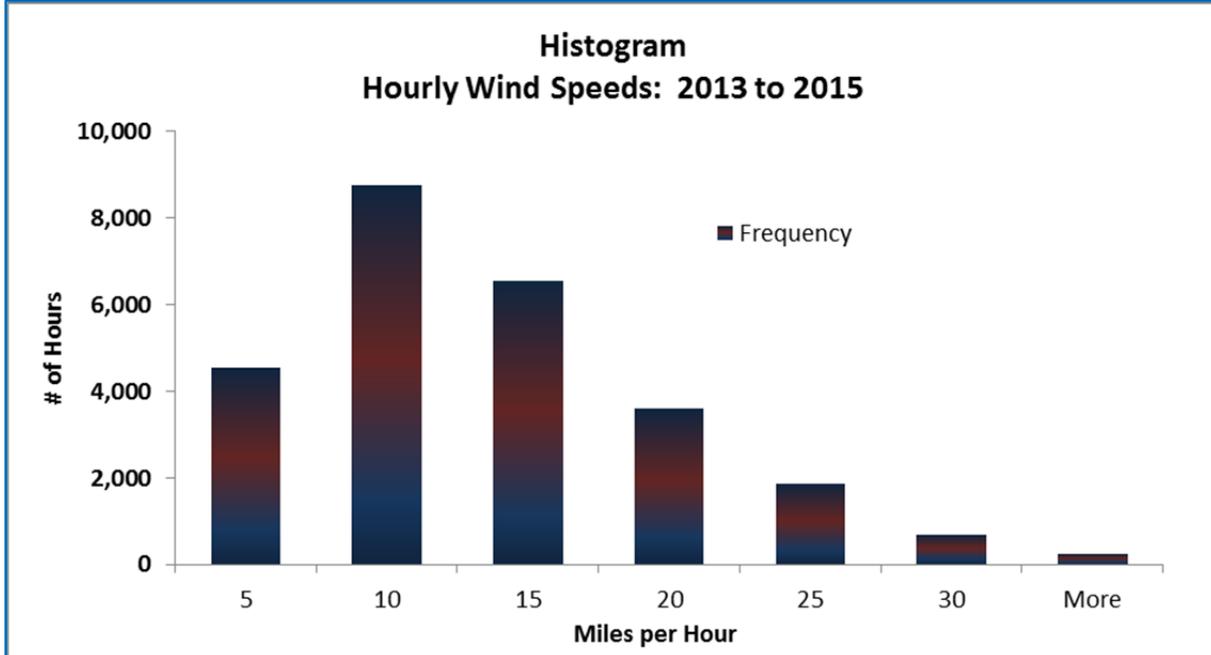
A summary of the wind speed data is provided in the table below. More information about this parameter is found in the following section of this report.

Table 7: Ambient Monitoring Wind Speed Summary: 2013 – 2015

Parameter	Value	Data (mph)	Parameter	Value	Data (mph)
By Month	Jan	14	By Hour	1	9
	Feb	11		2	9
	Mar	11		3	9
	Apr	13		4	9
	May	12		5	9
	June	11		6	9
	July	9		7	10
	Aug	8		8	10
	Sept	10		9	11
	Oct	11		10	12
	Nov	12		11	13
	Dec	10		12	13
				13	14
By Year	2013	10.8		14	14
	2014	11.5		15	14
	2015	10.7		16	14
				17	13
				18	12
				19	11
				20	10
				21	10
				22	10
				23	10
				24	9

In addition to summary statistics, it is also worth reviewing the distribution of the wind speeds. The figure below provides a histogram showing the frequency of occurrence for various categories of wind. The figure, by and large, shows that there are strong winds in the area. The two most common categories cover wind speeds from 5 to 15 miles per hour.

Figure 12: Histogram of Hourly Wind Speeds: 2013 - 2015



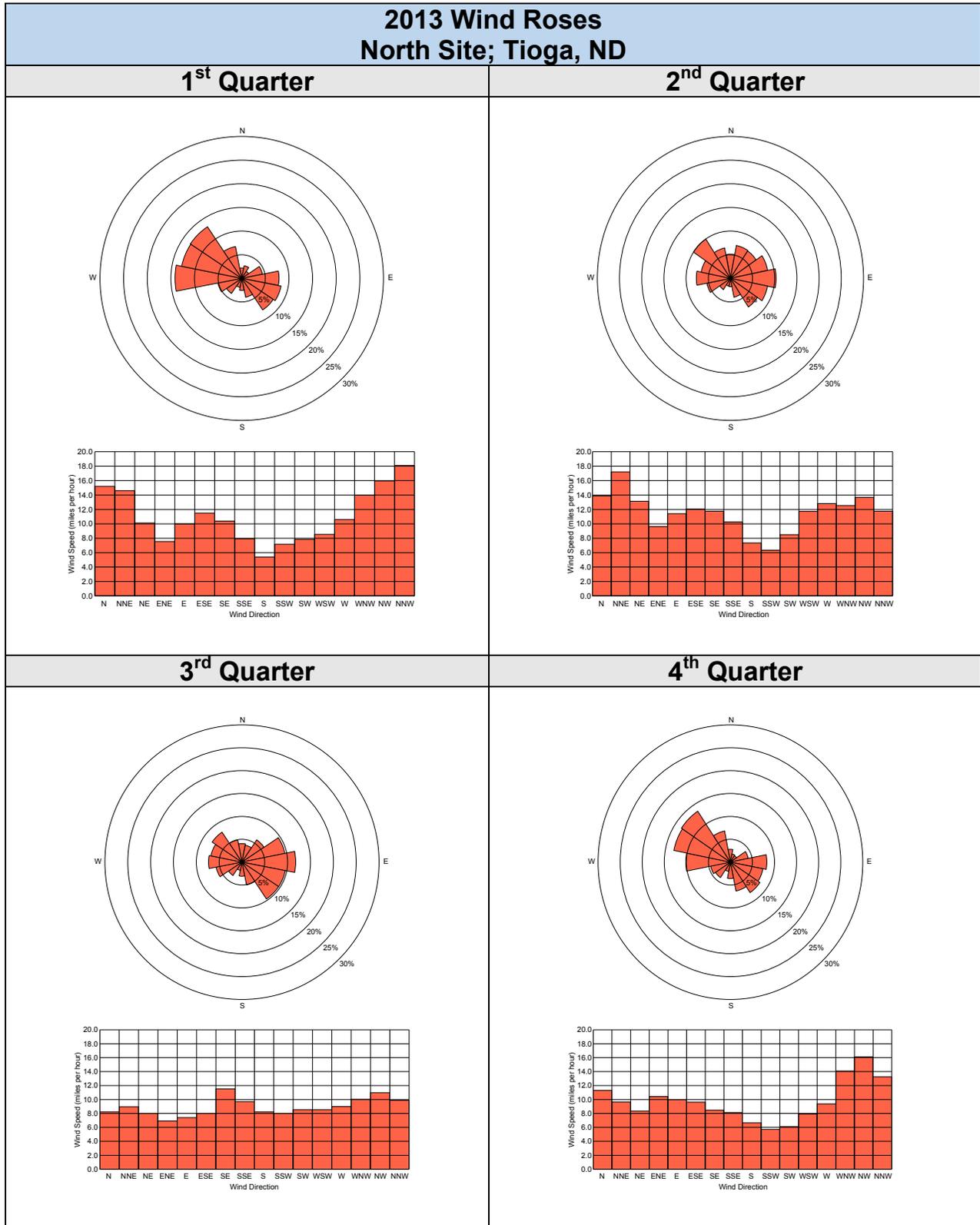
Wind Direction¹⁹ (and Speed)

A review of the wind direction data is presented in a different manner. This information may best be observed via a wind rose or frequency distribution by direction. Wind rose data are plotted on a quarterly basis in the quarterly reports submitted to NDDH. The submitted data also contains a bar graph that shows the wind speed through each of the wind direction components.

The following figures provide the quarterly roses from 2013 through 2015.

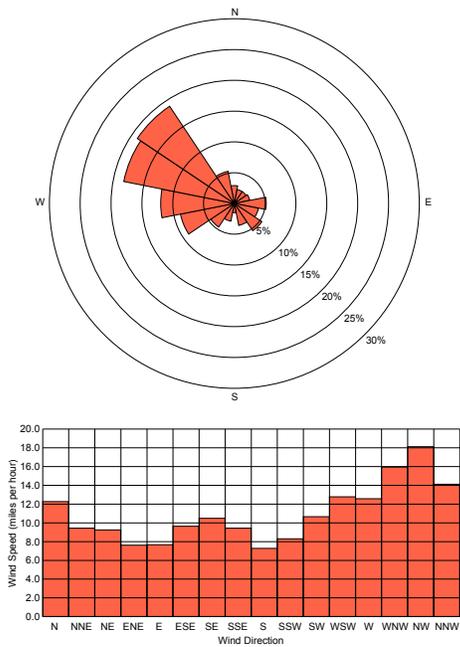
¹⁹ As a reminder to the reader, all wind direction data is presented as the wind direction from which the wind is blowing. The wind vector (the direction in which the wind is traveling) is a 180° adjustment from the reported wind unless otherwise indicated.

Figure 13: Wind Rose by Quarter: 2013 - 2015

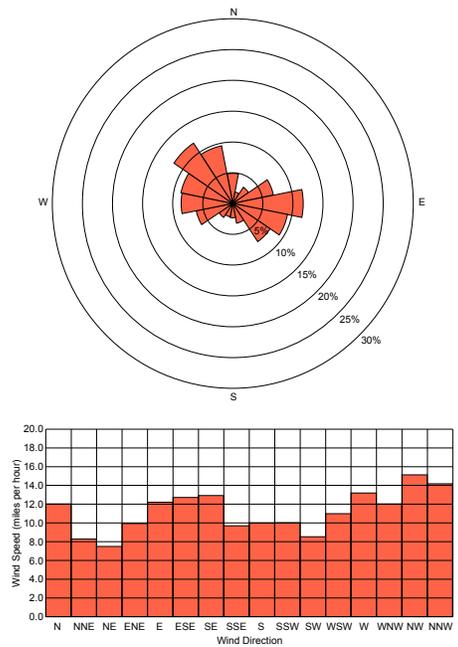


2014 Wind Roses North Site; Tioga, ND

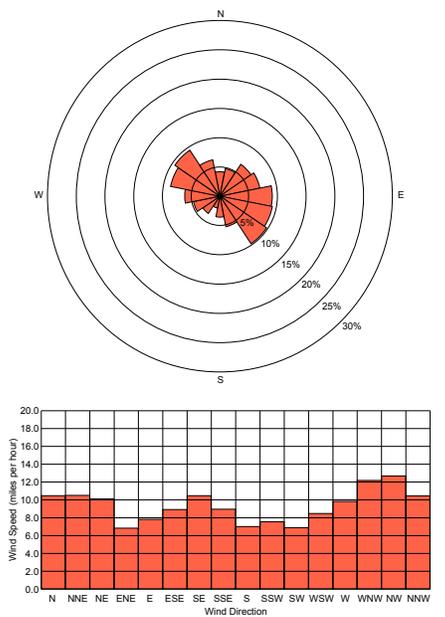
1st Quarter



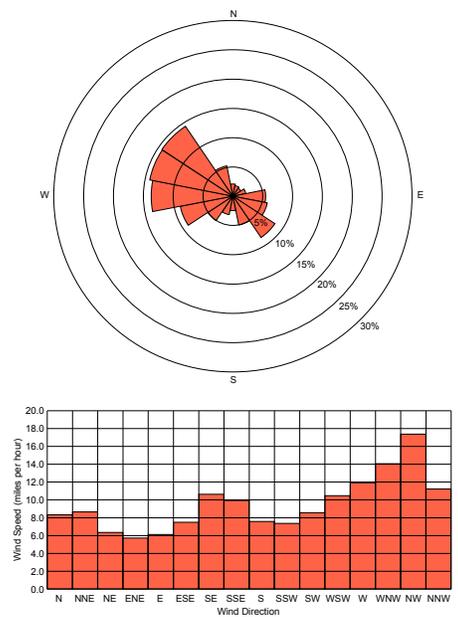
2nd Quarter



3rd Quarter

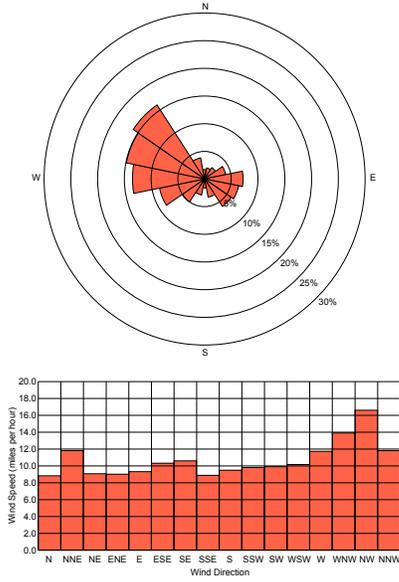


4th Quarter

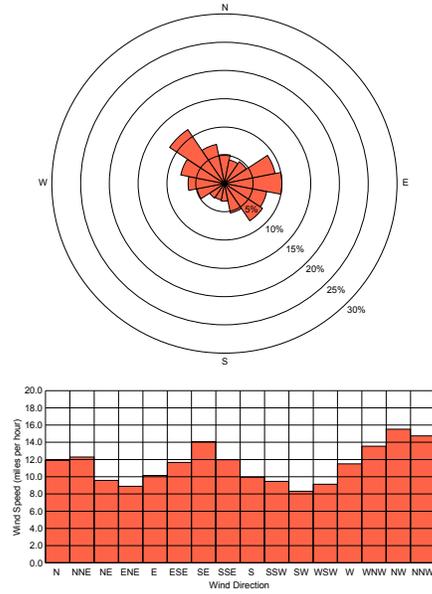


2015 Wind Roses North Site; Tioga, ND

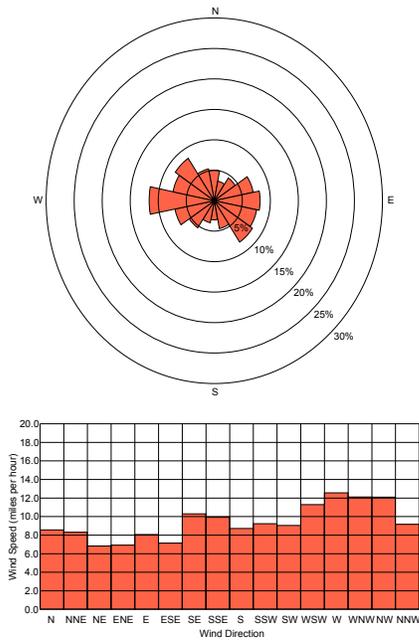
1st Quarter



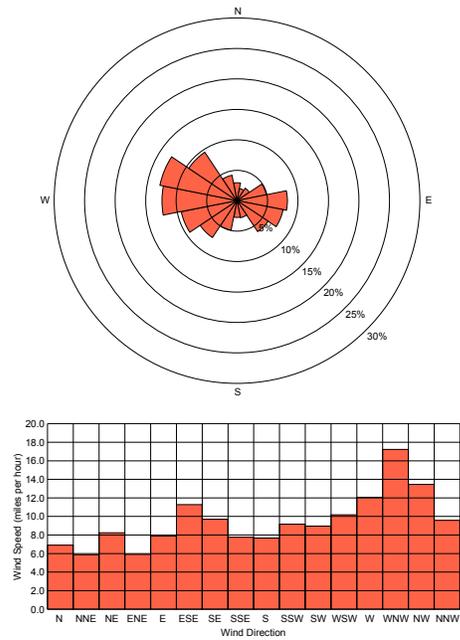
2nd Quarter



3rd Quarter



4th Quarter

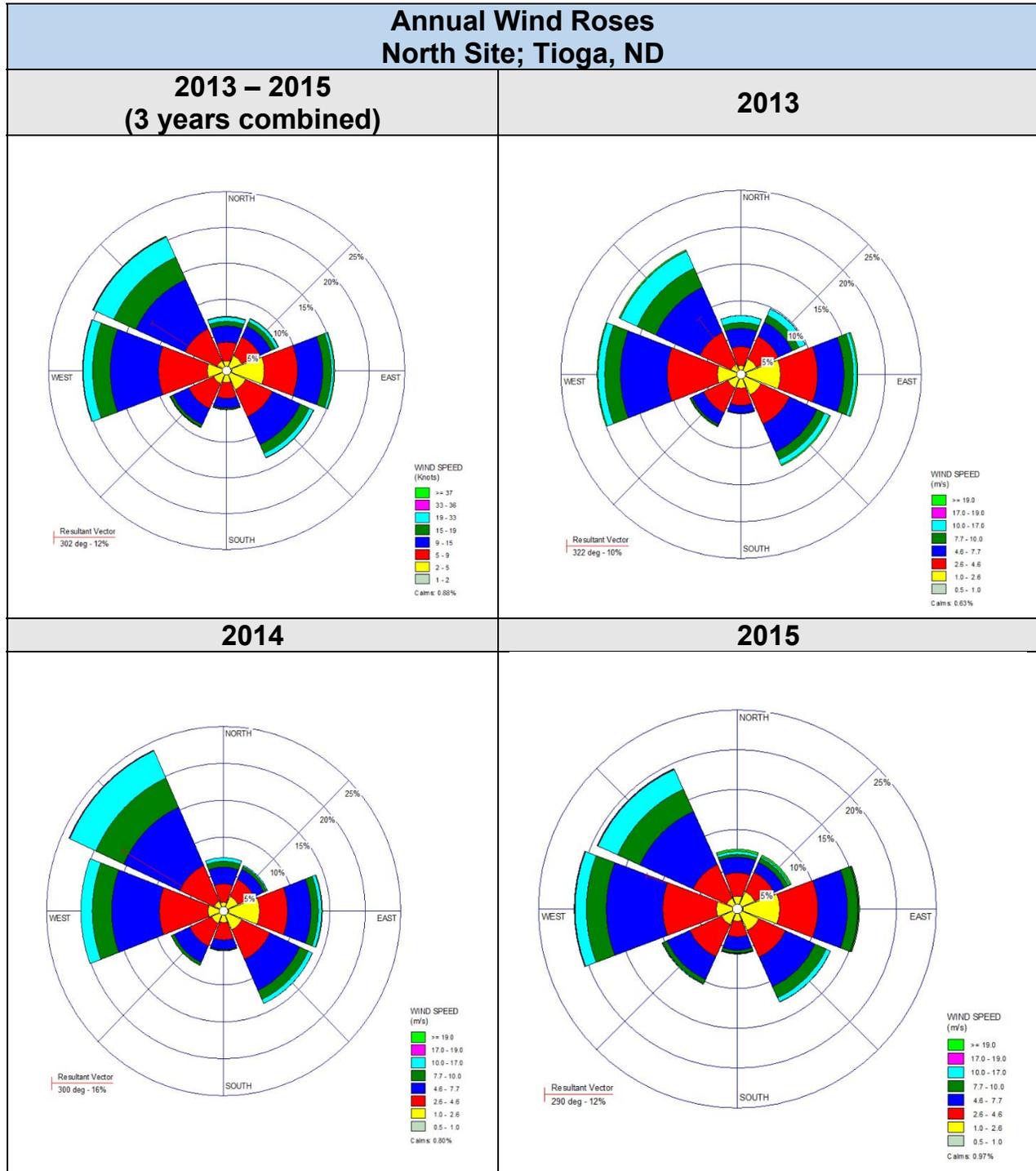


A review of those figures results in the following observations:

- Most of the quarters have a relatively consistent wind rose.
- The most frequently occurring directions are west through north.
- The least common sectors appear to be north through northeast and south through south-southwest.
- Wind speeds are relatively persistent through all directions. Regardless of the wind direction, the wind speed averages 8 to 16 miles per hour (roughly).

The quarterly wind roses presented provide a useful look into wind direction and speeds at various quarters. However, the purpose of this project is the selection of a reasonable ambient monitoring site. A review of the annual wind rose data is also constructive. Therefore, the following wind roses were generated to provide such a review.

Figure 14: Annual Wind Roses: 2013 - 2015



A review of these figures indicates similar results as noted in the quarterly roses. Notably, the predominant wind directions on an annual basis are more defined (with less variation) than quarterly data. The annual roses show that the most common wind

direction is either northwest or west for all four wind roses. Thus, prevailing winds tend to blow from the plant toward the Southeast monitoring site.

4.2.4.3. Meteorological Analysis

The analysis begins by first reviewing the temperature data. The information shown in the tables and figures above appears to be typical of the north-central United States. A short synopsis of this information might conclude:

- Temperatures are seasonably dependent.
- The temperature difference between day and night is notable.
- There do not appear to be any trends in temperatures between years.²⁰

None of these observations, however, seem to have any weight in the selection of an appropriate monitoring station. There is nothing in the data set that would provide insight into that decision-making process.

An analysis of the wind speed and wind direction data, however, is critical to the eventual site selection (Section 6 of this report). The most appropriate monitoring location is one in which there is the greatest chance of observing peak concentrations with any degree of certainty or frequency.

Although discussed briefly above, a review of the figures yields the following observations:

- 1) Wind speeds are, in general, greater than in the majority of the U.S., but not especially unique as far as the entire state of North Dakota.
- 2) Wind speeds are, to some extent, independent of the wind direction.
 - a) With each wind direction category (annual basis in particular), the percentage of wind speed categories is roughly similar.
 - b) The exception to that rule appears to be in the predominant wind directions of west and northwest. In those directions, the wind speed categories tend to be higher.
- 3) The predominant wind direction is either westerly or northwesterly.
 - a) For the three years combined, the northwest quadrant edges out the west.
 - b) Not surprisingly, the higher wind speeds are recorded in these two quadrants.
- 4) The least recorded wind direction quadrant is south.
 - a) The wind directions of north, northeast and southwest are not far behind the south quadrant.

²⁰ An analysis of a 10-year period confirms this observation. That analysis is not reproduced here to keep the report more concise.

- b) It is somewhat of a tie between southwest, northeast and north as the 2nd least recorded direction.
- 5) As an integral part of the preparation of the annual wind roses, a “resultant vector”²¹ is calculated. The resultant vector for each year and combined years is:

<u>Year</u>	<u>Resultant Vector *</u>
2013	322
2014	300
2015	290
2013 - 2015	302

** The reported vector is the direction from which the wind is blowing; not the direction the wind is traveling.*

4.2.5. Geographical Influences

A discussion about monitoring siting would not be complete without a review of the geography of the area of interest. In many western states this could be a major factor in site selection. For the Tioga area, however, this is not a significant parameter of interest.

The area surrounding Tioga varies from flat to soft rolling hills. There is less than 200 feet difference in elevation anywhere within a 10 mile radius of the plant. The relief is generally less than 50 feet for much of the area. With that in mind, several potential geographical influences, as mentioned in the TAD, are discussed below.

Thermal Driven Winds

Thermal driven winds are caused, in general, by uneven heating of the surface. This can lead to different air densities across the surface along with some possible pressure gradients. This is usually the result of a portion of land mass that due to its characteristics will absorb more heat (sunshine) than a nearby area. As this area heats, cooler denser air will flow into the (heated) area. These winds are, of course, not influenced by synoptic conditions.

With this in mind, a cursory review of the area was conducted (Google Earth and general on-site knowledge). That review does not indicate any areas of sufficient size that might lead to any significant uneven heating of the surface. Thus, there does not appear to be any reasonable expectation of thermally driven winds to influence the siting of an ambient station.

²¹ The wind roses were calculated and plotted via the WRPLOT software provided by Lake Environmental.

Vertically Coupled Flow

The TAD describes this geographically influenced wind as a downward airflow which is caused by winds aloft over or near a valley. These winds aloft influence the normal in-valley air flow. What results is a surface wind flow which acts more like the upper flow (or at least is influenced by upper flow) than the more typical in-valley (up and down a valley) direction.

There are no well-defined valleys in or near Tioga. As noted earlier there is less than 200 feet of relief with 10+ miles. Also, there are no major river drainages. Therefore, the geography of the area does not lend itself to vertically coupled flow.

Pressure Driven Channeling

The TAD describes this phenomenon as one possible geographic influence. However this channeling relates to high and low pressure areas within, generally speaking, large but short valleys. For the Tioga area, there is no presence of any definable valley for this phenomenon to occur. The 'channeling' requires a definable valley, usually large. Since this is not present anywhere within the region, it is assumed this geographical influence does not occur.

Forced Channeling

This geographical influence is one in which the winds will tend to move in a different direction from the overlying pressure due to terrain. Unlike pressure driven channeling, this activity is more common in narrow and short valleys. Again, this is not a likely geographical influence since there are no valleys of note within the Tioga area.

5. Monitor Siting

5.1. Introduction

Following the suggestions in the TAD, it is recommended that there are three possible approaches to analyzing and selecting a proper ambient monitoring station. Those approaches are:

- (i) Modeling (to inform monitor placement)
- (ii) Exploratory Monitoring for Monitor Placement; and
- (iii) Monitor Siting Based on Existing Data

Those three approaches are discussed below. For the purpose of this analysis, both (i) and (iii) were chosen. Using a combination of two approaches is prudent since it takes into account a substantial amount of both existing and new data.

5.2. “New” Dispersion Modeling

The TAD suggests that ‘new’ dispersion modeling is an approach that may be used “to inform monitor placement” for these purposes. The document goes on to suggest the use of “normalized” emission rates along with other recommendations in conducting such modeling. The idea expressed in the document is to assist the agency with a method of identifying likely areas of maximum concentration from the source or area at hand.

Following discussions with NDDH, a decision was made to use modeling, in part, to assist in defining the ambient monitoring network. Hess made the decision to conduct “new” modeling for the specific purpose of DRR implementation.

The reader is referred to Appendix A of this document for details about the dispersion modeling effort itself. The modeling was conducted using the procedures outlined in the TAD. In a few instances, minor adjustments were made (a denser receptor grid, for example) for this model in order to improve the output. The model was executed in the approved regulatory mode using meteorological data obtained from NDDH.

Appendix A outlines the meteorological, receptor, emissions and other data associated with the modeling itself. The reader is again referred to Appendix A for a detailed discussion about data input and output. For purposes of this section, the following table has been created to summarize the modeling effort.

Table 8: Dispersion Modeling Elements Summary

Parameter	Sub-Parameter	Units	Comments
Model	---	AERMOD	Version 15181
Meteorological Data (<i>compiled by NDDH</i>)			
	Surface Data	Williston NWS	2011 – 2013
	Upper Air Data	Glasgow, MT	2011 – 2013
Receptor Grid			
	Cartesian	100 / 250 / 500 meters	Extends to 20 kilometers (see discussion in Appendix A)
	Fenceline	50 meters	
	Total Receptors	8,010	Includes fenceline and Cartesian
SRU Stack Data			
	Height	50.3 meters	
	Diameter	0.89 meters	
	Exit Velocity	22.8 m/sec	Data from CEM
	Exit Temperature	578 °K	Data from CEM
	Emissions	1 lb/hour	Generic Rate (<i>see discussion below</i>)
	Building	---	Includes building downwash calculations based on on-site building dimensions
Output	3-Year Design	µg/m ³	Three-year average of the 1-hour daily maximum
	MAXDAILY		Outputs daily maximum value for each receptor for every day of processed meteorology (3 years)

In order to assist with siting an ambient monitor, the output of the model was coded to provide the “design” value. This is the three-year average of the 99th percentile of the daily hourly maximum reading at each site.²² AERMOD has been programmed to provide this specific information. The design value is calculated by the model for each and every receptor.

Before we begin with analyzing the output of the model, a few caveats are provided:

- The TAD suggests that (normalized) actual emission rates could or should be used in the dispersion modeling runs. For this exercise, it was decided not to use actual emission rates due to their variability during that time (i.e., the 2011 – 2013 meteorological data). Since then the plant has undergone multiple

²² This is the exact form of the ambient standard itself. The ambient standard is found in 40 CFR 50.17. Additionally, Appendix T (to 40 CFR 50) provides computational and data handling procedures associated with calculating the “design” value.

changes such that a different emission profile is expected from 2017 into the future. Thus a more conservative approach is to use a single emission value for all 8,760 hours for each of the three years. This assures the model is predicting ambient concentrations for all hours and does not miss potential impacts when the unit was either down or operating erratically.

- The emission rate programmed into the model was 1 pound per hour for all hours of all years. This is a nominal value and not intended for use as a compliance tool. The purpose of these model runs is to locate an ambient monitoring site; not to determine adherence to an ambient standard.
- The emission rate, regardless of the value, has no effect on ambient monitoring site selection for this project. Since there is only one noteworthy emission source in the model, then the (consistent) emission rate has no bearing on where a peak receptor might be located. The spatial distribution of the data is the same.
- The output of the model is in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) as is common to AERMOD analysis. The values are not suitable to compare against the ambient standard since the emission rate itself is nominal.

5.2.1. Design Value Analysis

The first step in reviewing the model results is to create a simple table that identifies the receptor site location against its predicted ambient concentration. There were over 8,000 receptors, but in order to focus on possible locations with high concentrations, a summary of the top 20 receptors was chosen. The table below contains that summary.

Table 9: Rank Order - Top 20 Receptors

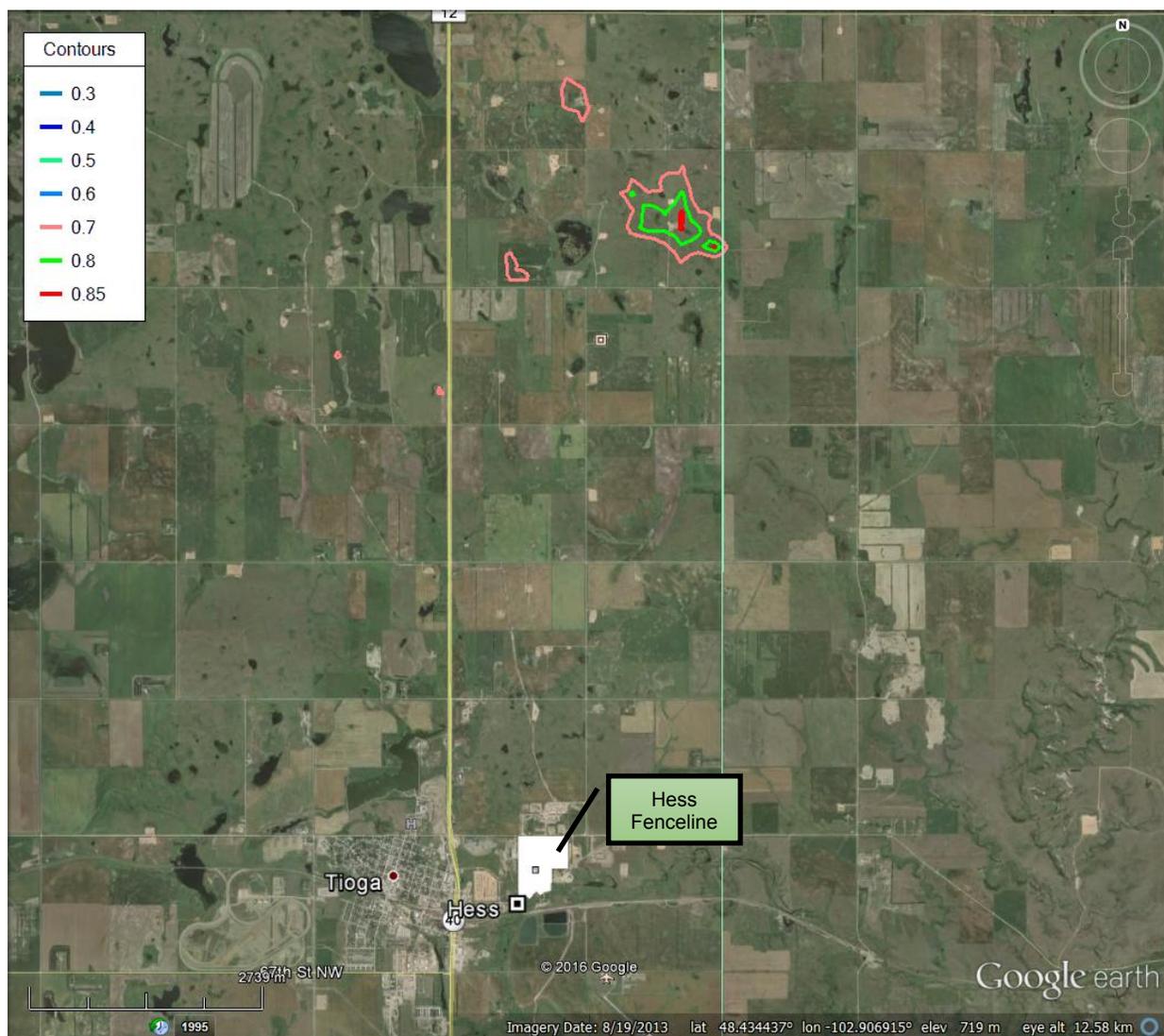
Rank Order	Easting (meters)	Northing (meters)	Receptor Design Value ($\mu\text{g}/\text{m}^3$)
1	656,200	5,369,900	0.91
2	655,800	5,370,300	0.88
3	656,100	5,370,000	0.87
4	655,500	5,370,200	0.87
5	656,200	5,370,000	0.86
6	655,300	5,370,500	0.86
7	655,400	5,370,300	0.86
8	655,800	5,370,400	0.86
9	655,800	5,370,200	0.86
10	655,300	5,370,400	0.85
11	655,400	5,370,400	0.85
12	655,800	5,370,100	0.85
13	655,300	5,370,300	0.84
14	655,400	5,370,200	0.84
15	655,700	5,370,200	0.84
16	655,500	5,370,500	0.83
17	653,000	5,368,300	0.83
18	655,600	5,370,300	0.83
19	656,100	5,370,100	0.82
20	655,600	5,370,700	0.82

Easting and Northing = UTM

The data shows design values do not change dramatically from the peak receptor. The first 10 receptors are within 5% of the peak value. In addition, receptors 11 through 20 are within roughly 10% of the peak value.

The figure below was created as an isopleth to show the reader the location of the high recording receptors and the spatial extent of that data.

Figure 15: Design Value Isopleths



The figure indicates that the area of highest concentration is located approximately five miles NNE of the SRU stack. (The plant site is shaded in white in the lower middle portion of the figure.) The maximum concentration is $0.91 \mu\text{g}/\text{m}^3$ (based on 1 pound per hour emission rate). Since the dispersion model is an estimation tool, it would be prudent to consider a monitoring location area in or near the 0.91 value; but not necessarily at that exact location. To define such an area, it was decided to consider all areas that are within about 10% to 20% of the peak value. The area could be expanded with confidence if it is not possible to find a suitable monitoring station.²³

²³ By using the term “suitable” we are referring to a location that has electricity, physical access, and permission may be obtained from the current landowner or access permitted from a public source (i.e., roads).

The figure indicates that an area of about ½ km x ½ km would include an isopleth containing design values within about 10% or so of the maximum.

The figure also contains a few other pockets of isopleths with values in the vicinity of the maximum design value. However, these areas are quite small compared to the area above. It would not seem reasonable to consider these areas for a monitoring site since they are small in nature. One would have a much higher probability of yielding high ambient data at the larger isopleth.

5.2.2. Frequency Analysis

In addition to considering the area (isopleth) that yields the largest design value, it is also appropriate to consider the frequency in which high concentrations are found. This concept is discussed at some length in the TAD for example:

“... the site selection process also needs to account for the frequency in which a receptor sees daily maximum concentrations.” (p. A-6).

Using the TAD as a general guide, an analysis was conducted of the frequency of occurrence of which receptors yield the most frequent ‘daily maximum concentrations.’ The raw data used to make this analysis is from the MAXDAILY option in AERMOD. Therefore, during the modeling runs, this option was executed.

This modeling run option outputs the maximum 1-hour concentration for each day for each receptor for all three years of meteorological data. For this case, the output file was imported into Access and then sorted by daily maximum concentrations. Any maximum concentration that was less than ½ of the single highest value was removed from the data set. This left about 14,000 records which could then be copied into Excel for processing.

This pared down dataset was then analyzed. A count was executed to tally the number of times (day) in which a particular receptor was found to have the highest recording value among all receptors for that particular day. As such those receptors that had among the most frequently occurring ‘daily maximum’ readings would be candidates for possible site selection.

The table below is a summary of the top 25 receptors that had the most frequent occurrence as the daily maximum values among all receptors.

Table 10: Receptor Rank Order - Daily Max Frequency

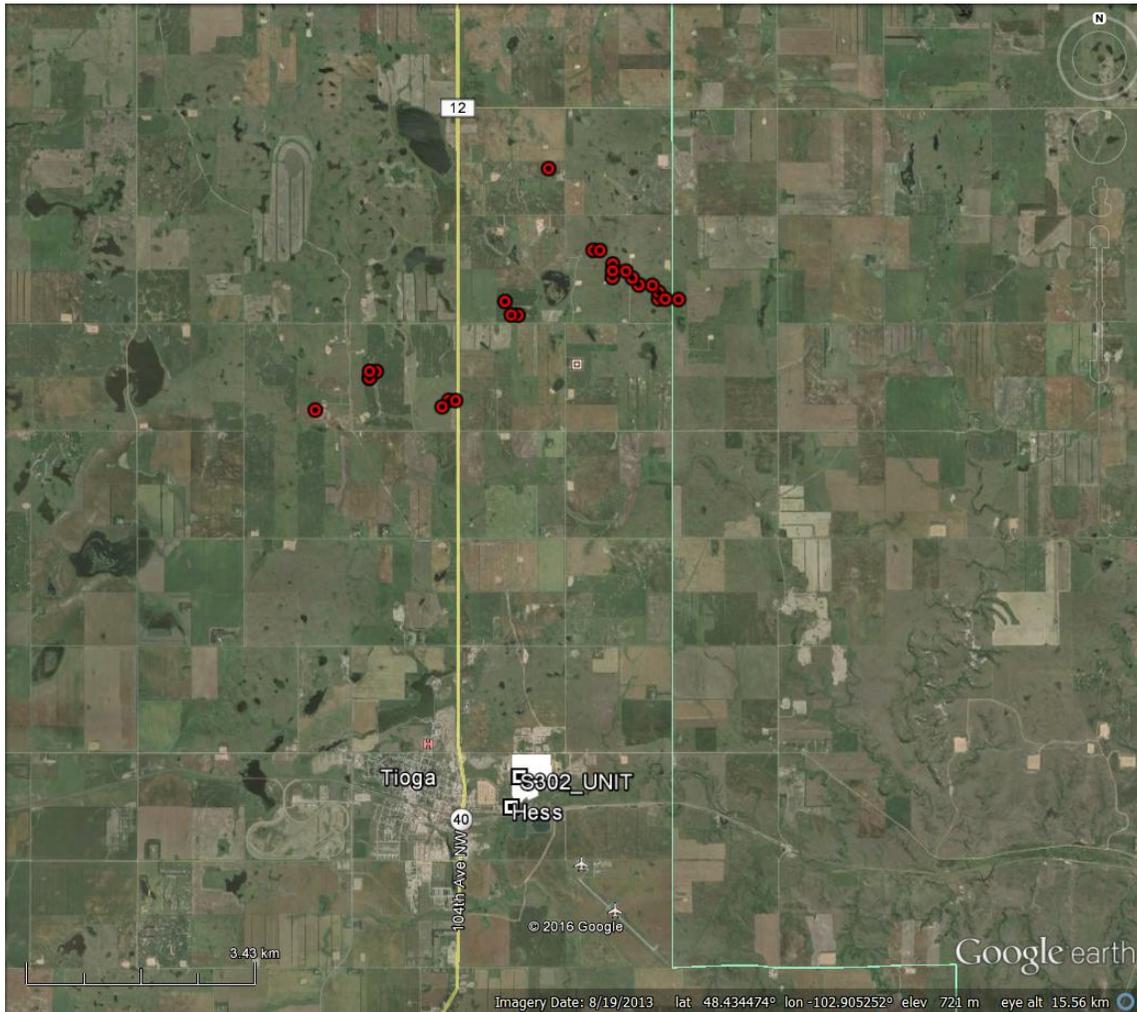
Rank	Receptor #	Count (# of Daily Max)	X – UTM	Y- UTM
1	201	25	653,000	5,368,300
2	990	18	653,900	5,369,600
3	1193	18	656,200	5,369,900
4	1602	18	655,100	5,370,600
5	1309	11	655,800	5,370,100
6	991	9	654,000	5,369,600
7	1252	9	656,100	5,370,000
8	1368	9	655,700	5,370,200
9	1603	9	655,200	5,370,600
10	140	8	652,900	5,368,200
11	1311	8	656,000	5,370,100
12	368	7	651,800	5,368,600
13	2315	7	654,400	5,371,800
14	369	6	651,800	5,368,600
15	1425	6	655,400	5,370,300
16	1485	6	655,400	5,370,400
17	202	5	653,100	5,368,300
18	429	5	651,800	5,368,700
19	430	5	651,900	5,368,700
20	1109	5	653,800	5,369,800
21	1192	5	656,100	5,369,900
22	1195	5	656,400	5,369,900
23	1365	5	655,400	5,370,200
24	1427	5	655,600	5,370,300
25	61	4	651,000	5,368,100

A review of the table indicates that the frequency of occurrence does not change drastically within the top ranking receptors. Although the complete dataset is not shown here (for brevity), a review of the top 200 receptors indicates the same trend; there is no clear demarcation between receptors in the top 25 (or 200+) receptors.

Also, the table indicates that the receptor locations are grouped together. All of the receptors, save #201, are within approximately 1,000 meters of each other.

The figure below provides the location of these receptors overlaid on a Google Earth© map.

Figure 16: Top 25 Frequently Occurring Receptors



The results are similar to the isopleth plots provided earlier. In nearly all cases, the receptors with the highest degree of frequency are also the same receptors (or nearby receptors) with the highest design values.

This makes the selection of the monitoring site, based on modeling, reasonably straightforward. Both the design value and frequency analyses indicate the same general location as a desirable area for ambient monitoring.²⁴

5.2.3. Receptor Ranking – Model Score

Although both the design value analysis and frequency analysis indicate the same general area as an ambient monitoring site, it was decided to carry the analysis one step further. This analysis follows the ranking suggestions found in Appendix A of the TAD.

²⁴ This assumes, of course, that power, access and other parameters are available for this area.

The analysis uses the information obtained in the two sections above to create an overall ranking of potential site (receptor) locations. The data and ranking are combined (design value and frequency) in order to create an overall score for the entire analysis. The table below provides the analysis.

Table 11: Receptor Scoring - Modeling

Receptor #	X – UTM	Y- UTM	Design Value Rank (Table 9)	Frequency Day Count (Table 10)	Frequency Count Rank	Score (sum of rank)	Score Rank
201	653,000	5,368,300	17	25	1	18	5
990	654,200	5,368,700	74	18	3	77	19
1192	565,100	5,369,900	24	5	17	41	12
1193	656,100	5,369,900	1	18	3	4	1
1252	655,800	5,370,100	3	9	7	10	3
1253	655,700	5,370,000	5	1	25	30	8
1365	656,100	5,370,000	14	5	23	37	9
1366	656,200	5,370,000	4	3	34	38	10
1367	655,700	5,370,100	21	1	35	56	17
1368	655,800	5,370,100	15	9	36	51	14
1424	656,000	5,370,100	13	2	42	55	16
1425	656,100	5,370,100	7	6	44	51	15
1427	656,200	5,370,100	18	5	24	42	13
1428	655,400	5,370,200	31	1	28	59	18
1429	655,500	5,370,200	2	3	36	38	11
1484	655,500	5,370,200	10	1	15	25	6
1485	655,700	5,370,200	11	6	14	25	7
1488	655,900	5,370,200	39	1	65	104	20
1602	655,500	5,370,200	4	18	3	7	2
1603	655,600	5,370,300	28	9	9	18	4

Note: The top 3 receptors are highlighted in yellow

By combining the results of the two ranking analyses, one can then make an assessment of the overall likely success of the high-ranking receptors. Both the frequency and design value analysis point toward Receptor 1193 (or any area thereabout). The top three receptors are all within ¾ kilometer of each other. Thus the modeling analysis suggested a receptor about five miles NNE of the SRU unit would be reasonable.

5.2.4. Near Fenceline vs. Model Receptor

Although the results of the design value analysis and frequency analysis both indicate the same receptor area as a (modeling) preferred location, the analysis was expanded slightly. NDDH’s initial suggestion was to consider a receptor nearer the plant (fenceline)²⁵ in consideration of previous screening modeling conducted by the agency.

²⁵ It needs to be noted here that Section 6 of this document concludes that indeed a site near the plant is appropriate. That site is chosen based on an analysis of existing data for the reasons outlined in Section 6 below and extensively elsewhere in this document. In the interest of a complete analysis, this section reviews the modeling data for an assessment of a receptor close(r) to the plant fenceline.

More specifically it was decided to make a frequency comparison between those receptors in the west through northwest direction along (and outward) of the fenceline property versus the north area receptors (Figure 15). The reader will note from earlier figures and detailed modeling output files that these fenceline receptors recorded design values less than those found in the North area (≈5 miles NNE of the SRU unit). Despite this difference a frequency analysis between the “north” and the “fenceline” area was conducted.

To that end, a separate model run was executed. This model run was identical to the prior runs except the output was limited to only those receptors near the “north” area and those near the fenceline (west through northwest). The “north” area consisted of 100 receptors covering 1 square kilometer. The receptors were Cartesian and separated by 100 meters each. A similar grid was set up in the northwest corner of the fenceline. Due to property boundary considerations, this grid had 83 receptors. All other parameters in the model execution were the same as previously described in this section and Appendix A.

The model output was specified to yield the “DAILYMAX” output. This allowed us to conduct a frequency analysis in the same vein as Section 5.2.1 and Table 10 above. The daily maximum value was output for each and every receptor for all three years of data. Using that information, the maximum concentration receptor was chosen for each day of output (1,096 days). Those maximum concentration receptors were then counted to determine the frequency of occurrence for all receptors. Those results were tallied (ranked) to determine which receptor most frequently assigned the maximum daily value. The results were analyzed to determine which general location (north or fenceline) is the most likely to yield maximum or frequent ambient SO₂ values.

Since there were only two areas of interest in this model run, there are many DAILYMAX values which were zero or near zero. (This occurs when the winds for that given day do not blow in the direction of these two receptor areas.) Obviously those data should not play a role in distinguishing between the two areas. It was decided to only analyze ambient data in which the model output was at least ½ (0.46 µg/m³) of the maximum predicted concentration for the three years.

Table 12 below provides a summary of the top 20 ranked receptors.

Table 12: North vs. Fenceline Area Frequency Ranking

Rank	Receptor #	Area	Count (# of Daily Max)	X – UTM	Y- UTM
1	N-100	North	25	656,200	5,369,900
2	N-109	North	13	656,100	5,370,000
3	N-174	North	13	655,600	5,370,700
4	N-116	North	12	655,800	5,370,100
5	N-125	North	12	655,700	5,370,200
6	N-118	North	11	656,000	5,370,100
7	F-9	Fenceline	11	654,164	5,363,016
8	F-61	Fenceline	10	654,000	5,363,000
9	N-102	North	10	656,400	5,369,900
10	N-118	North	9	656,000	5,370,100
11	F-11	Fenceline	9	654,361	5,363,022
12	F-8	Fenceline	8	654,065	5,363,013
13	F-10	Fenceline	8	654,263	5,363,019
14	N-99	North	7	656,100	5,369,900
15	N-144	North	5	655,600	5,370,400
16	N-115	North	4	655,700	5,370,100
17	N-136	North	4	655,800	5,370,300
18	N-101	North	3	656,300	5,369,900
19	N-114	North	3	655,600	5,370,100
20	F-55	Fenceline	3	653,900	5,362,900

Since this exercise is only for the purpose of finding an ambient monitoring site, no specific statistical test will be applied to the data. However, the ranking has a clear trend. All of the top six ranked receptors were located in the north area. There is less than a 2% chance this would happen due to randomness alone (given a 50:50 chance between north and fenceline).²⁶

This information shows a clear bias toward the north site. The data from the fenceline does not add any statistical information that would be sufficient to overturn the conclusions of the two previous analyses (design and frequency). Therefore, it is concluded that the north area is the preferred location based on the modeling data.

5.3. Exploratory Monitoring

Another approach suggested by the TAD is to conduct “exploratory” monitoring. This involves conducting a set of temporary monitors over a large (or targeted) area either in a spatial or temporal approach. Typically, one deploys a set of (portable and low-cost)

²⁶ To be fair, there were a few more north receptors than fenceline area receptors (100 vs. 83). Using that data, the chance that the first six ranks were all north receptors is less than 3% $[(100/183)^6]$.

monitors over an area. The monitors obtain data over a set period of time. That data is then analyzed to determine which area yielded the highest or most frequent SO₂ ambient data. That site or area is then a likely candidate for fulfillment of the DRR provisions.

The advantage of such a network is that it avoids predictive equations (modeling) as a means of identifying high concentrations of SO₂ and uses actual ambient results.

The disadvantages of this monitoring are several:

Timing

The biggest obstacle in the deployment of this approach is the time it would take to identify the possible saturation network, purchase the devices, deploy, and then analyze the results. For our purposes, the selected monitoring site must be included in NDDH's publication of the Annual Network Review which is due by July 1. Given that constraint, it is not reasonable to employ this approach.

Cost

The cost would be significant to acquire, place, and analyze this information.

Accuracy

These portable devices come in many sizes and shapes. While they are capable of generating basic information about ambient SO₂, they lack accuracy, and precise detection limits. Since it is likely that the area will contain values below the ambient standard, then detectability at these low concentrations is a concern.

Due to the time constraints and other disadvantages, the exploratory monitoring approach will not be undertaken. Additionally, there is sufficient existing data to make an informed decision on an appropriate monitoring location.

5.4. Monitor Siting Based on Existing Data

For the reasons outlined above and due to the wealth of existing data, it is logical to select one of the monitoring stations from an analysis of the existing data. Previous sections have outlined in detail the emissions profile, ambient data and meteorological data collected in or near the Hess facility at Tioga. The existing data provides us with:

- An extensive history of the emissions data that could influence site selection,
- Meteorological data which indicates where a potential plume would travel thus identifying a site location; and
- Ambient monitoring data to give us a sense of the values that may be observed in the future.

Section 6 below describes more fully an ideal site and rationale for its selection.

6. Monitor Site Selection

Having carefully considered the analyses in this document, a monitoring program designed to fulfill North Dakota's obligations under the DRR rule (40 CFR 51.1200 *et seq.*), the following monitoring program is proposed.

Table 13: Selected SO₂ Ambient Monitoring Program

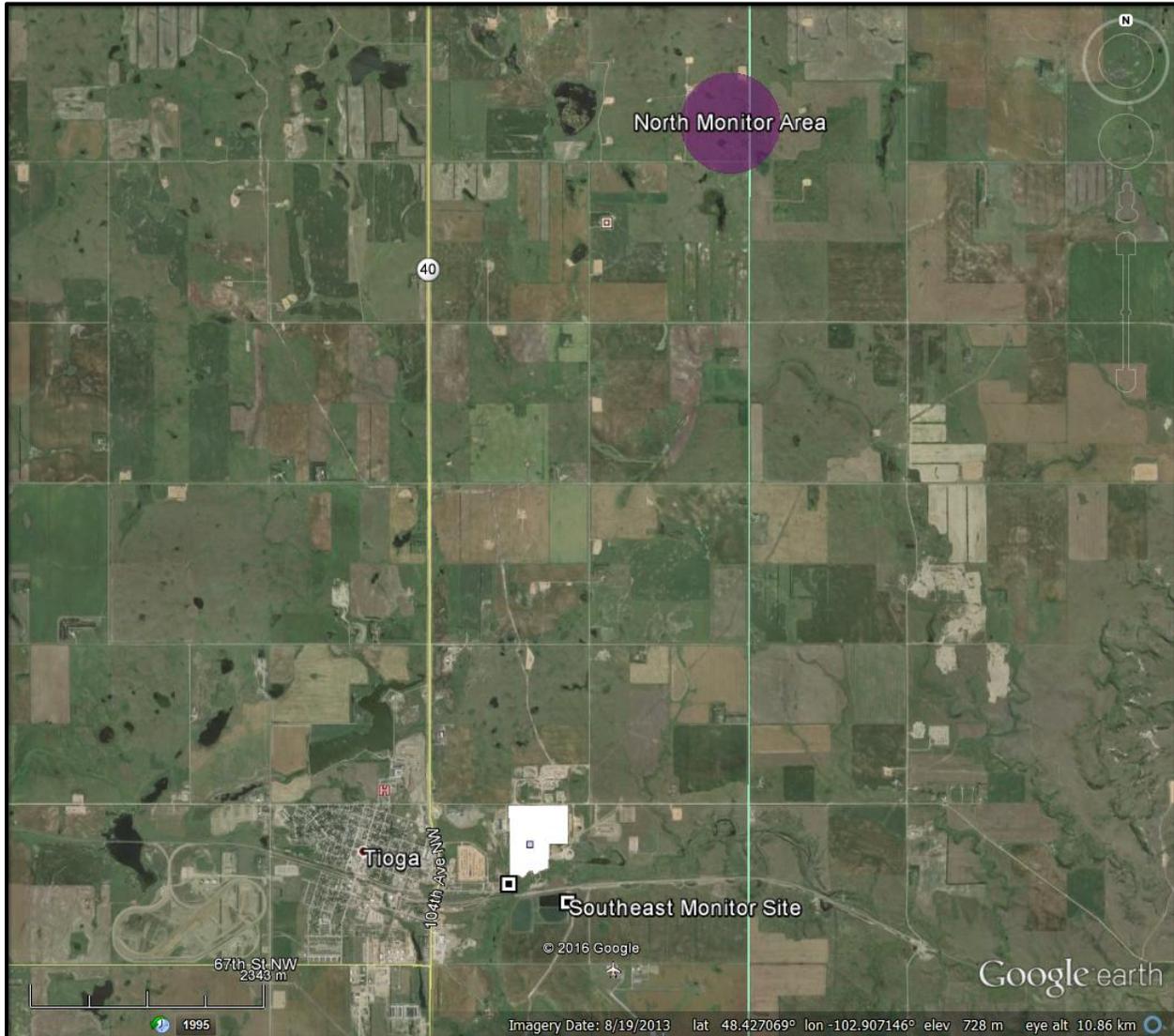
Parameter	Data	
Stations	2	
Monitored Parameters		
<ul style="list-style-type: none"> • SO₂ • Meteorology (North site only) <ul style="list-style-type: none"> ○ Wind Speed ○ Wind Direction ○ Wind Sigma ○ Temperature 		
Start Date	1/1/17	
End Date *	1/1/20	
Parameter	North Site	Southeast Site
Elevation (feet)	2485	2215
Latitude	48.4659	48.3926
Longitude	-102.8942	-102.9102

The proposed DRR monitoring network consists of two stations: North site and Southeast site. The Southeast site is at the same location as the current ambient monitoring station operated by Hess as a condition to Title V Permit T5-O82002. This site is chosen based on a review of existing data: emissions, ambient and meteorology. Additionally, this location appears necessary because this is precisely the data that has triggered the DRR requirements in the first place.

The second station (North) has been selected from new dispersion modeling data. The dispersion modeling, conducted as suggested by the TAD, indicates that the peak ambient impacts (as a design value) occur at or near this selected site.

The figure below identifies the location/area of the two stations.

Figure 17: Selected Monitoring Locations



Our rationale for this choice is explained in the analysis and discussion below.

6.1. Site Selection #1 – Southeast – Existing Data

The rationale for the selection of this site is primarily based on an analysis of the existing data. As noted extensively in this document, there is a great deal of ambient, meteorological and emissions data from which to draw to establish this particular site.

One of the primary reasons for selecting this site is the result of historical ambient data. This station has been in operation for more than 25 years. More importantly, data following the adoption of the 1-hour ambient standard has yielded values in excess of

the 75 ppb threshold. The station data was not used for designation purposes²⁷ but is relevant to DRR characterization, and in fact triggered DRR applicability.

The site location and its rationale are discussed below:

Wind Direction

The location of the chosen monitoring site must be related to which wind category will yield either the highest or most frequent plume impact. Both parameters (frequency and magnitude) should be factors in the chosen location.²⁸ The chosen site (Southeast Site) speaks to these two items:

Frequency

The chosen site is at a 320° direction measured from the site to the SRU unit. That is, a reported wind direction of 320° would take air directly from the SRU stack to the Southeast site. This same direction falls within the northwest quadrant direction and frequency shown previously in Figure 14 and elsewhere.

The northwest quadrant, which includes 320°, is the most frequent direction observed over the past three years. This observation of actual wind data indicates that, based on direction, the wind is more likely to blow from the SRU to the chosen site than any other direction.²⁹ This suggests that any monitor southwest of the plant (SRU) is an ideal candidate.

Resultant Wind Vector

In addition, the resultant vector for the three years of monitoring interest, 2013 – 2015 (see Section 4.2.4.3 above) represents the ‘average’ wind direction for the year (or multiple years). The resultant vector as calculated uses the unit wind speed (i.e., a wind speed of “one”) for each hour of the year. This unit wind speed is combined with the observed wind direction. The final resultant vector (sans magnitude) is then the direction that emerges from the vector addition of all hours in the year (or multiple years). The resultant wind vectors are noted here:

²⁷ As noted earlier in this report, EPA and to some extent NDDH have expressed concern about the quality of this data for ‘regulatory’ purposes. That is not to say that the data from the site is invalid. To the contrary, the data has been gathered in substantial compliance with the QA/QC requirements for SLAMS stations (40 CFR 58). Nonetheless, EPA chose not to use this data for designation purposes since certain QA procedures were either not known or not verifiable. The data, however, is very useful for purposes of a site selection. It would be difficult to ignore more than two decades of data for the purposes of locating an ambient monitoring station.

²⁸ The TAD speaks to a consideration of not just the highest concentration, but the frequency of the event as a consideration.

²⁹ A westerly direction is also frequently observed. Based on the 3-year cumulative wind rose, the westerly direction occurs only slightly less than northwest.

<u>Year</u>	<u>Resultant Vector *</u>
2013	322
2014	300
2015	290
2013 - 2015	302

* *The reported vector is the directions from which the wind is blowing, not the direction the wind is traveling.*

The resultant wind vector represents an ideal direction(s) from which an ambient site could or should be located. The chosen site location is within the range of resultant wind vectors for all three years and the 3-year average.

Wind Speed and Stack Characteristics

In addition to wind direction, the wind speed was also analyzed and has played a role in the site selection. The wind direction directs a plume while the wind speed helps determine how quickly or to what extent a plume may expand and reach the ground.

For our case, the presumed primary source of future ambient SO₂ concentrations is the SRU stack. This stack is about 50 meters in height. In most industrial settings, this would be considered a short stack. Further, a review of the stack CEM data shows that the average stack exit temperature was about 520°F (2013 – 2015). The exit velocity at the stack tip is about 45 mph. In general terms, the stack temperature and velocity will tend to provide a plume with fair degree of loft (buoyancy flux). The ‘final plume rise’ is limited by the short initial release height of the stack itself (and wind speed).

While the previous discussion about wind direction suggests an ambient monitoring site southeast of the plant, it does not necessarily give guidance as to an appropriate distance from the main stack. As a rule, one would expect a light wind to allow a buoyant plume, such as this 520°F stack, to rise significantly before impinging on the ground at some downwind distance.³⁰ A moderate to high wind speed might limit plume rise and impact the ground at a shorter distance downwind (depending on actual speed and vertical atmospheric stability). Since there does not appear to be an *a priori* ideal downwind distance for a monitoring location, one might need to compromise to find a candidate monitoring location (at a certain direction) based on wind speed.

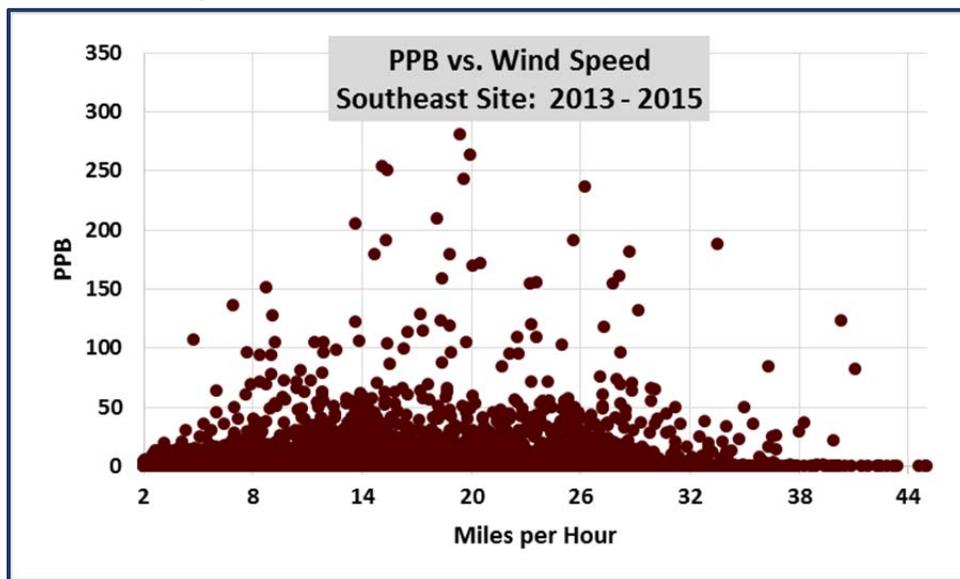
For this analysis we have historical data that presents actual ambient concentrations and concurrent meteorology; wind speed in particular. Therefore, it was decided to test the current monitoring site (Southeast) data to find which wind speed yields the highest

³⁰ We are referring here to a portion (or measurable) portion of a plume to reach the ground; not necessarily the plume centerline.

ambient monitoring data. If high(er) monitoring values occur during a particular wind speed category, this could provide insight as to which distance is most ideal.

The analysis was conducted by graphing ambient concentration versus wind speed. The figure below provides this analysis.

Figure 18: PPB vs. Wind Speed: 2013 – 2015



The results show that the elevated ambient concentrations are, for the most part, independent of wind speed. Elevated concentrations occur during all wind conditions ranging from about 6 to 38 miles per hour. This indicates that the current station is situated at an ideal location. The peak concentrations are not dependent upon plume behavior affected by wind speed. Rather this site is just as likely to record an elevated SO₂ ambient concentration during low, medium or high winds. It would be difficult to find another location along with wind vector that could or would provide a SO₂-recording data distribution based on wind speed meteorology.

This site is selected as one of the ambient monitoring stations for DRR purposes because:

- The site has significant historical value,
- This location has traditionally observed high concentrations of SO₂,
- The station is located along a predominant wind direction; and
- The station is positioned at a distance favorable to elevated concentrations.

6.2. Site Selection #2 – North – Modeling Data

The decision on the location of the second monitoring site is based almost solely on dispersion modeling. The use of dispersion modeling was highly encouraged by NDDH.

In addition, the TAD discusses the use of dispersion modeling for site selection at length for example:

“Modeling is a powerful tool that should be strongly considered to inform the identification of potential monitoring sites intended to satisfy the expected data requirements rule.” (Section 3.1, TAD).

For these reasons, modeling was chosen as the primary factor for selecting the second site for DRR purposes.

Section 5.2 above provides a detailed summary of the modeling results. Details of the dispersion model itself are found in Appendix A. In general terms, the dispersion model followed the recommendations of the TAD. The model used the most recent version of AERMOD and included a dense set of receptors (8,000+) to ensure identifying the peak area. Further, the model used nearby meteorological data gathered and processed by NDDH. The data consisted of surface data from nearby National Weather Service stations for the years 2011 through 2013. Stack parameter data was based on actual CEM information taken from the SRU stack at the Hess facility.

Finally, the emission rate programmed into the model was a single value. This was used in lieu of three years of actual normalized data as suggested by the TAD. A single emission rate was chosen because there was a high degree of variability (spikes) in the actual emission rates from 2011 through 2013 (and later). That pattern of emissions is not expected to continue as the DRR monitoring stations begin operation in 2017. Hess undertook a series of actions to reduce the number of spikes which also included the implementation of an “Administrative Consent Agreement” in 2013. As a result, it appears more appropriate to provide a consistent emission rate for every hour of every day rather than rely on the vagaries of variable emissions which are not likely to continue following the establishment of these monitoring stations.

The results of the modeling have been expressed in several ways. The first is a review of the location of the design values for all 8,000+ receptors. Those results are shown in Figure 15. The figure indicates that the area about five miles north-northeast of the plant yields the highest concentrations.

The second analysis was to analyze the frequency of occurrence of the maximum daily values. This analysis was conducted as Tables 10 and 11 above. That analysis indicated that the same location (five miles NNE) of the facility is the area which is most frequently impacted based on daily maximum observations (the basis of the ambient standard).

Finally, at NDDH’s suggestion, an additional frequency analysis was also conducted comparing the “north” area against an area on or near the fenceline. This was conducted to ensure that an area closer to the plant might not indicate a better monitoring location. For this analysis the model was re-run using only two areas of

receptors: fenceline³¹ and north. The same output was created as in the original model run in order to conduct a frequency analysis. The frequency analysis was conducted to determine if perhaps the fenceline area might be more superior to the north area insofar as frequency of occurrence of elevated concentrations. (The design value model runs had already established the north site as a potentially better location.)

The results of the two-area frequency analysis are found in Section 5.3.4 and Table 12. The analysis continues to indicate that the north area is a superior site location insofar as the modeling output is concerned.

Therefore, based on the modeling results (design value and frequency analysis), a monitoring station located about five miles NNE of the SRU stack is the second ambient monitoring station location for DRR purposes.

6.3. Conclusion

The results of the analyses in this document have identified two ambient monitoring station locations that may be used to fulfill the obligations under the DRR. The two selected station locations offer a good balance between empirical and predicted data.

Empirical (existing) data was used to select one monitoring station. That location is based upon decades of recorded information including meteorology, ambient SO₂ and emissions data. That monitoring station location is SE of the plant property. It is in fact this same location that triggered the need for an analysis of DRR. It would be illogical not to include this station given its ambient history and regulatory basis.

The second site is based on predicted (dispersion modeling) data. This data uses nearby meteorology coupled with actual stack parameter data to identify a candidate monitoring area. Based on an analysis of the predicted maximum concentrations (design value) along with an analysis of the frequency of occurrence among the 8,000+ receptor network, a location approximately five miles NNE of the SRU main stack represents a reasonable location for an ambient monitor for DRR purposes.

³¹ The fenceline area was limited to those receptors on or near (a few hundred meters) the fenceline property to the west and north of the plant. The area to the south and east are already addressed based on the southeast monitoring location selected in Section 6.1 above.

Appendix A

Dispersion Modeling Report

1) Introduction

This appendix discusses the general air dispersion modeling methodology that was used in order to select an appropriate ambient SO₂ monitoring site near Tioga, North Dakota. The purpose of this monitoring site selection is to fulfill the North Dakota Department of Health's (NDDH) obligations with the Data Requirements Rule (DRR).¹

The methodology used in this dispersion modeling exercise primarily relied upon discussions with NDDH personnel and EPA's published guideline in implementing the DRR itself. As an integral part of promulgating the DRR, EPA published the following document: "SO₂ NAAQS Designations Source-Oriented Monitoring Technical Assistance Document," February 2016, DRAFT" (TAD). The document may be found at the following web site:

<https://www3.epa.gov/airquality/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf>.

2) Background and Rationale

Dispersion modeling is widely used in the U.S. and North Dakota as a means of predicting, prior to construction, if an industrial facility will comply with ambient air quality standards. The prediction is based primarily on meteorology, geography and emission source characteristics.

This project, however, is different. The rationale behind this dispersion modeling does not attempt to determine a specific ambient impact based from a known emission source. This project is merely attempting to locate the area of peak impact. As a result, the modeling parameters are slightly different. Nonetheless, the modeling project uses most of the guidelines typically found in dispersion modeling studies such as 40 CFR 51, Appendix W (Guideline on air Quality Models). The primary difference in this model execution was the number of meteorological years of data (three instead of five) and the emission source itself (using a unit or normalized emission rate).

¹ The Data Requirements Rule (DRR) was adopted on August 21, 2015 (80 FR 51052) and is codified in 40 CFR 40 CFR 51.1200 – 1205

3) Model Selection

The model chosen for this project was EPA's preferred air dispersion model for regulatory compliance demonstrations: AERMOD. The model was also approved by NDDH for execution for this project. AERMOD calculates ambient air concentrations using hourly meteorological data processed by the AERMET program and elevation data produced by the AERMAP program. The BEEST© for Windows Version 11.04 (Oris Solutions, LLC) was used for this project. It incorporates the following EPA software versions:

- AERMOD – 15181
- AERMET – 15181
- AERMAP – 11103

In order to complete the modeling the AERSURFACE (Version 13016) algorithm was also used. This program extracts information from land use data files and calculates surface roughness, albedo, and Bowen ratio values that are all used by AERMET.

4) Model Input

The Hess facility has only one primary source of sulfur dioxide emissions:² the sulfur recovery unit (SRU). This source was modeled for the purpose of calculating the SO₂ "design value."³ The results of this analysis were compared to appropriate design values for SO₂. The modeled receptors registering peak concentration impacts were then further analyzed for the frequency of modeled impacts.

4.1) Meteorological Data

AERMOD requires hourly meteorological (met) data with a minimum set of parameters such as temperature, wind speed, and wind direction to calculate concentration impacts. The TAD suggests the use of three complete years of meteorological data.

For this modeling effort NDDH suggested using surface data collected at the Williston, ND, NWS station which is near the project. NDDH processed three years of meteorological data which includes January 2011 through December 2013.

The data provided to AERMOD must be processed through the AERMET module. AERMET requires, at a minimum, one set of hourly surface observation

² This facility also has a flare which emits SO₂ during periods of upsets. However, the flare was not considered in the modeling runs for reasons more fully described in Section 4.2.1 of the main body of this report.

³ The design value is, effectively, the methodology for calculating the basis of the ambient standard itself. For the 2010 1-hour SO₂ standard it is calculated as the 3 year average of the 98th percentile of the daily hourly maximum concentration. More information regarding determining the design value may be found in 40 CFR 50, Appendix T.

data and a complementary set of twice-daily upper air sounding data. This data was processed by NDDH and used in the model.

Data describing surface characteristics surrounding the surface meteorological station are an additional required input to AERMET. Seasonally and directionally varying data are available in the form of land cover data files available from the Multi-Resolution Land Characteristics Consortium. Files from the 1992 National Land Cover Database (NLCD1992)⁴ were obtained from this site for input into AERSURFACE, which reads the data and reports surface characteristics that can be entered into AERMET.

The AERMOD suite also requires upper air data from one or more NWS / ASOS stations. The Glasgow, MT, station was used for upper air data. The purposes of each dataset (surface and upper air) are:

NWS surface station (Williston, ND):

- Wind speed and wind direction;
- Temperature;
- Cloud cover (used to calculate atmospheric stability);
- (The entire dataset was pre-processed by NDDH and made available in CD144 format).

NWS upper-air station (Glasgow, MT):

- Upper air soundings (used to calculate twice-daily mixing heights).

4.2) Surface Characteristics Data

The program AERSURFACE was run using the BEEST AERMET for Windows Graphical User Interface. The options were left as default except for the following:

- Primary and Secondary Site Surface Characteristics Frequency set to SEASONAL.
- Primary and Secondary Site Wind Sectors set to 12.⁵
- Winter Season Snowcover set to “Yes.”
- Arid set to “No.”
- Moisture set to “Average.”
- Airport set to “Yes” for NWS data.

The Williston NWS 1992 Land Use/Land Cover data was used for this area.

4.3) Elevation

Base elevations are required for receptors, sources, and structures for models with elevated terrain. Additionally, AERMOD requires that receptors be defined

⁴ Note that, although newer datasets are available, they are not currently supported by AERSURFACE.

⁵ The patchwork of LULC data surrounding the plant was variable enough that, upon examination, it was deemed better to use maximum wind sector division than to attempt a summarization of multiple custom sectors.

by a parameter known as “hill height” that AERMAP calculates as a function of the terrain elevations surrounding each receptor. To ensure this value can be calculated for each receptor in the modeling analysis, EPA guidance requires terrain elevation data within an area that includes all terrain features with an elevation exceeding a 10% slope from every modeled receptor. The BEEST program’s “domain calculation” function was used to identify this terrain domain which, for the current modeling analyses, was bounded by latitudes of 48.625 and 48.125 degrees and longitudes of 103.25 and 102.625 degrees.

Terrain elevation data were provided to AERMAP using National Elevation Dataset (NED) files downloaded from a United States Geological Survey (USGS) web site.⁶ NED data are provided in the NAD83 horizontal datum. Datasets were created with a 1/3 arc-second (approximately 10 meters) horizontal resolution and were provided in the form of multiple Geographic Tagged Image File Format (GeoTIFF) files, copies of which are included on the DVD accompanying this application.

4.4) Domain

The modeling domain was determined by placing a receptor grid that extended 20 kilometers (km) from the property boundary. This results in a modeling domain that is approximately 40 km by 40 km square as suggested in the TAD.

4.5) Receptors

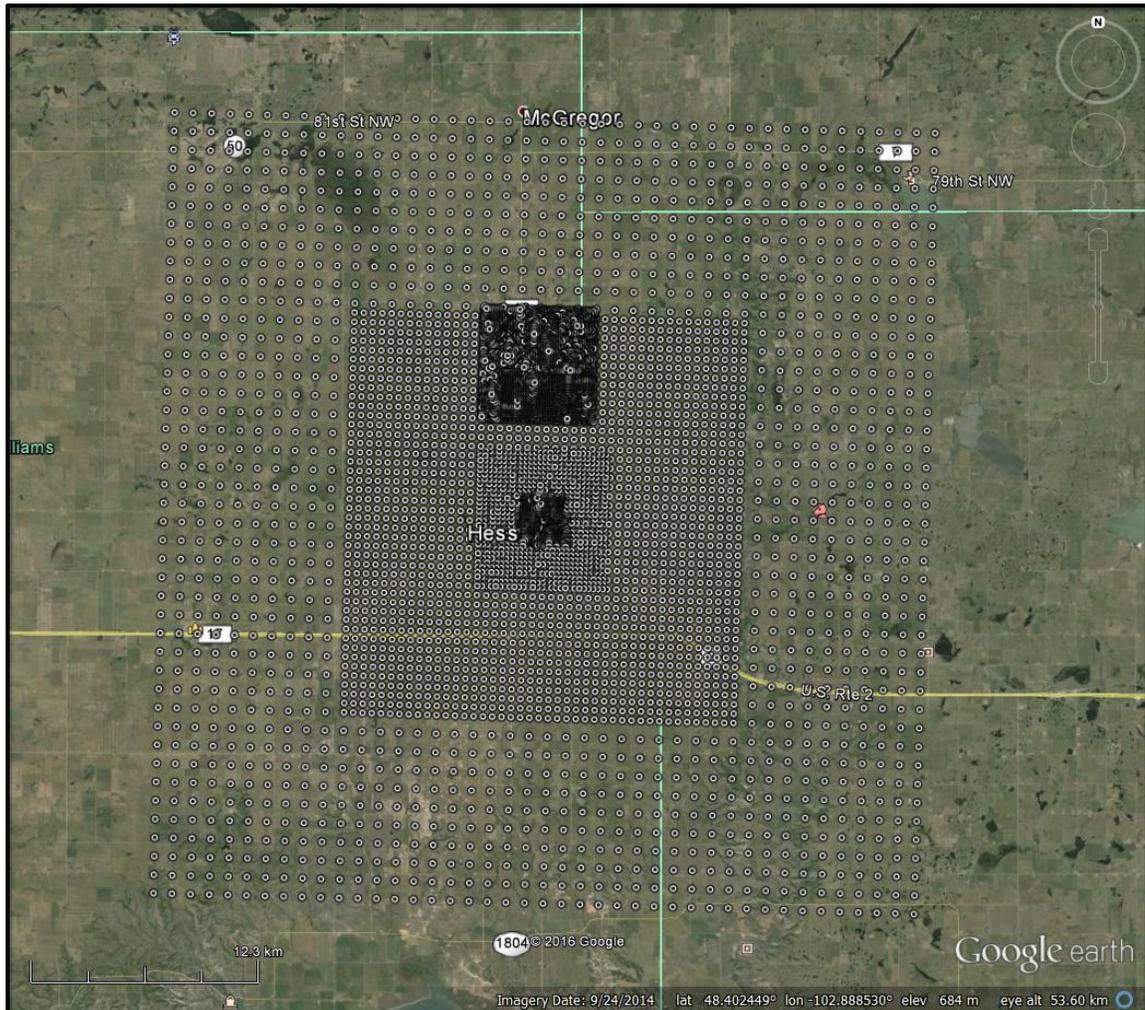
To obtain sufficient modeling resolution, the following Cartesian system was used:

- ◆ Receptors were placed along the plant boundary at 100-meter intervals;
- ◆ Receptors were placed at 100-meter spacing from the plant boundaries to a distance of approximately 1 km;
- ◆ Receptors were placed at 250-meter spacing from 1 km to 2 km;
- ◆ Receptors were placed at 500-meter spacing from 2 km to 7 km;
- ◆ Receptors were placed at 1 km spacing from 7 km to 20 km;
- ◆ Hot spot receptors were placed at 100-meter spacing around the highest design value receptors.

The receptor grids were generated using the Fenceline Grid Method of the “Special Grid” tab in the “Receptor Options” window in BEEST. By using the Fenceline Grid Spacing option coupled with the Fenceline Grid Distance option, a buffer of receptors is created around the boundary, omitting the unnecessarily dense receptors beyond the appropriate distance identified above. By removing these unnecessary receptors, the appropriate level of analysis is maintained, and model run times are reduced linearly with the reduction in total receptors. Figure 1 depicts the receptor domain and density for the monitor placement analysis.

⁶ See <http://www.mrlc.gov/> as geotiff versions of NED data are no longer available on the USGS National Map Viewer.

Figure A-1: Receptor Domain



4.6) Coordinate Location

AERMOD requires that all structures such as large tanks and buildings, emissions sources, and fencelines (used for defining fenceline receptors and for excluding receptors within the facility boundary) be defined by a pair of north/south and east/west coordinates. The buildings included in the model and the locations of the fencelines and emissions sources were defined through the use of the site plan map. The information was translated to UTM coordinates.

4.7) Source Parameters

AERMOD requires that all structures such as large tanks and buildings, and the emissions sources be included in the model. Nearby buildings were input into the model to allow for downwash calculations (BPIP-Prime) as deemed necessary by the model algorithms.

Stack parameter data was used based on actual stack data (stack height and diameter). The exit velocity and temperature of the stack were obtained from the past three years of CEM data. The average temperature and velocity were used for input.

The emission rate used for this analysis was nominal value of 1 lb/hour chosen in consultation with NDDH. Since the rate input into the model is only used to identify candidate monitoring locations, the modeled emission rate may be nominal. The location of the peak impact will be the same irrespective of the emission rate input into the model.

Consideration was given to using the actual emission rates from the CEM data. However, this was rejected because the emission rate was uncharacteristically variable during the period. This pattern is not expected to continue when the ambient monitoring program begins in 2017. Section 5.2 and elsewhere in the main body of this report provides more information and rationale.

5) Model Output

The model was coded to provide an output comparable to the ambient standard itself (design value). AERMOD automatically executes this feature when the pollutant ID parameter is coded as "SO2."

In addition to the standard (*.LST) output file, the model was also coded to provide information that may be imported into graphical programs to show the data in a simpler pattern.

Finally, a special option "MAXDAILY" was executed during the model runs. This option outputs the maximum 1-hour value for each day for each receptor. This option was included in the output to allow for an analysis of the frequency of occurrence of peak or high values as recommended in the TAD. The frequency analyses conducted using this data are found in Section 5.2 of the main body of this document.

6) Summary

The dispersion model system for this exercise was AERMOD and its associated programs AERMET, AERMAP and AERSURFACE. This modeling system is an EPA-approved model for regulatory use found in 40 CFR 51, Appendix W. The model was executed in substantial conformance with the recommendations of the TAD. (Those minor exceptions to the TAD are discussed in this appendix and in the main body of this document). The table below provides a summary of the modeling data used for the project.

Table 1 Model Parameters Summary

Parameter	Sub-Parameter	Units	Comments
Model	---	AERMOD	Version 15181
Meteorological Data (compiled by NDDH)			
	Surface Data	Williston NWS	2011 – 2013
	Upper Air Data	Glasgow, MT	2011 – 2013
Receptor Grid			
	Cartesian	100 / 250 / 500 meters	Extends to 20 kilometers
	Fenceline	100 meters	
	Total Receptors	8,010	Includes fenceline and Cartesian
SRU Stack Data			
	Height	50.3 meters	Physical height
	Diameter	0.89 meters	Physical diameter
	Exit Velocity	22.8 m/sec	Data from CEM
	Exit Temperature	578 K	Data from CEM
	Emissions	1 lb/hour	Generic Rate
	Building	---	Included building downwash calculations based on on-site building dimensions
Output	3-Year Design	$\mu\text{g}/\text{m}^3$	3-year average of the 1-hour daily maximum
	MAXDAILY		Outputs daily maximum value for each receptor for every day of processed meteorology (3 years)