FHR Air Emissions Update

October 13, 2014

Agenda

- Background on Air Pollutants & Air Emissions
- Air Monitoring around Pine Bend Refinery
- Refinery Emissions Overview
- Refinery Compliance with Air Permit

Air Pollutants

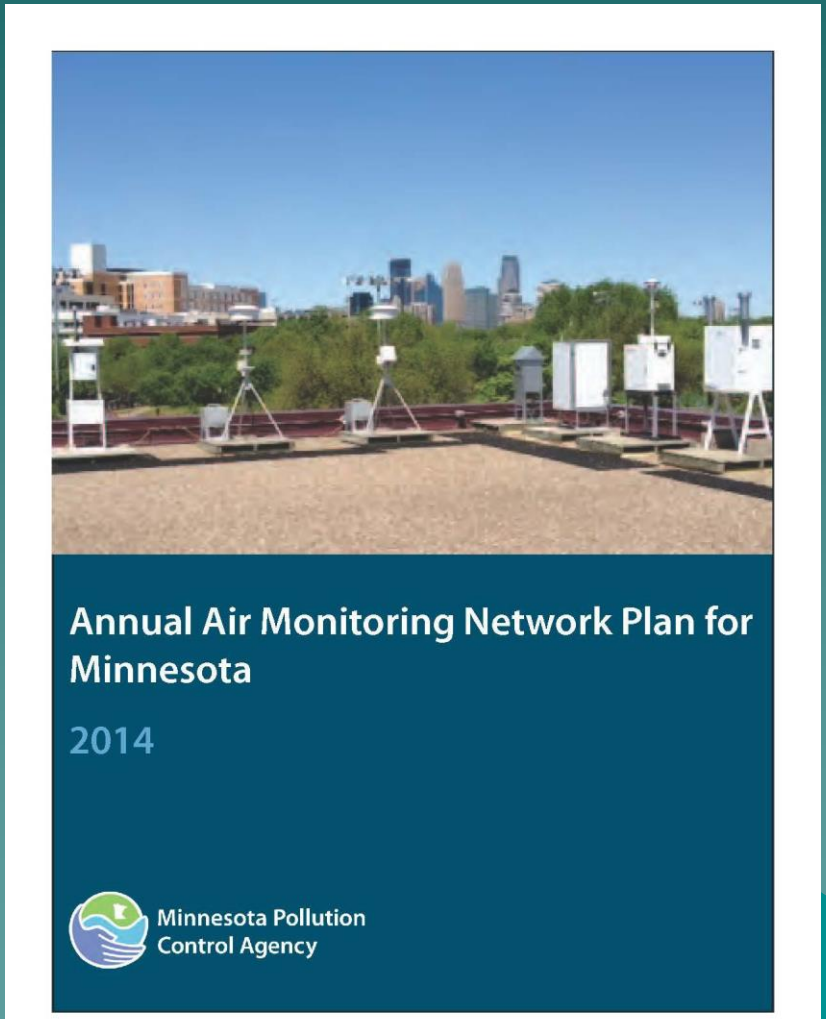
- Types of Emissions
  - Traditional Criteria Pollutants (non-greenhouse gas)
    - VOC (volatile organic compounds)
    - CO (carbon monoxide)
    - NOX (nitrogen oxides)
    - SO2 (sulfur dioxide)
    - Particulates - PM/PM10/PM2.5
  - Greenhouse Gas or GHG (CO2, methane)
  - Air Toxics e.g. benzene, chromium

Emissions Reporting to Agencies

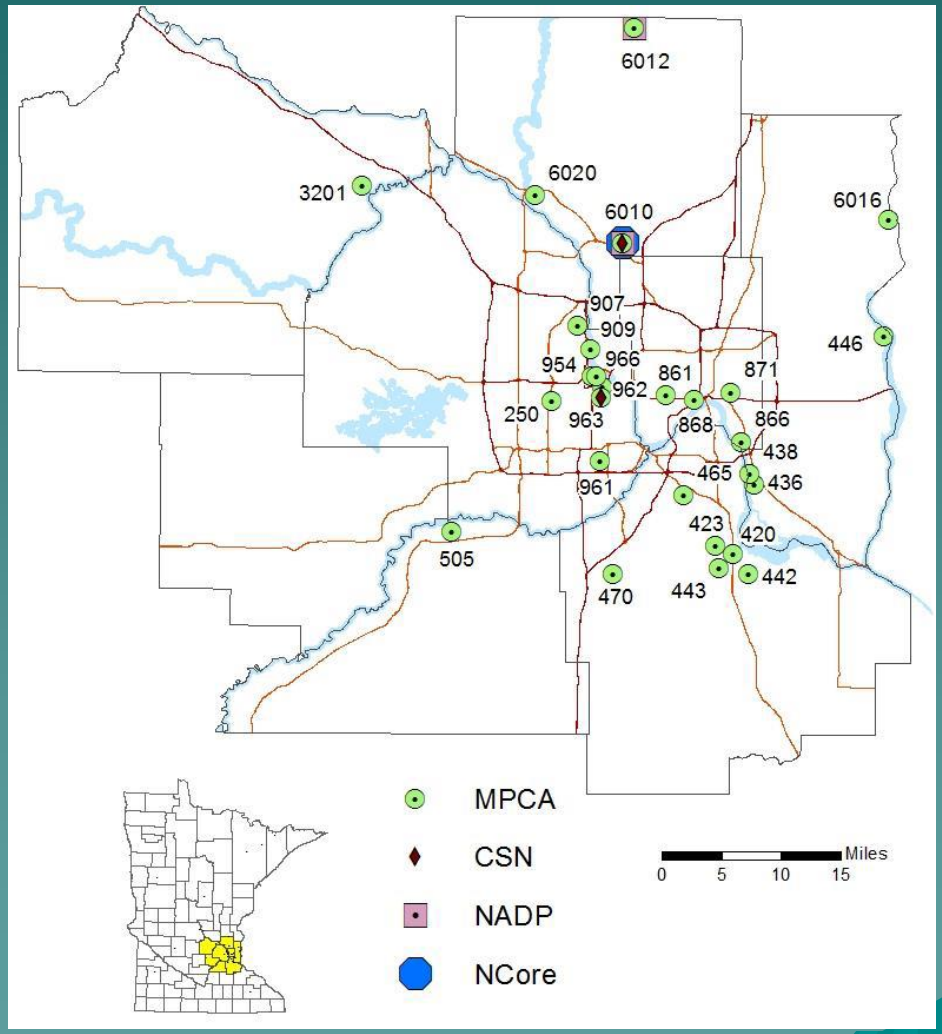
- Environmental Protection Agency
- Minnesota Pollution Control Agency
- Reports provided on Air emissions:
  - Emission Inventory – criteria pollutants (details all the direct air emissions from heater stacks and any other emitting equipment)
    - http://www.pca.state.mn.us/index.php/air/air-monitoring-and-reporting/air-emissions-modeling-and-monitoring/criteria-air-pollutant-emission-inventory/facility-actual-emissions-data.html
  - Greenhouse Gas Inventory
    - http://www.epa.gov/ghgreporting/index.html

Air Monitoring Network

- MPCA maintains statewide network of air quality monitors
- Used to show compliance with air standards
- Four monitors around the refinery – the most for any facility in the state



Twin Cities Metro Area Monitor Locations



Site 420, 423, 442, and 443, and the Flint Hills Refinery (FHR)

MPCA Air Monitors near Refinery Measured Parameters

Measurement Parameter	Site 420	Site 423	Site 442	Site 443
Sulfur Dioxide (SO2)	X	X	X	X
Meterology (Wind Speed, Wind Direction, Sigma, Temperature)	X	X		
Nitrogen Oxides (NO, NO2, Nox)	X	X		
Carbon Monoxide	X	X		
Total Reduced Sulfur	X	X		
57 Volatiile Organic Compounds	X	X	X	X
7 carbonyl compounds	X	X	X	X
Total Suspended Particulate Mass and 15 Metals Concentrations	X			

Air Quality Standards – ‘NAAQS’

- Stds set for NOx, SO2, CO, Fine Particles, Ozone
- Set by EPA to protect the air we all breathe.

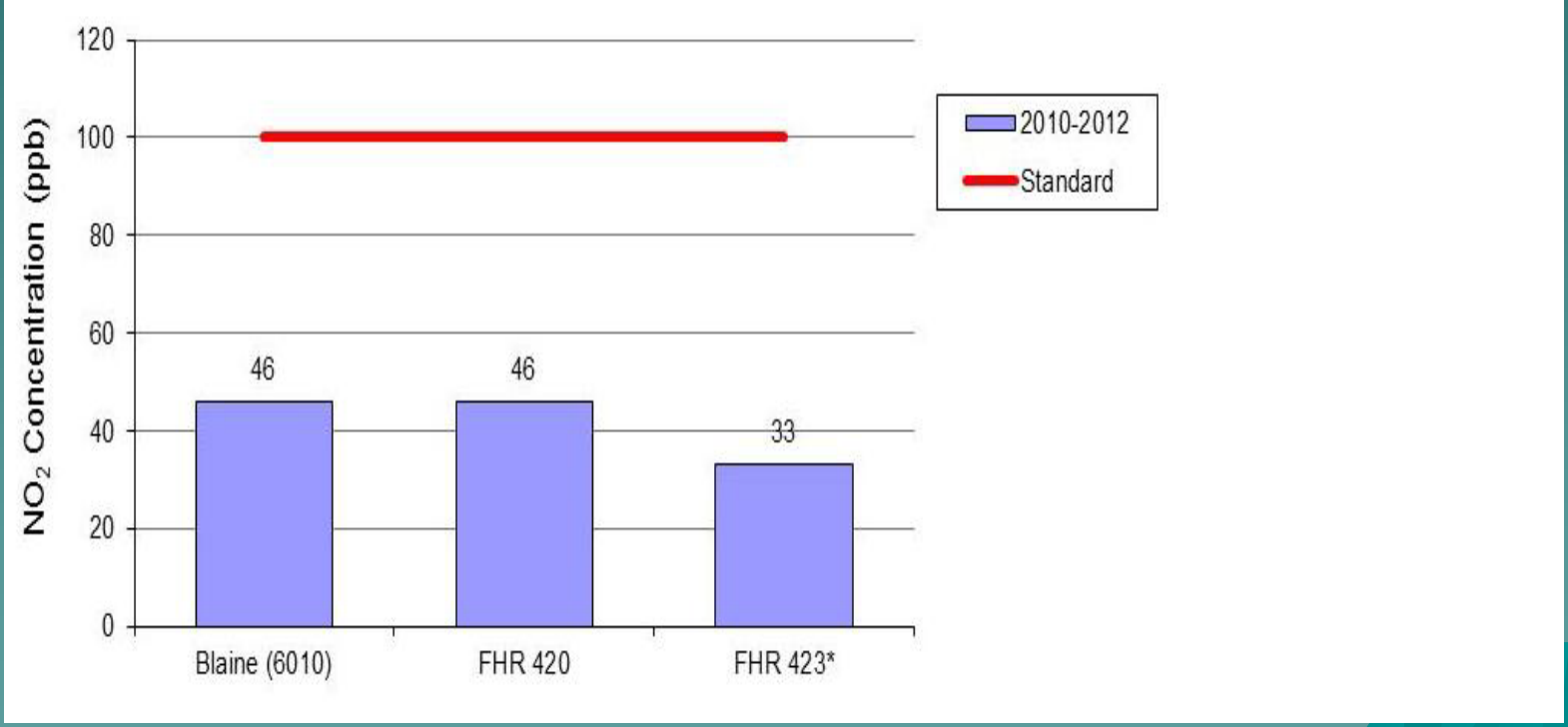
Current Air Quality Standards

Pollutant	Primary Std	Averaging Time	Statistical determination to determine compliance
Nitrogen Oxides (Nox)	100 ppb	1 Hr Avg	98th percentile, avg over 3 years
	53 ppb	Annual Avg	Annual Mean
Sulfur Dioxide (SO2)	75 ppb	Daily	99th percentile of 1-hour daily maximum concentrations, averaged over 3 yrs
	500 ppb	3 Hour	Maximum 3 hour concentration not to be exceeded more than once per year
Carbon Monoxide (CO)	9 ppm	8 hour	Maximum over an 8 hour averaging time. Not to be exceeded more than once per year.
	35 ppm	1 hour	
TSP – measure of particulate	260 ug/m3	24 hour	
	75 ug/m3	Annual	

* TSP is a Minnesota Standard the Federal Standard is fine particulate based - PM10 and PM2.5, The monitors near the refinery do not measure PM10 or PM2.5.

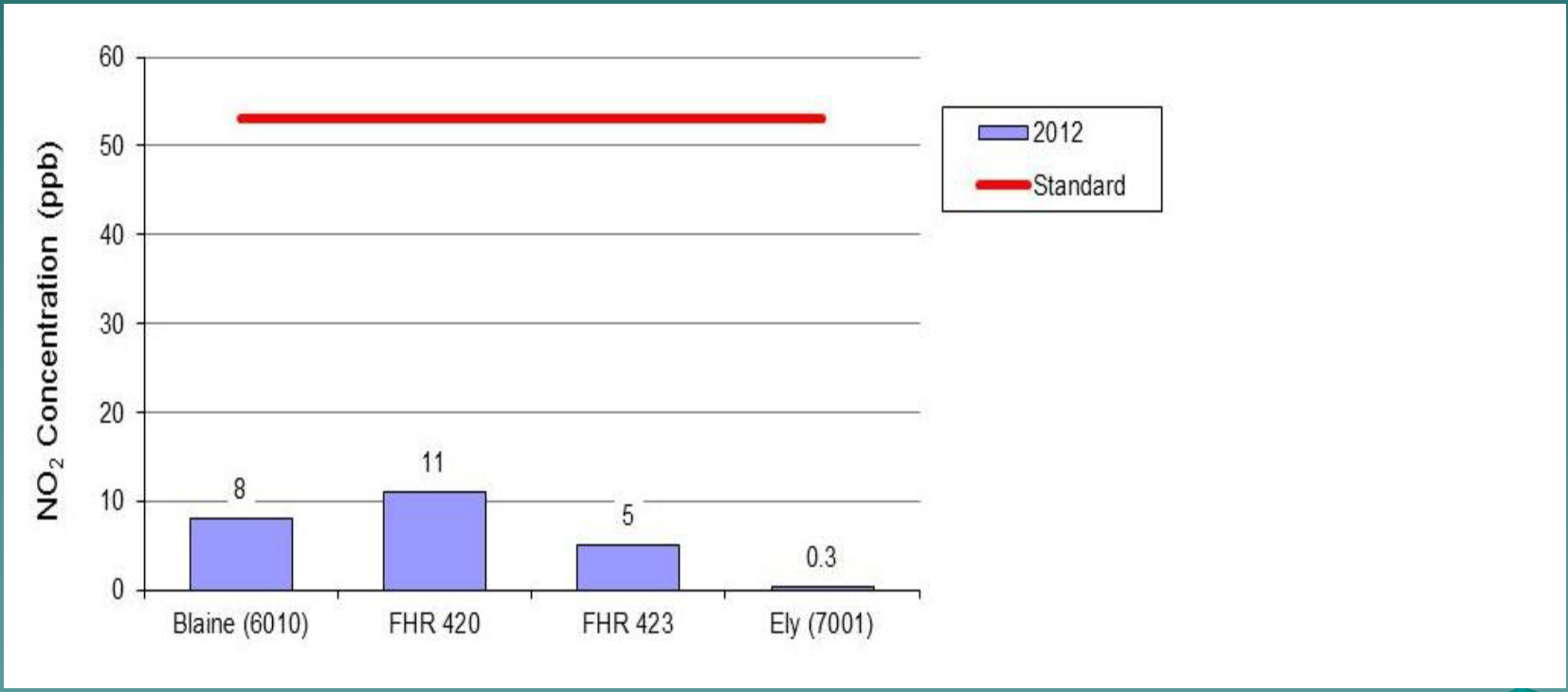
MPCA Air Quality Report
1-hour Average NO_2 Concentration Summary

- Air Monitor Results relative to these standards



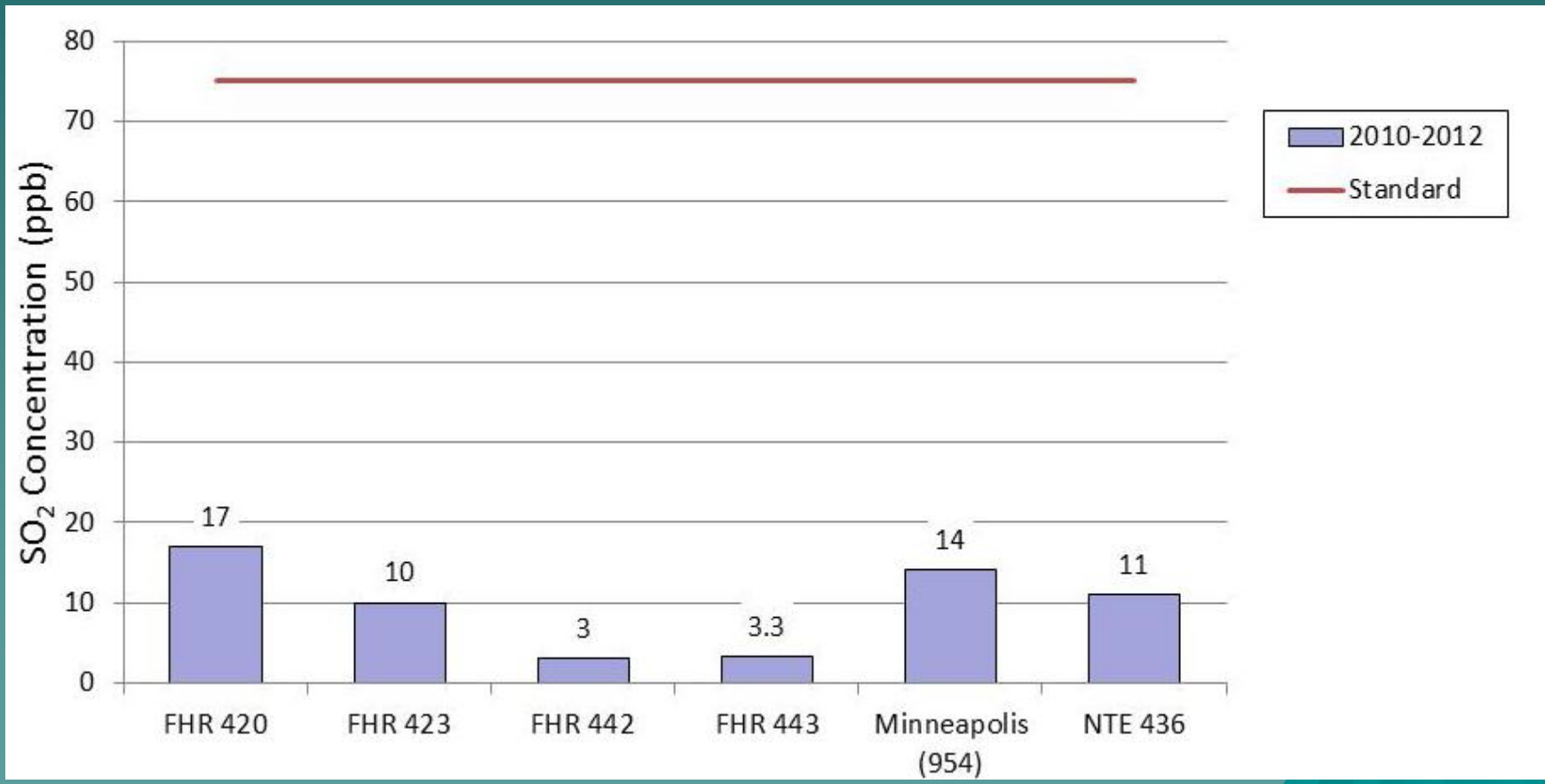
Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

MPCA Air Quality Report
Annual Average NO_2 Concentration



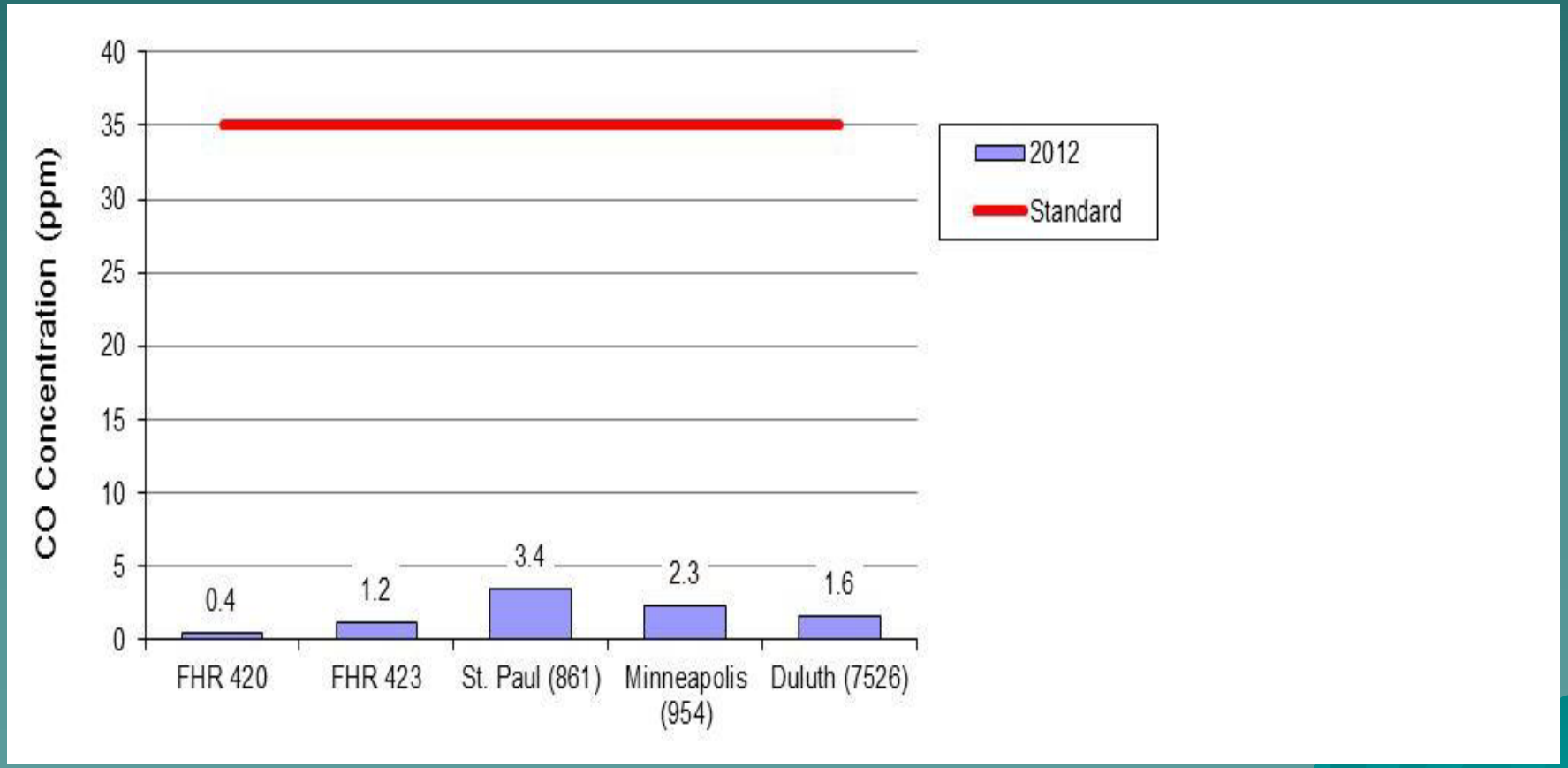
Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

MPCA Air Quality Report
1-hour SO_2 Concentration



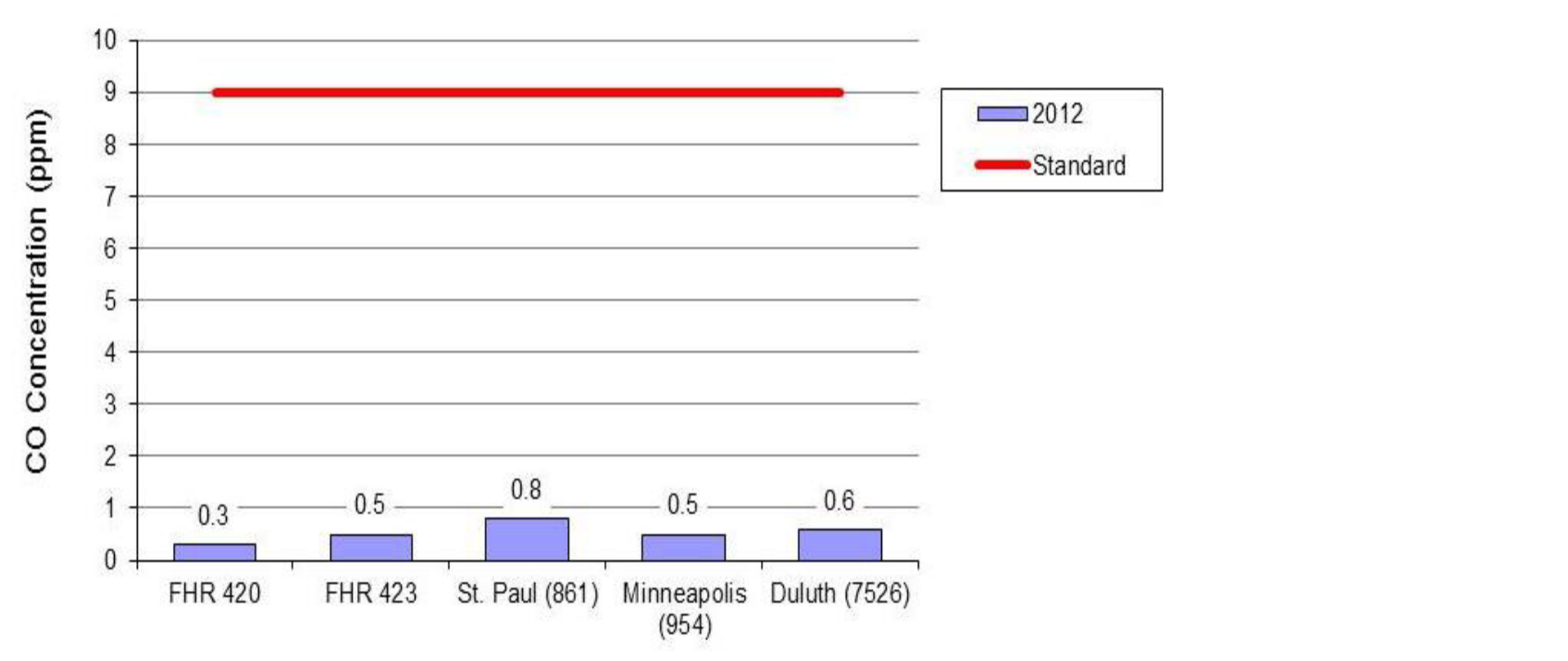
Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

MPCA Air Quality Report
1-hour Average CO Concentration



Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

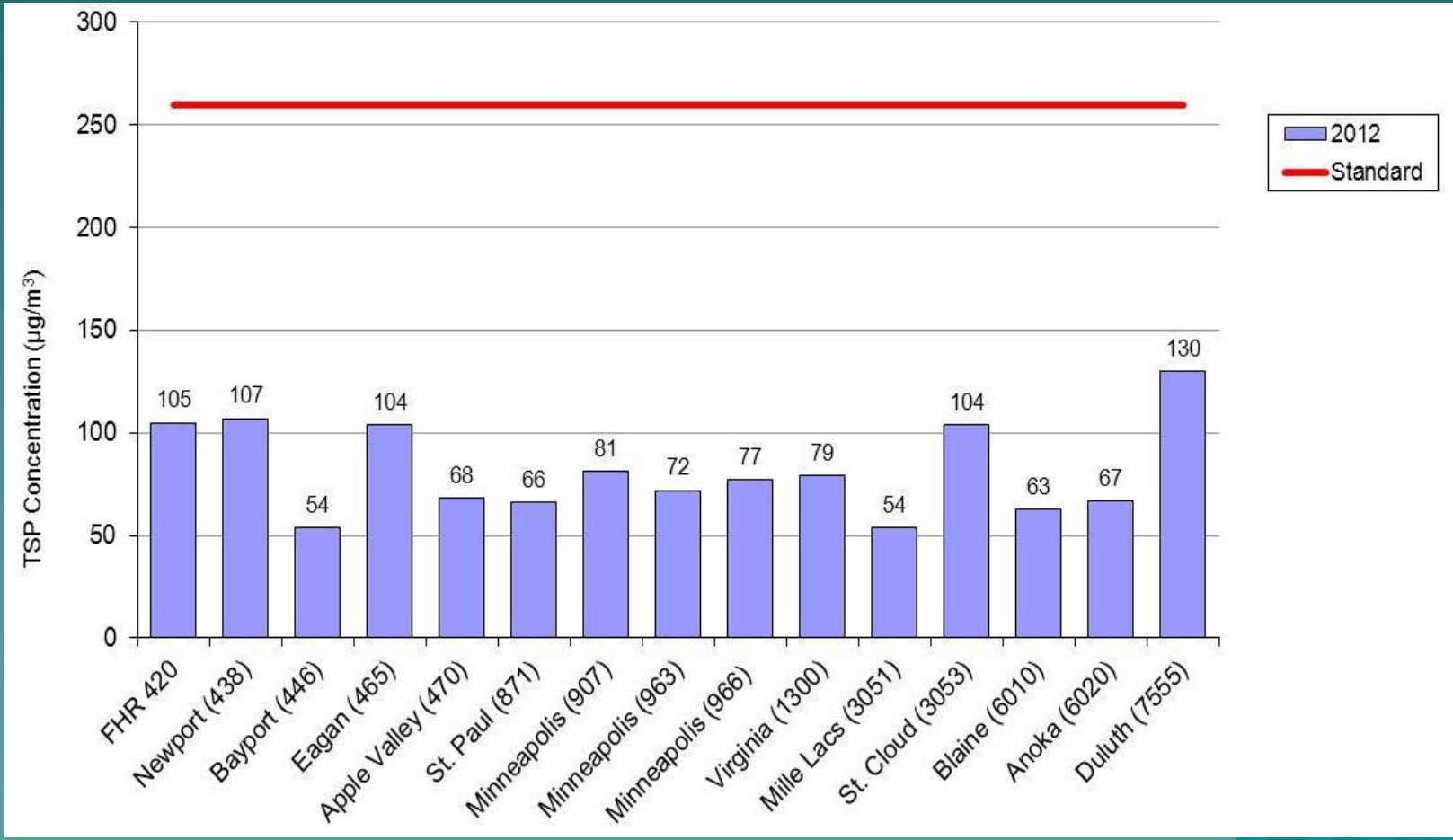
MPCA Air Quality Report
8-hour Average CO Concentration



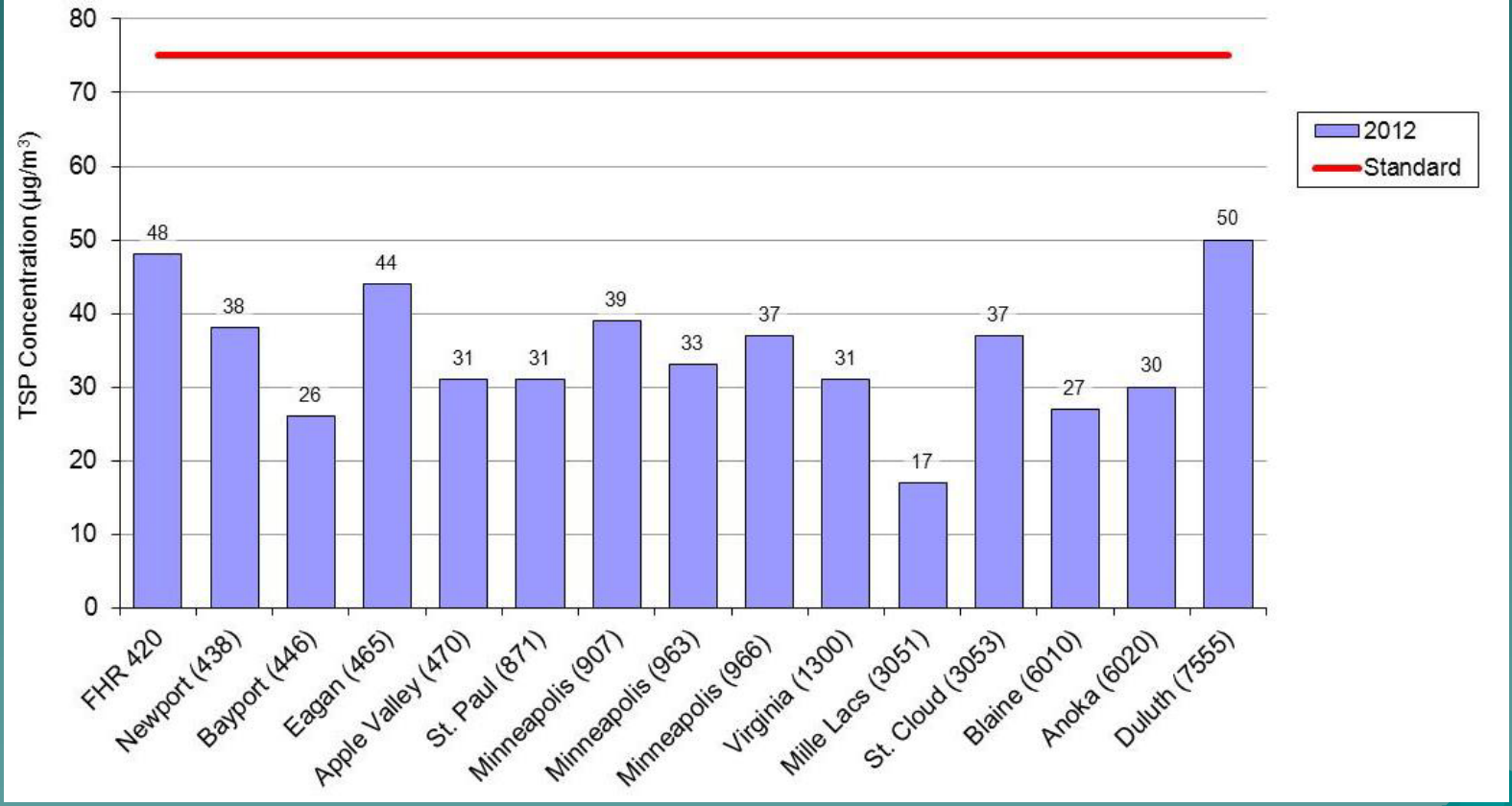
Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

MPCA Air Quality Report

24-hour Average TSP Concentration



MPCA Air Quality Report
Annual Average TSP Concentration

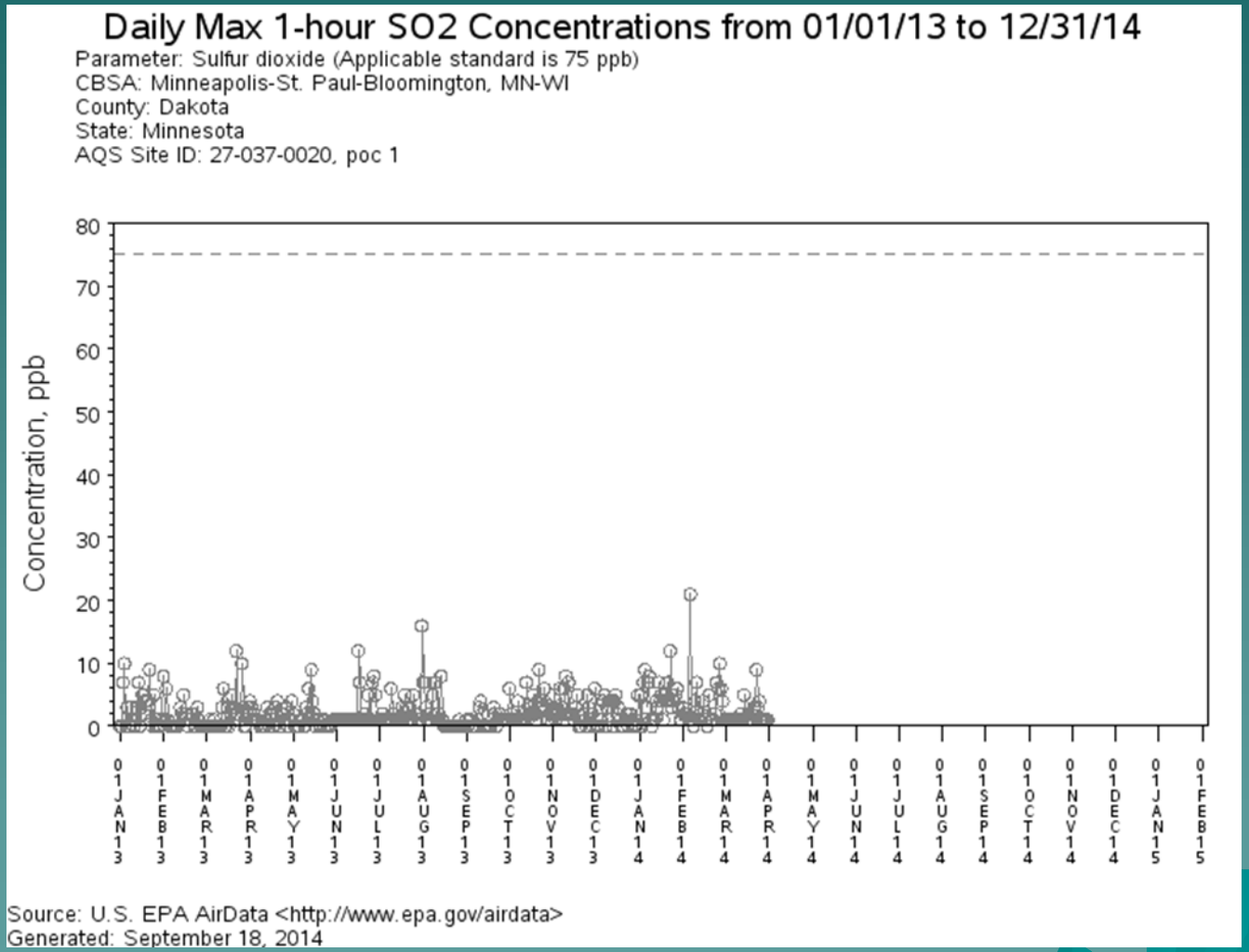


Source – 2014 Annual Air Monitoring Networking Plan for Minnesota

Monitor Data publicly available via EPA and MPCA

EPA Web Site Data (SO2)

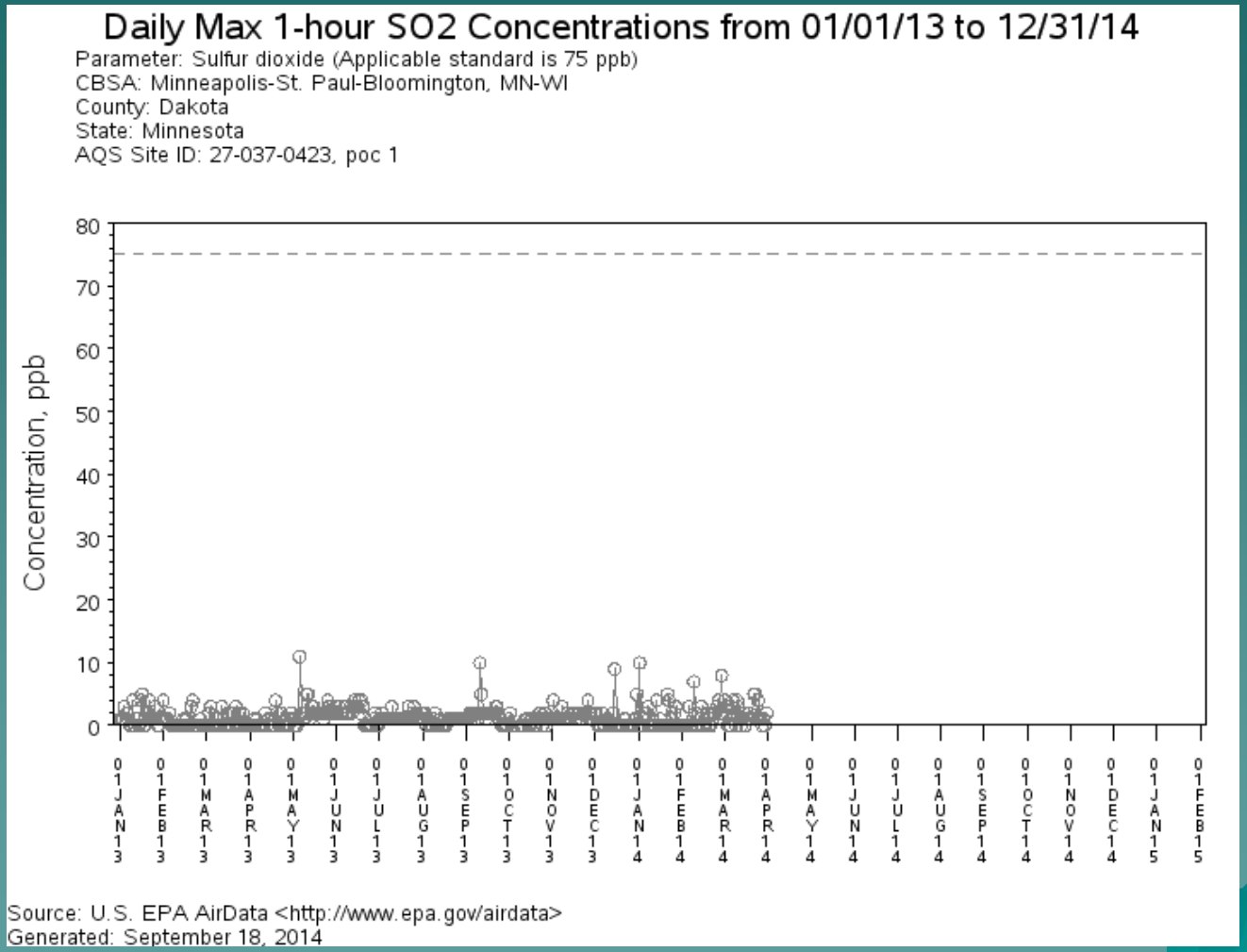
FHR 420 Analyzer



Source – EPA Air Data Website

EPA Web Site Data (SO2)

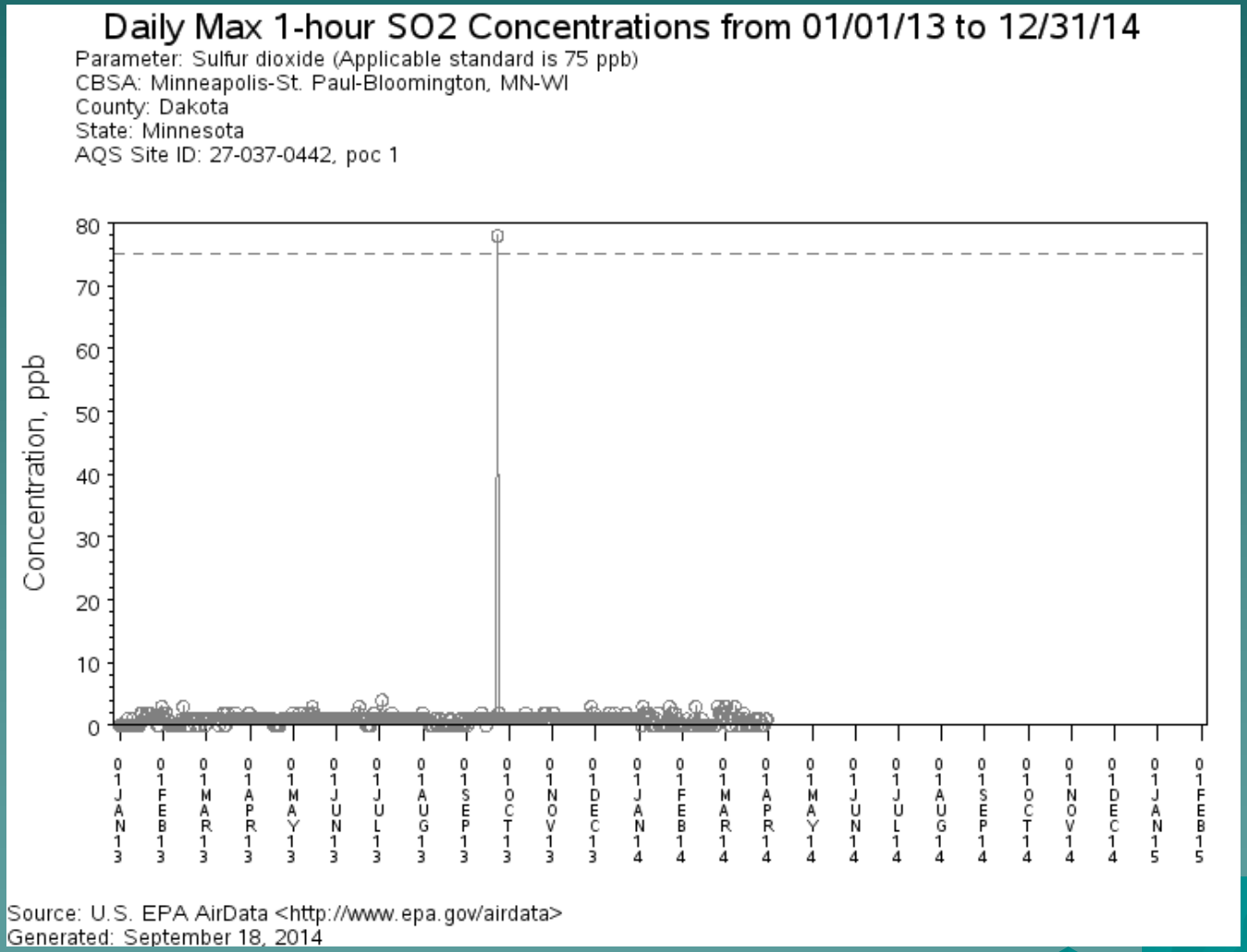
FHR 423 Analyzer



Source – EPA Air Data Website

EPA Web Site Data (SO2)

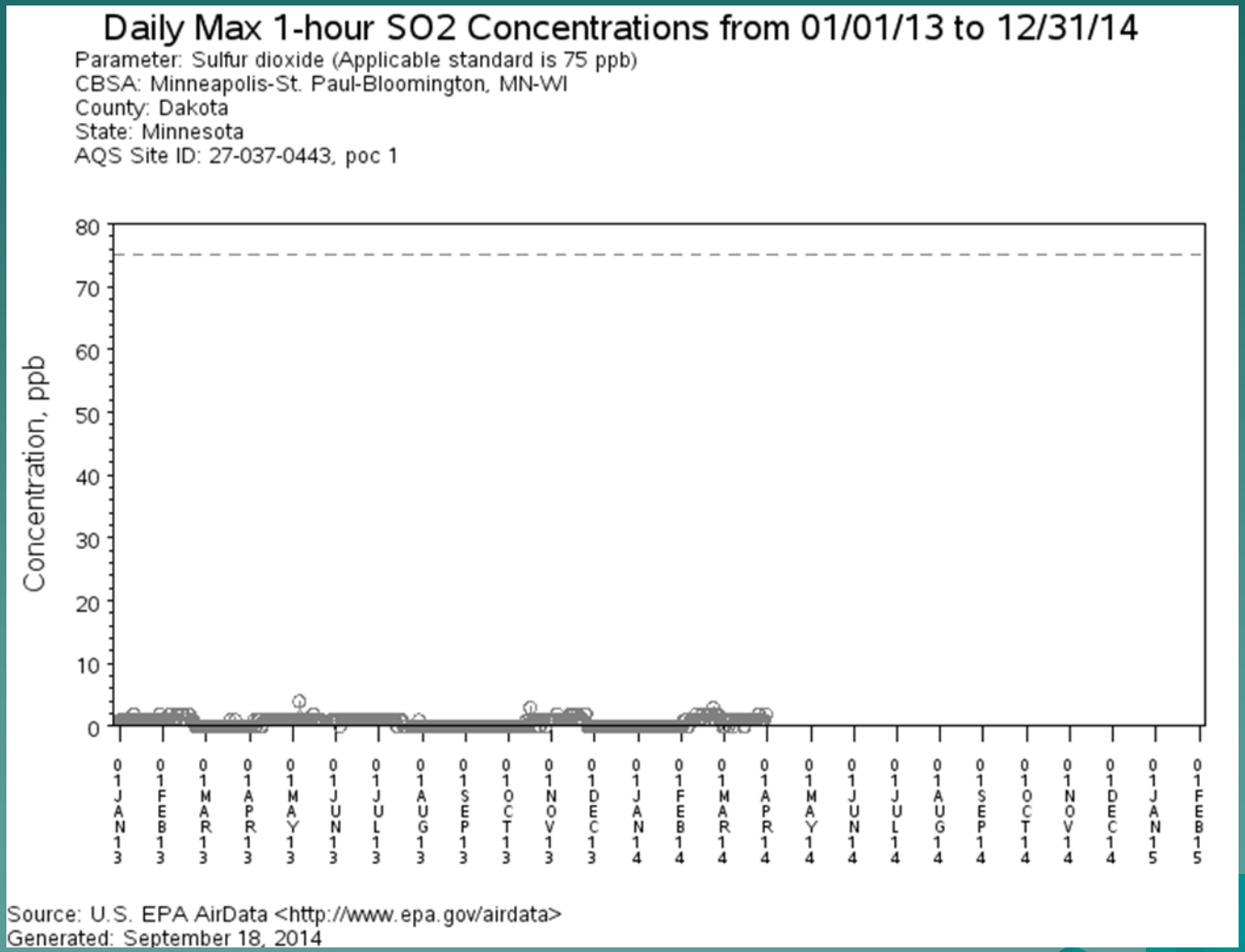
FHR 442 Analyzer



Source – EPA Air Data Website

EPA Web Site Data (SO2)

FHR 443 Analyzer



Source – EPA Air Data Website

Air Toxics

- Monitors also provide Air Toxic data
- Air Toxics are those that can potentially cause cancer or serious health effects.
- No standards – instead there are health benchmarks
- 3rd Party review of the Air Toxic Data completed by U of MN professor
- Metals included based on analysis of TSP particles

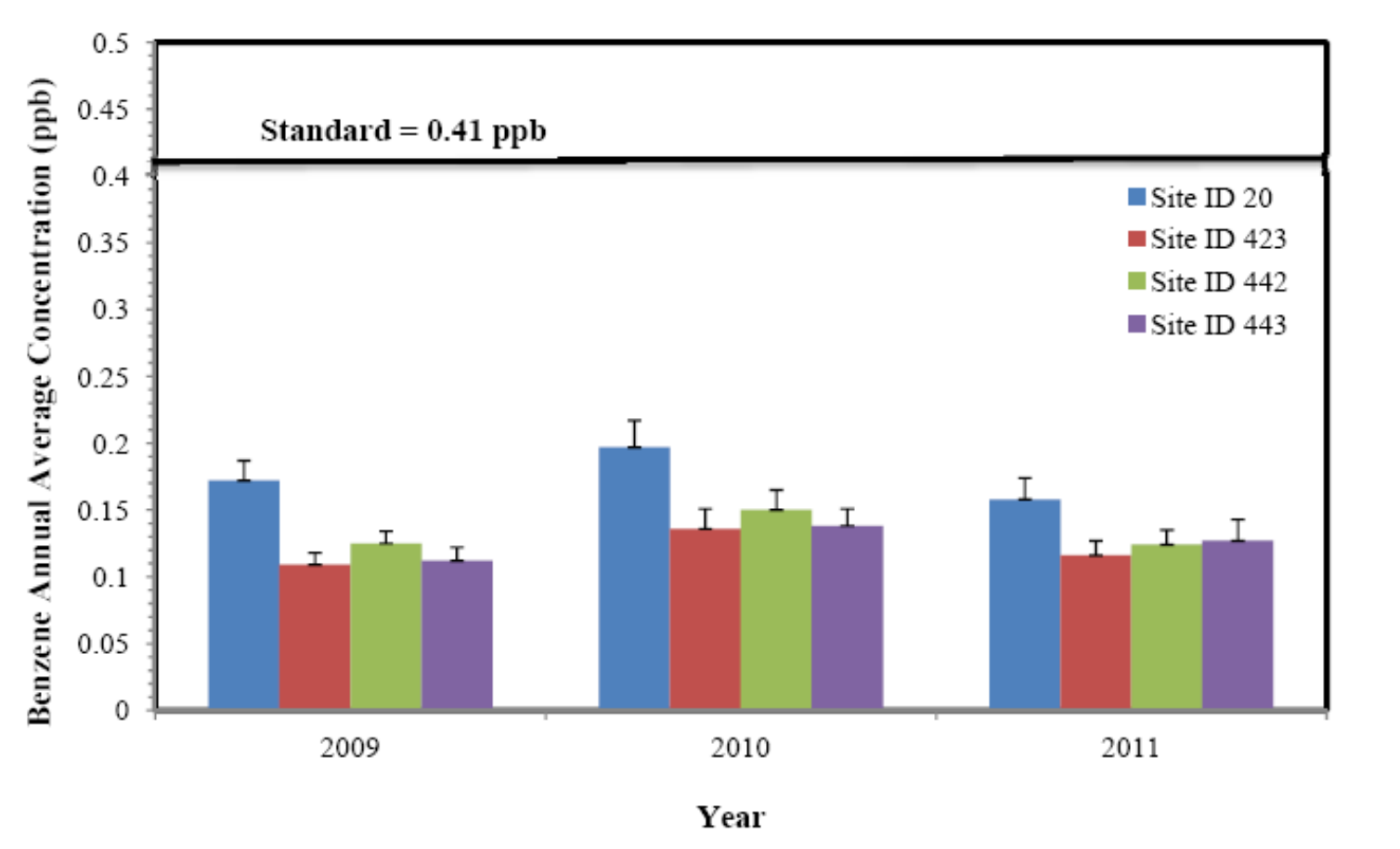
Health Benchmark Examples

Chemical	Exposure Limit	Source	Decision Statistic
Formaldehyde	2 $\mu g/m^3$ or 1.63 ppb	MDH	Annual average air concentration based on 10^{-5} Cancer risk
Benzene	1.3 $\mu g/m^3$ or 0.41 ppb	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk
Carbon tetrachloride	1.7 $\mu g/m^3$ or 0.27 ppb	IRIS	Annual average air concentration based on 10^{-5} Cancer risk

Metals in Total Suspended Particulates (TSP)

Chemical	Exposure Limit	Source	Decision Statistic
Antimony	0.2 $\mu g/m^3$	MDH HRV	Lower respiratory system effects
Arsenic	0.0023 $\mu g/m^3$	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk
Cadmium	0.0056 $\mu g/m^3$	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk
Beryllium	0.0042 $\mu g/m^3$	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk
Chromium	0.00083 $\mu g/m^3$	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk
Manganese	0.2 $\mu g/m^3$	MDH HRV	Nervous system effects
Nickel	0.021 $\mu g/m^3$	MDH HRV	Annual average air concentration based on 10^{-5} Cancer risk

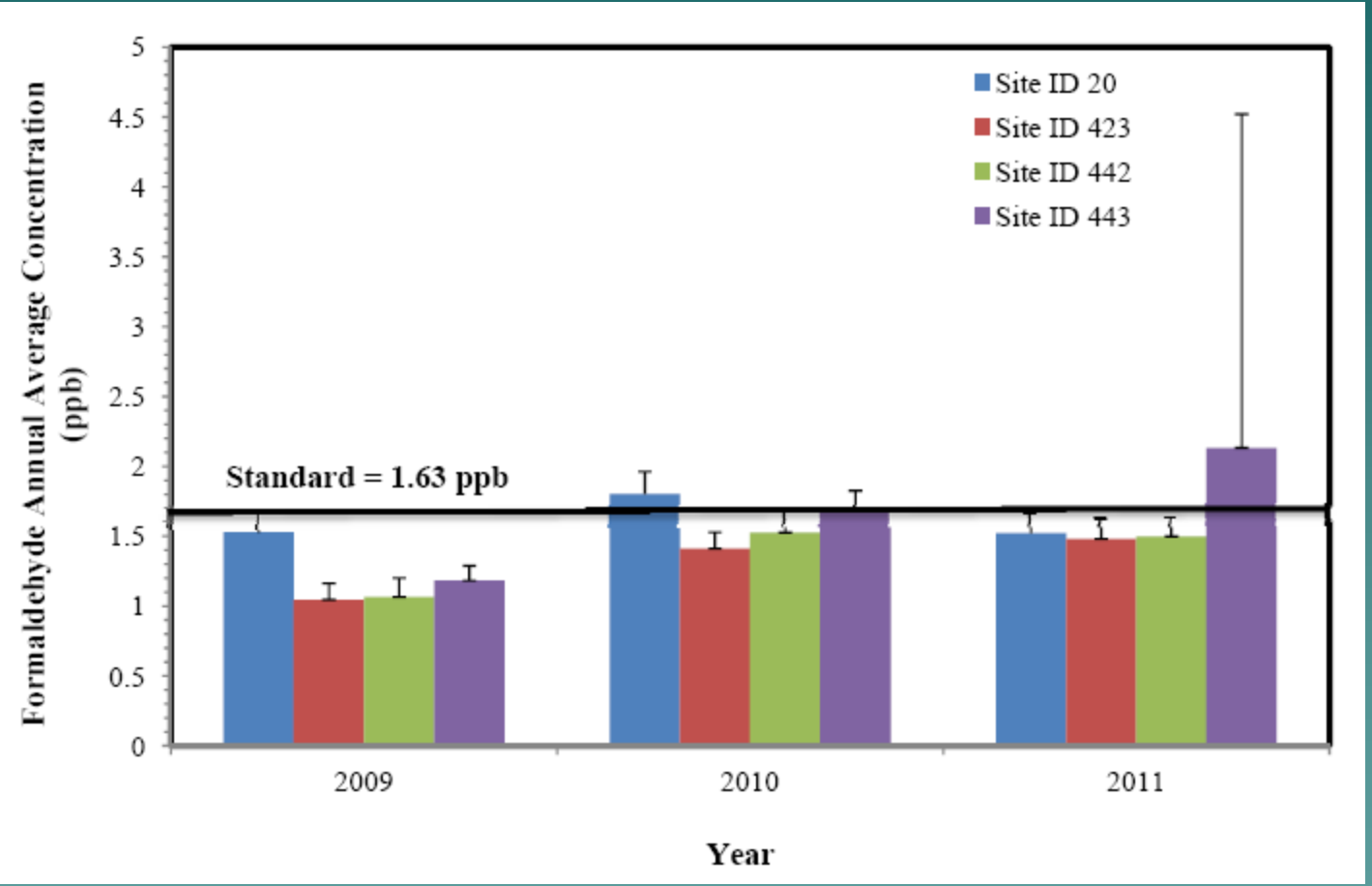
U of M 2012 Study
Benzene Annual Average



The benzene measurements were taken as 24-hour composite samples, collected once every six days.

Source – U of M Analysis

U of M 2012 Study
Formaldehyde Annual Averages

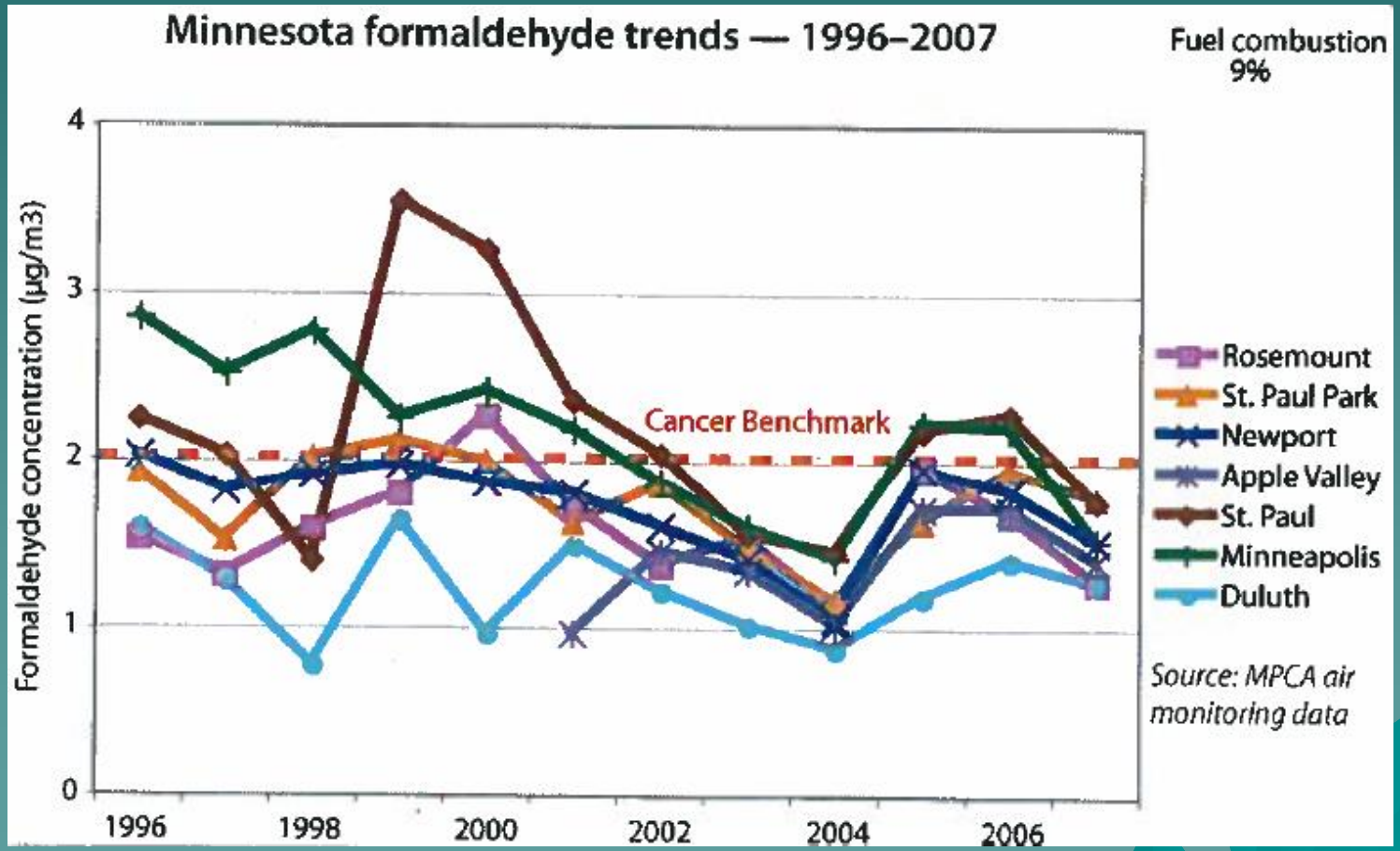


The formaldehyde measurements were taken as 24-hour composite samples, collected once every six days.

Source – U of M Analysis

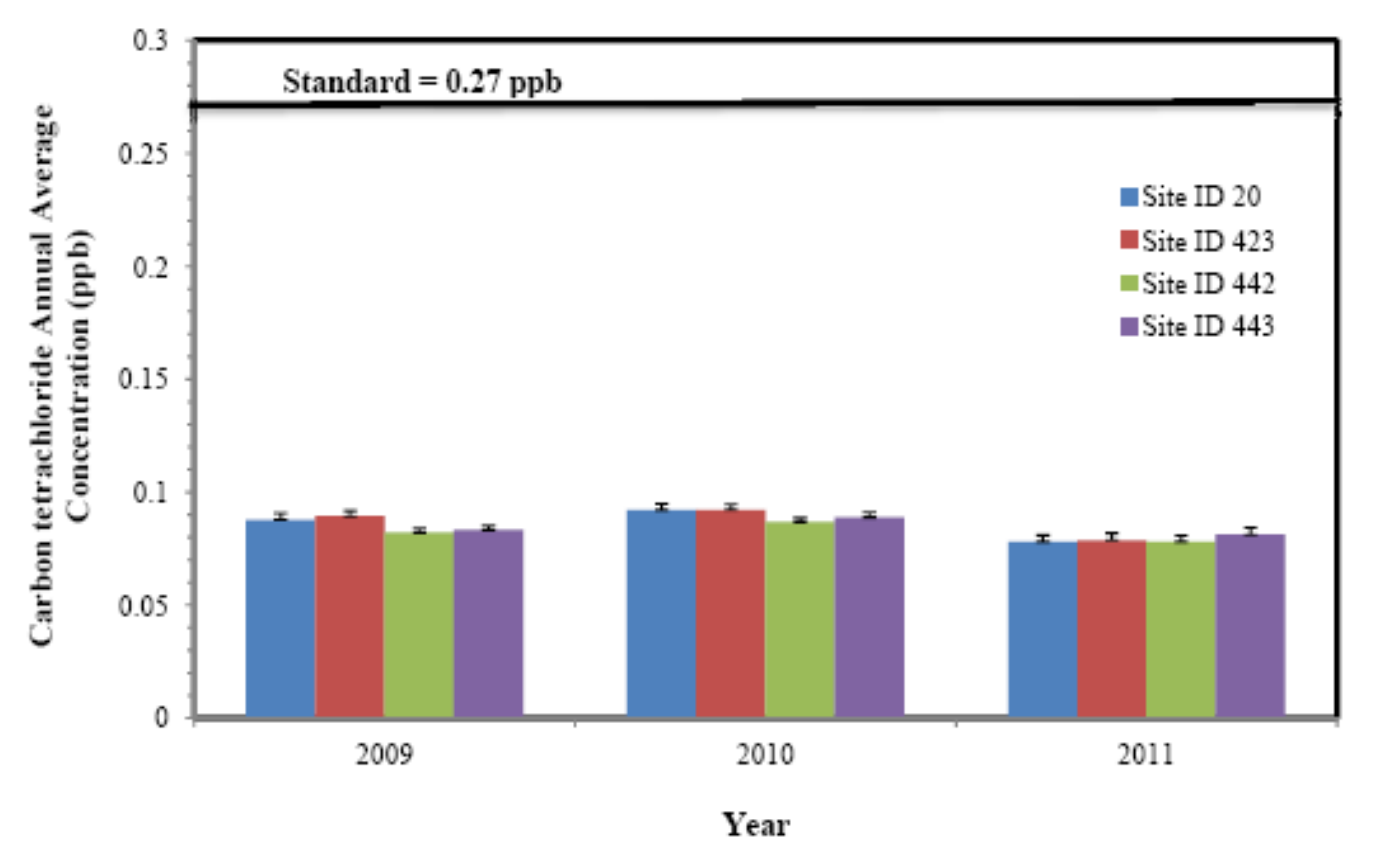
Formaldehyde Around Minnesota

- Naturally occurring throughout the State



Source – MPCA Air Monitoring Network Report

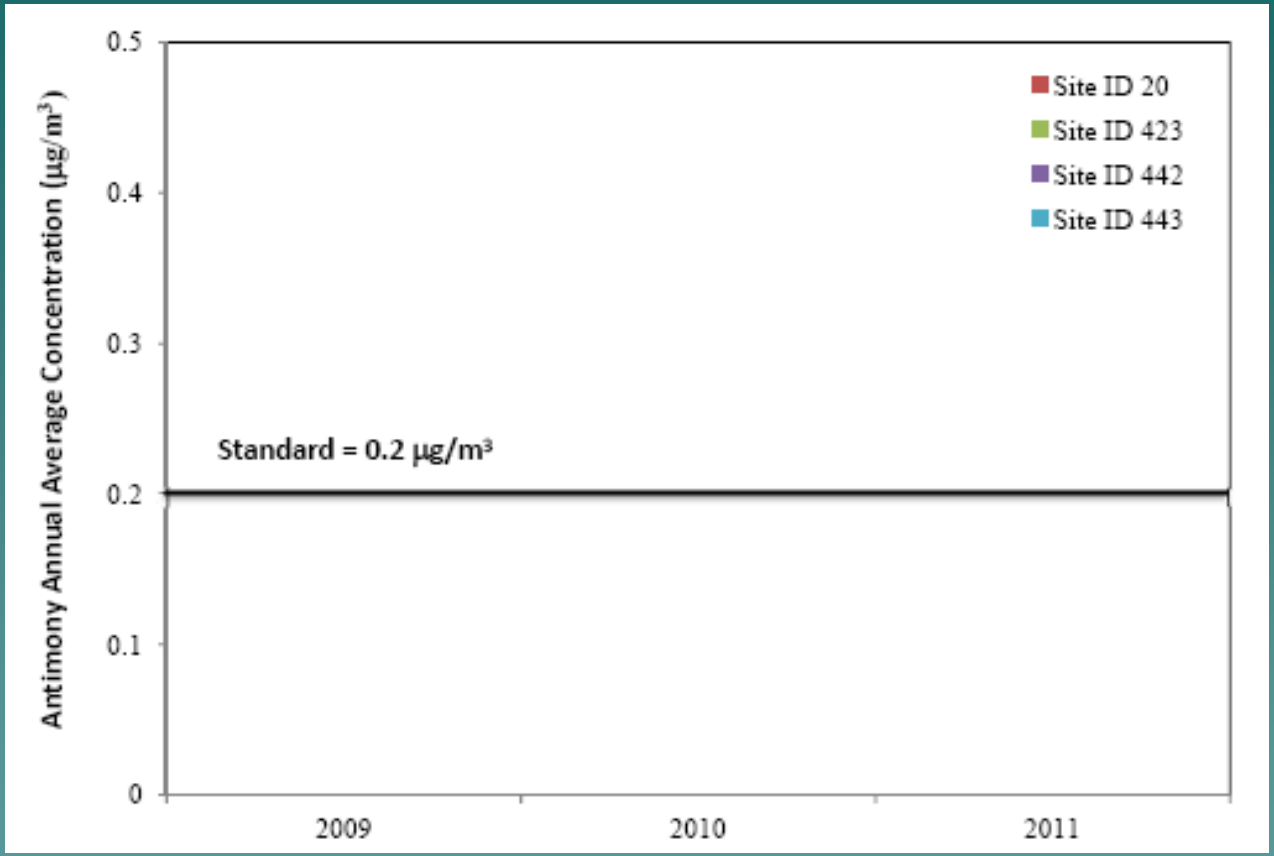
U of M 2012 Study
Carbon Tetrachloride Annual Average



The carbon tetrachloride measurements were taken as 24-hour composite samples, collected once every six days.

Source – U of M Analysis

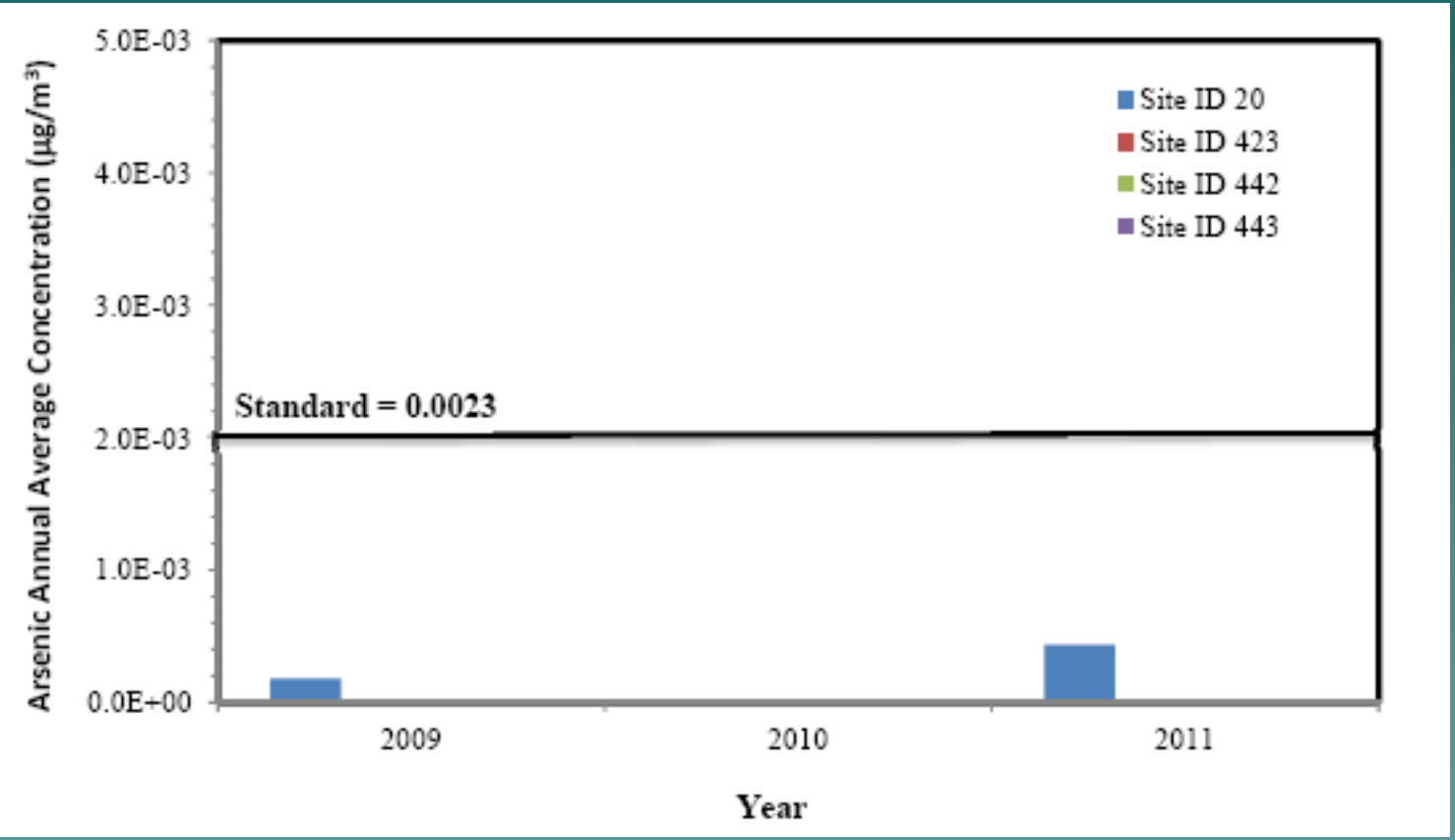
U of M 2012 Study
Antimony Annual Average



- The antimony measurements were taken as 24-hour composite samples, collected once every six days.
- Only site 420 had measurements from all three years; sites 423, 442 and 443 had measurements from 2009 only

Source – U of M Analysis

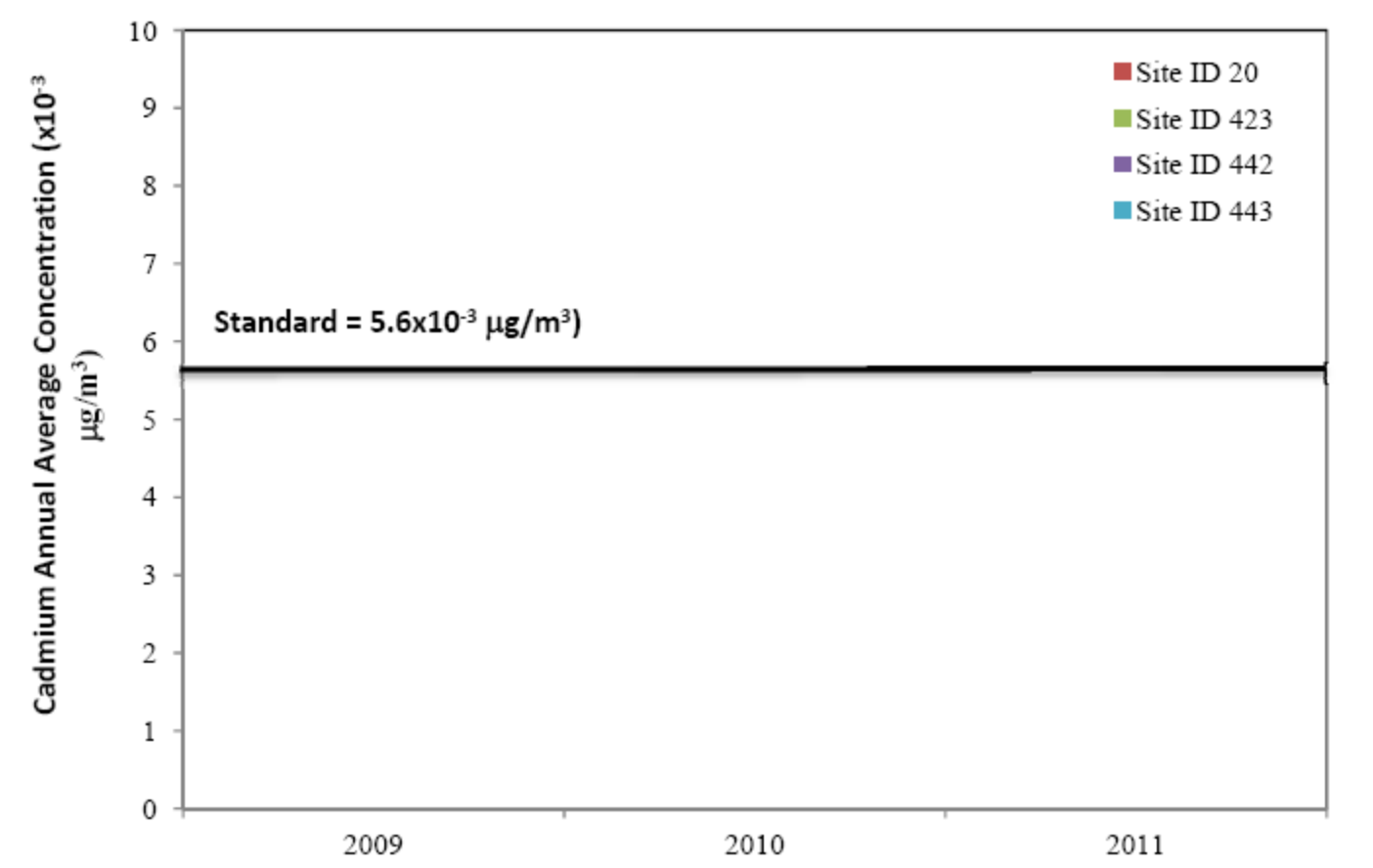
U of M 2012 Study
Arsenic Annual Average



- The antimony measurements were taken as 24-hour composite samples, collected once every six days.
- All the four sites had measurements from 2009 only.

Source – U of M Analysis

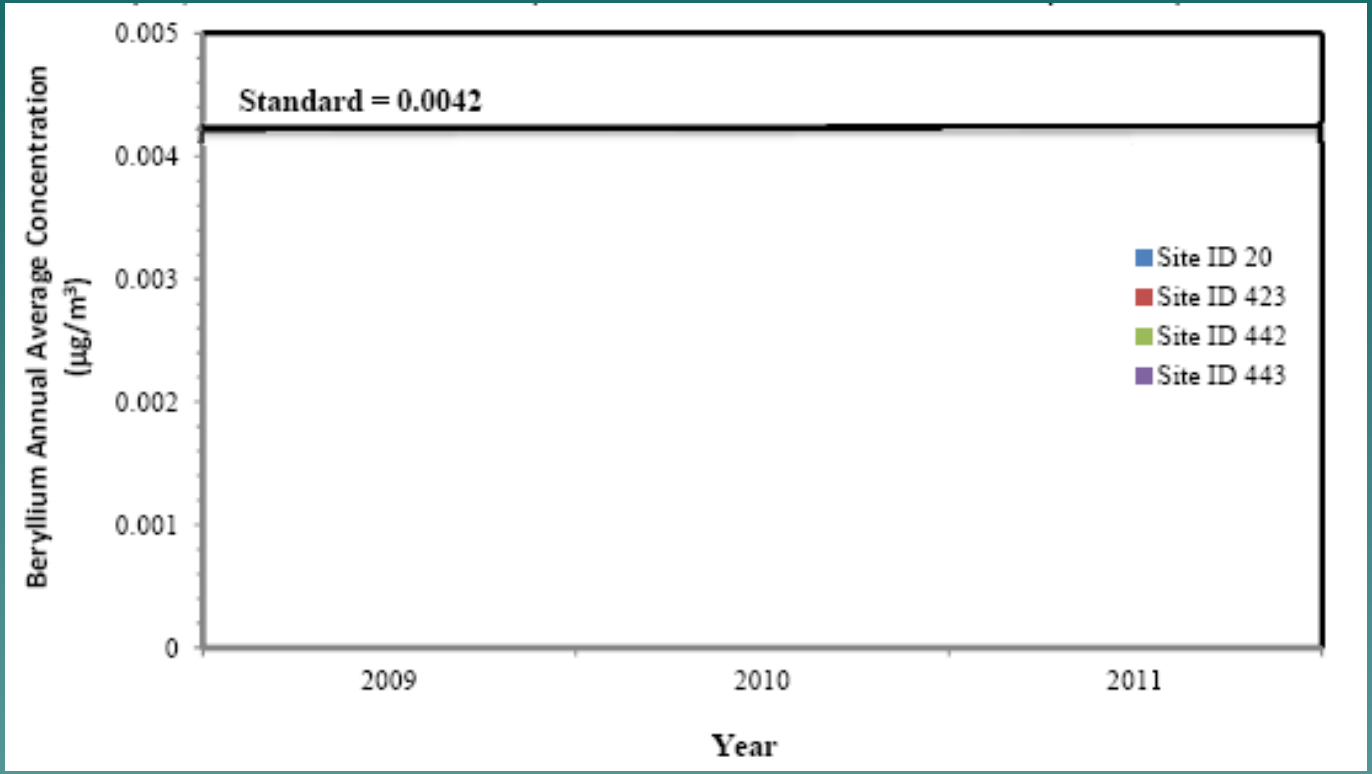
Cadmium Annual Average



- The cadmium measurements were taken as 24-hour composite samples, collected once every six days.
- Only site 420 had measurements from all three years; sites 423, 442 and 443 had measurements from 2009 only.

Source – U of M Analysis

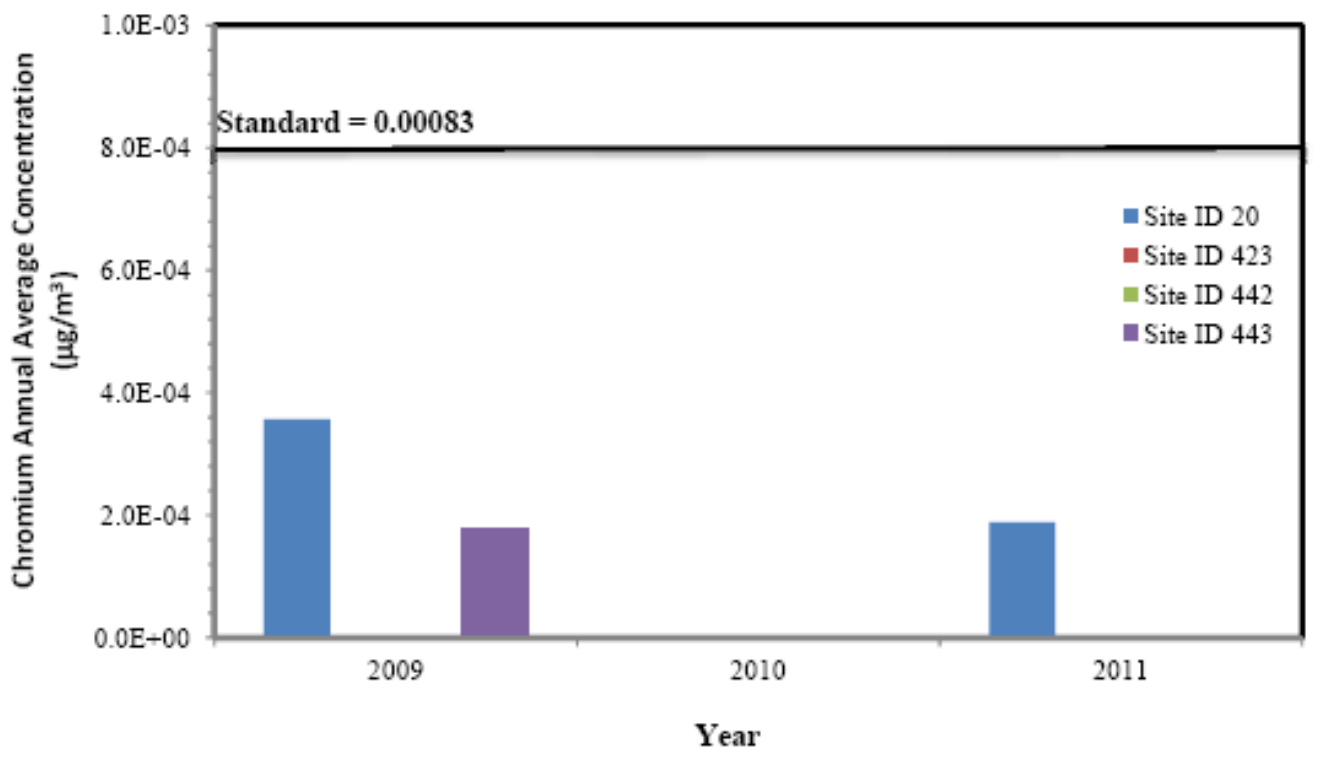
Beryllium Annual Average



- The beryllium measurements were taken as 24-hour composite samples, collected once every six days.
- Sites 420 and 423 had measurements from all three years while sites 442 and 443 had measurements from 2009 only .

Source – U of M Analysis

Chromium Annual Average

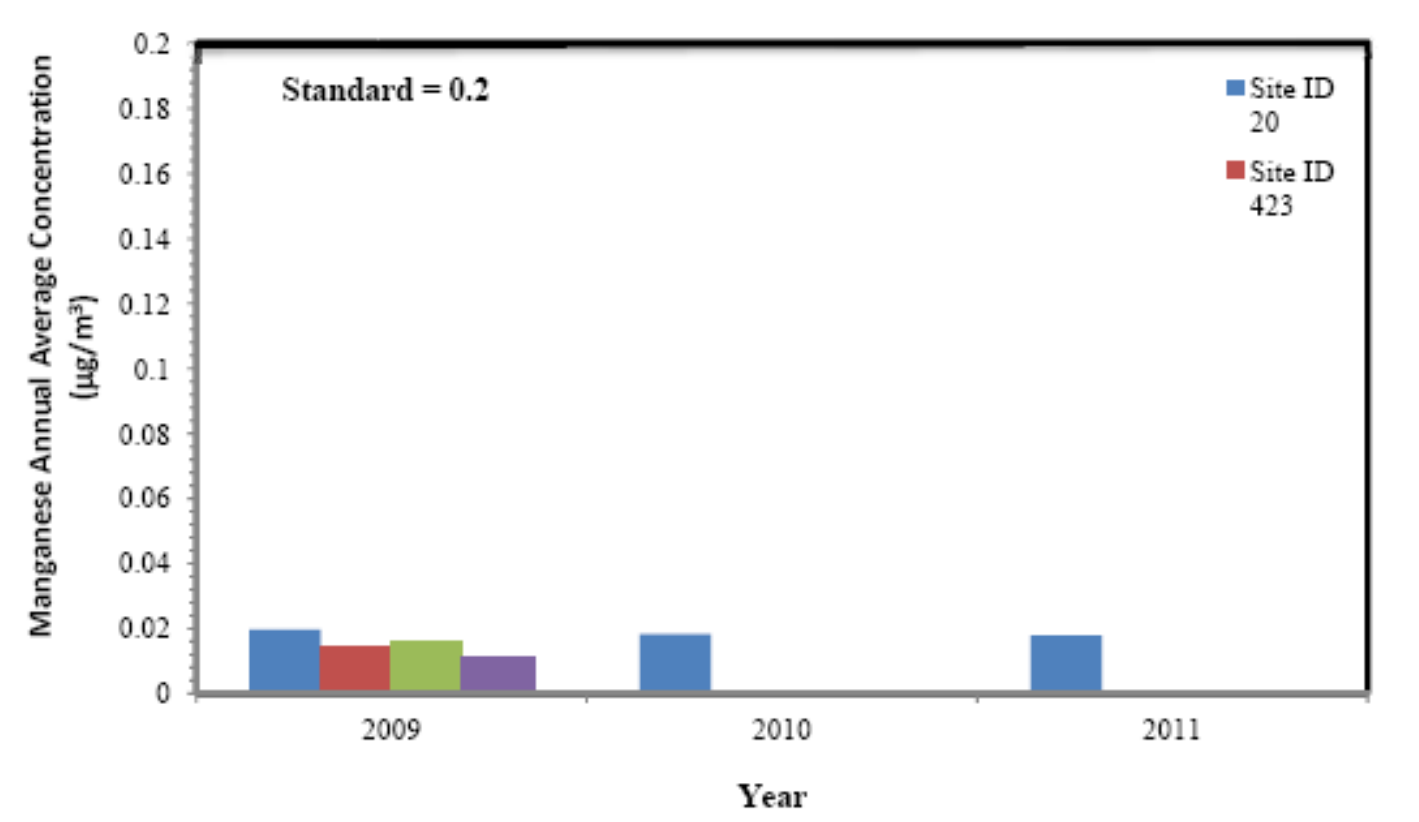


- The chromium measurements were taken as 24-hour composite samples, collected once every six days.

- Only site 420 had measurements from all three years; sites 423, 442 and 443 had measurements from 2009 only.

Source – U of M Analysis

Manganese Annual Average

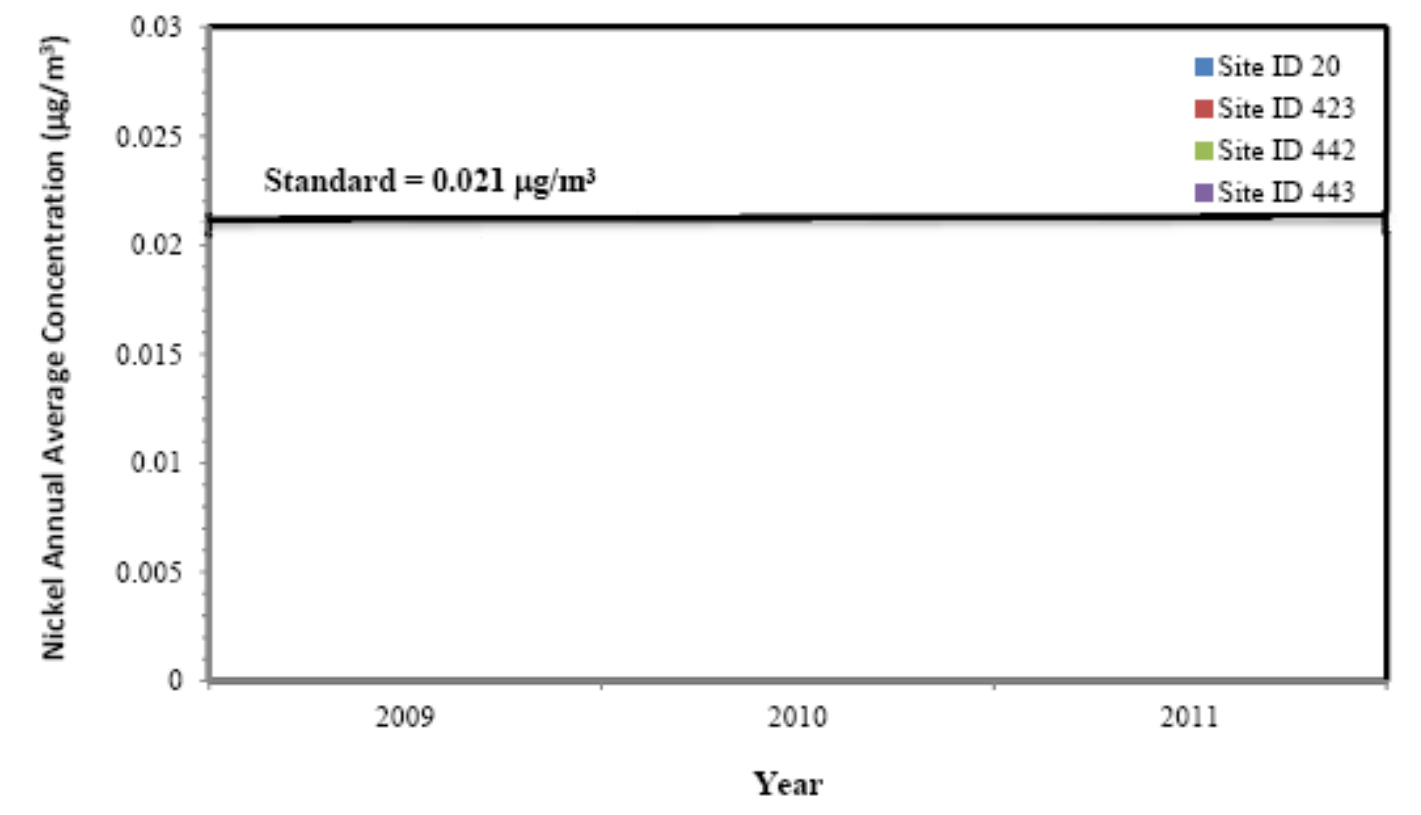


- The manganese measurements were taken as 24-hour composite samples, collected once every six days.

- Only site 420 had measurements from all three years; sites 423, 442 and 443 had measurements from 2009 only.

Source – U of M Analysis

Nickel Annual Average



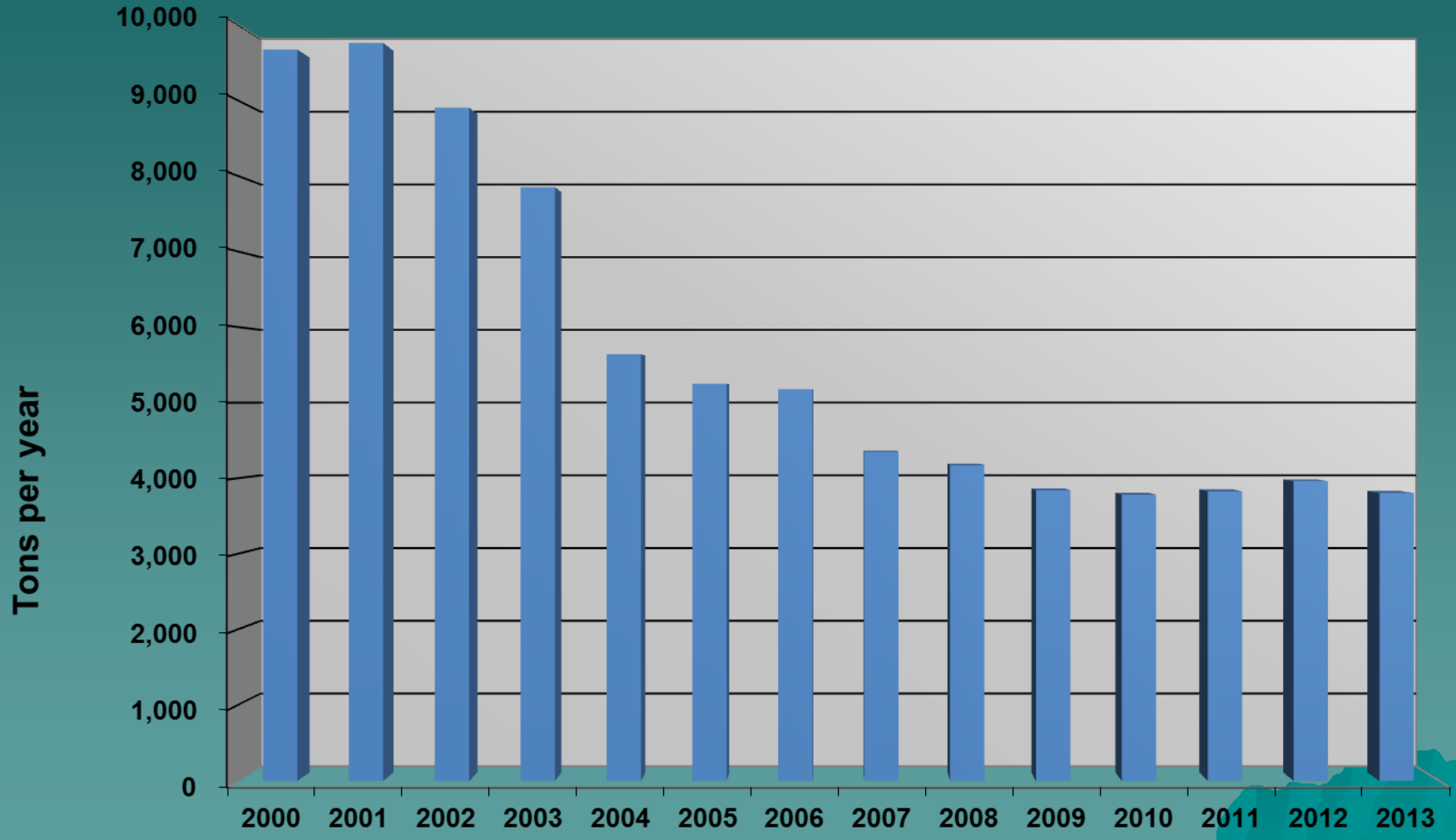
- The nickel measurements were taken as 24-hour composite samples, collected once every six days.

- Only site 420 had measurements from all three years; sites 423, 442 and 443 had measurements from 2009 only.

Pine Bend Refinery Direct Emissions Data

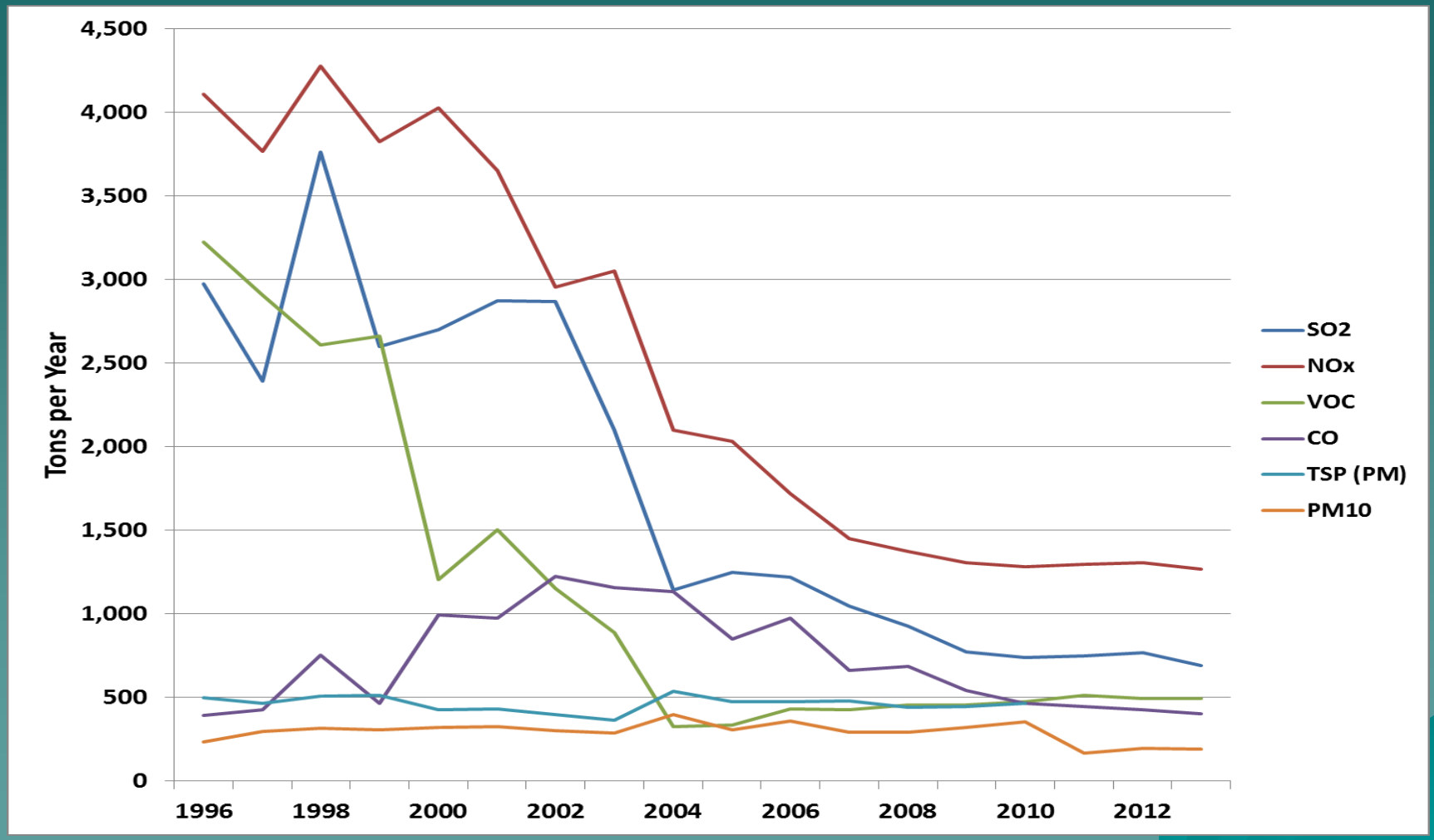
- Direct emissions from most sources are measured using modern instruments and advanced technology
- Measures emissions from heater stacks and other significant sources that generate emissions

Total Refinery Emissions Trend

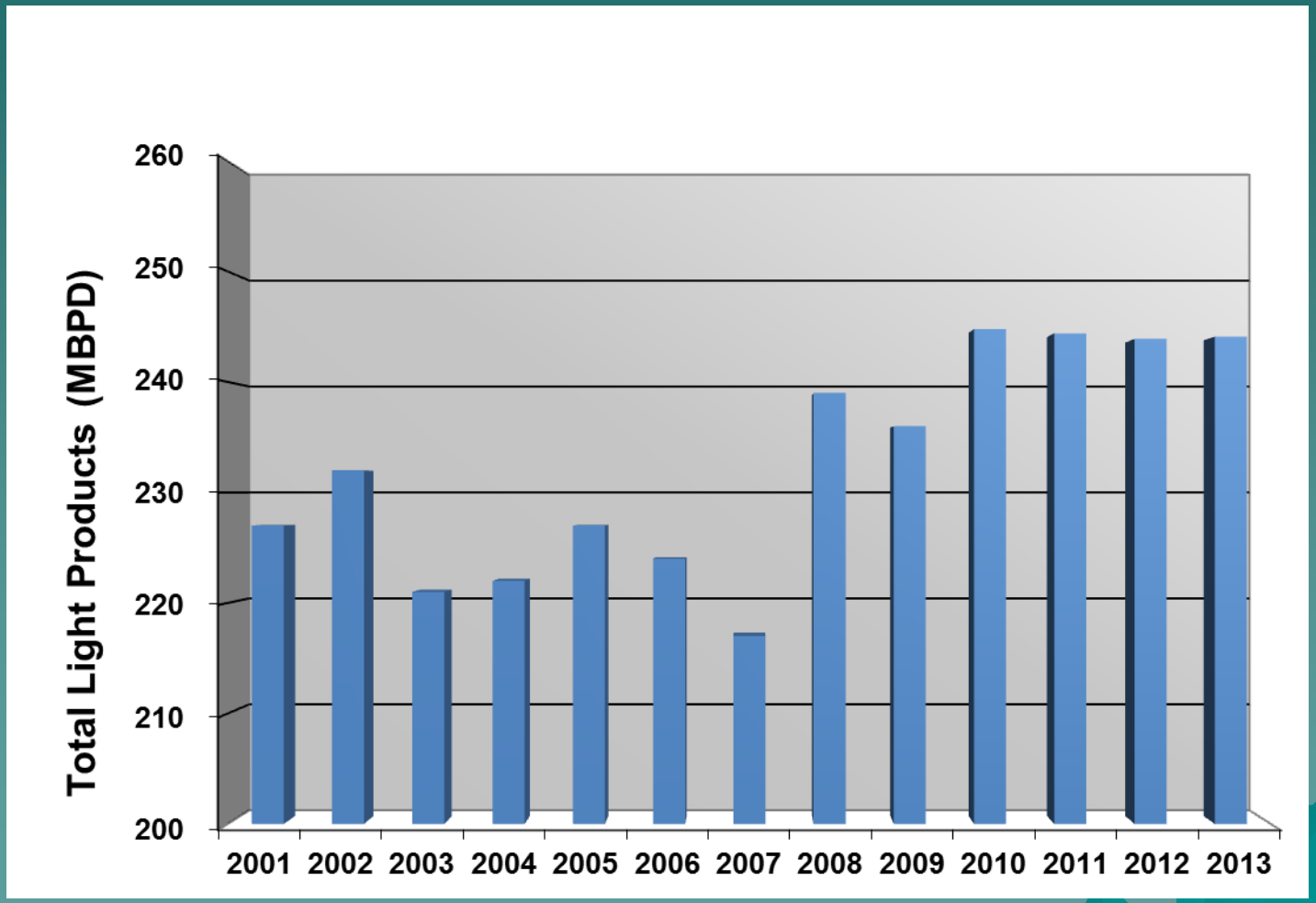


Total Criteria Emmisions

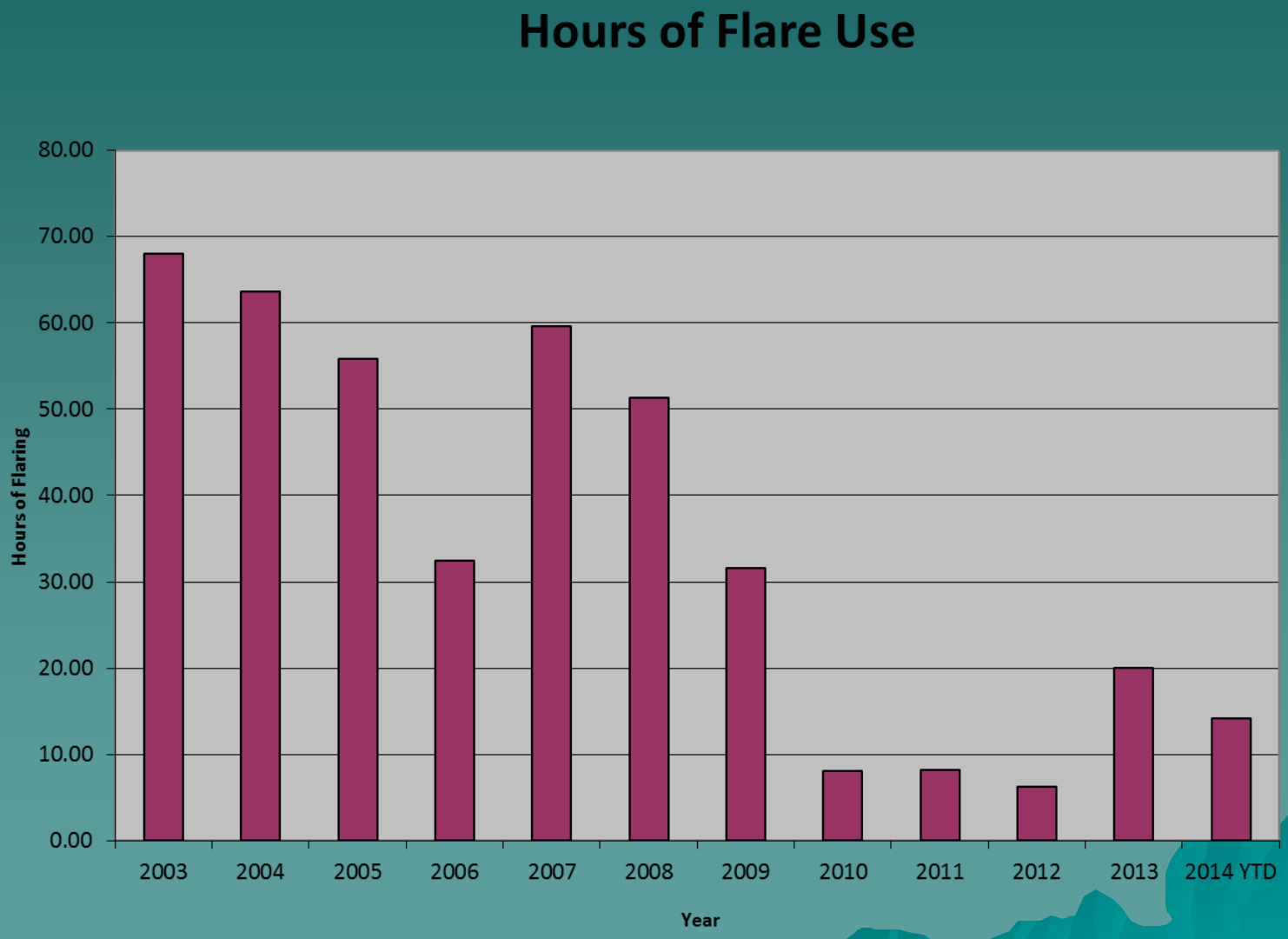
1996 through 2013



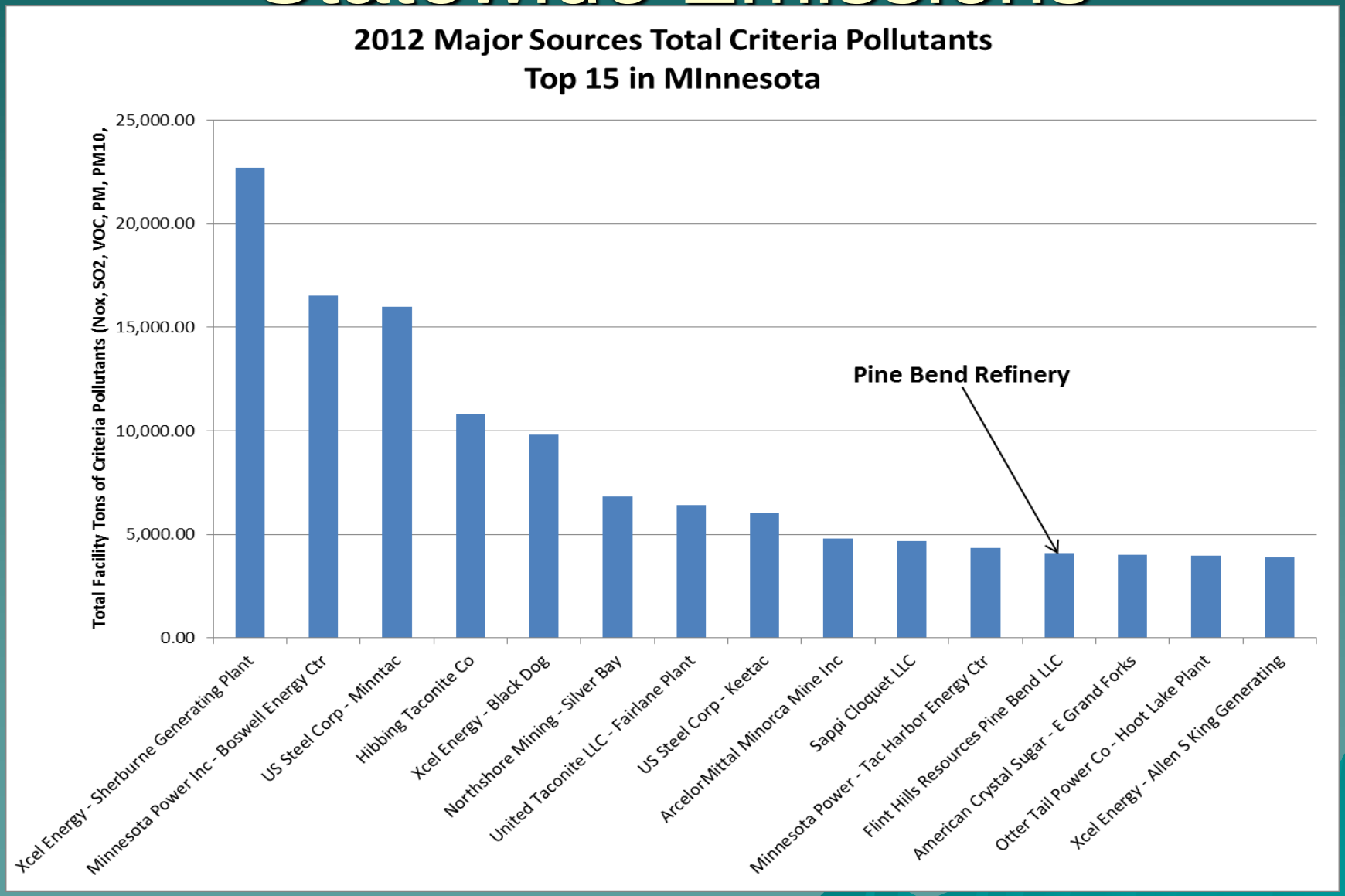
Total Refinery Light Products Production Levels



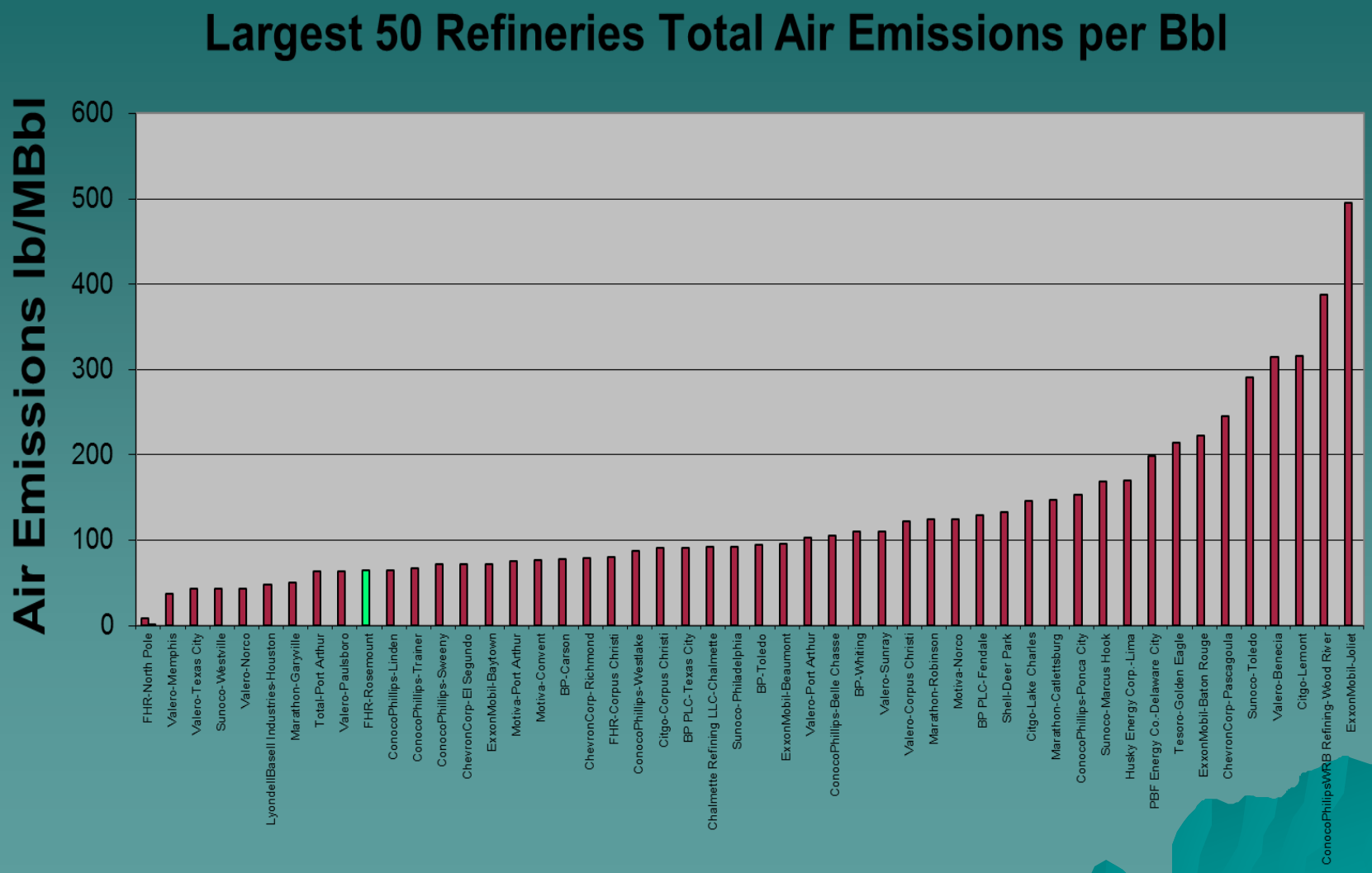
Pine Bend Refinery Flaring



Statewide Emissions



Air Emissions by Refinery



FHR Overall Refining Emissions vs. Other Refiners

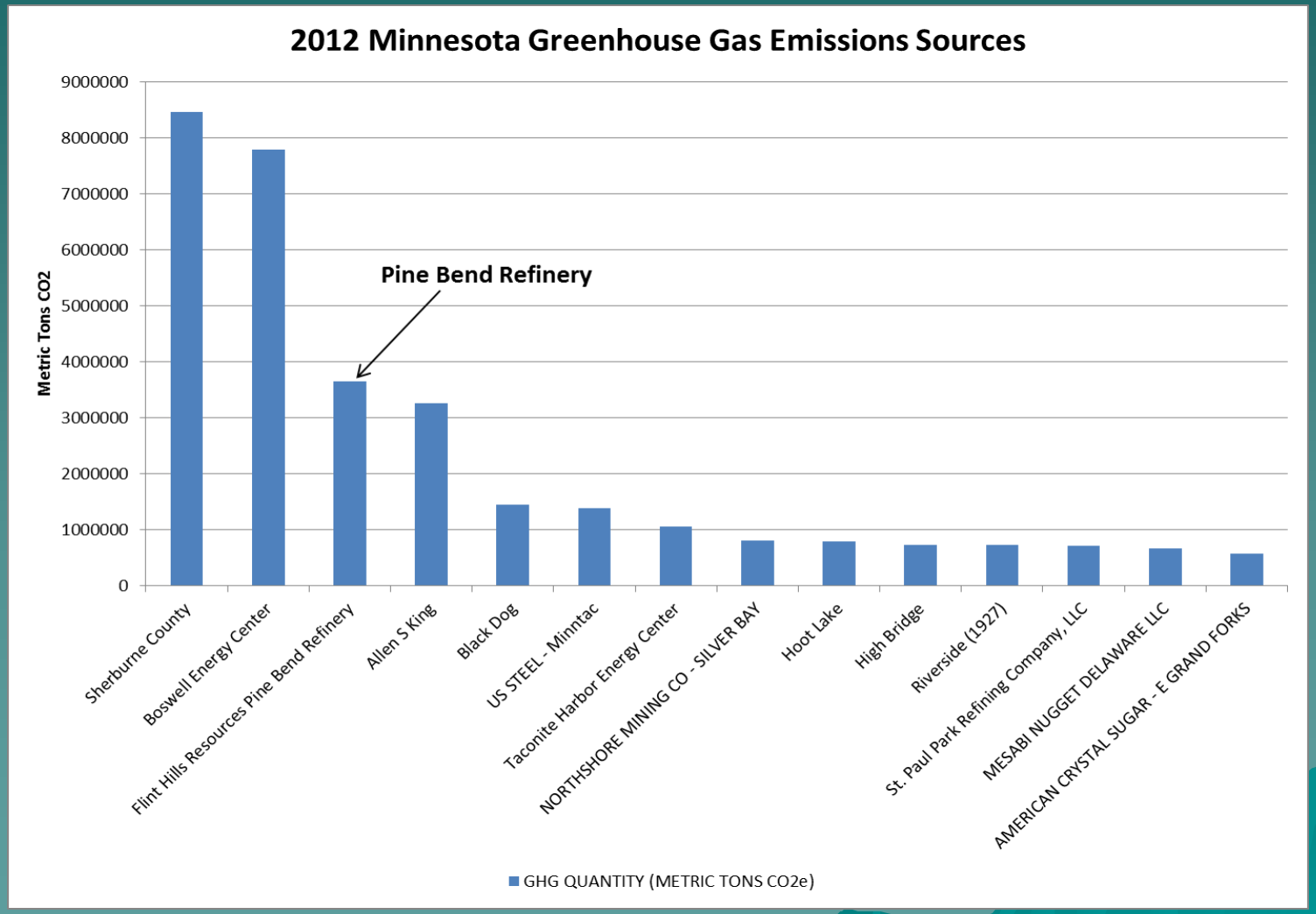
Refiners With Combined Crude Capacity >100 TBPD

Company	Emissions (lb/MBbl)
LyondellCitgo (268)	48
FHR (817)	55
Total (174)	64
Alon USA (241)	68
Valero (2210)	88
Marathon (1196)	90
Motiva (732)	91
Chalmette Refining LLC (193)	92
BP (1463)	100
Shell Chemical (140)	109
Western Refining (218)	137
Sunoco (825)	140
Murphy (158)	141
Coffeyville Resources (114)	143
Shell (621)	144
ConocoPhillips (2212)	147
ChevronTexaco (941)	155
Husky Energy Corp. (162)	170
Citgo (756)	170
Tesoro (658)	179
ExxonMobil (1873)	185
Frontier (187)	188
Pasadena Refining (117)	190
Others (802)	194
PBF Energy Co. (210)	198
Cenex (142)	208
Holly (290)	281

Greenhouse Gas

- Total of 3.6 Million Metric Tons CO2e from site
- Pine Bend is 3rd highest facility in MN (2012 data)
- GHGs generally correlate with production volumes (measure of energy usage)
- Energy efficiency improvements reduce GHGs
- No “scrubber” exists for GHGs

Minnesota Greenhouse Gas Emission Sources



Significant Emission Reductions Over Last 10 Years

- Asphalt additive (H2S)
- Sulfur Recovery Unit (SRU) Larger Reactor (CO/SO2)
- Gas Plant Absorber w/lean oil (SO2)
- Cooling Tower Mist Eliminator (PM)
- Gasoil Hydrotreater reactors (SO2)
- Heater NOx control including burners and catalytic (NOx)
- Wastewater Treatment Plant (WWTP) improvements (NH3)
- Flaring Reductions (All)

Air Permits & Limits

- Title V Air Permit lists every limit and requirement that the refinery must meet for air compliance.
- The 362 page permit is among the largest and most complex in MN
- Data submitted to MPCA for the past 5 Quarters:
  - Compliance with Air Limits – 99.94% of time

Compliance Demonstration

- MPCA audits compliance with Air Permit at least every 2 years onsite.
- FHR reports any Air Permit compliance exceptions formally twice per year.
- In the last 5 years, Pine Bend has received 1 Notice of Violation (NOV) letter identifying three Air Permit exceptions:
  - Analyzer outage
  - CO limit Exceedance
  - Late stack test
- FHR self-reported and immediately corrected

Summary

- Reduced total criteria air emissions ~70% over last 14 years
- Reductions have leveled out but not increased even as the light products produced has increased
- Emissions per bbl dropping but other refineries are also dropping
- Sustained top level industry performance for flare use in the last 5 years
- Significant number of regulatory terms to comply with, compliance performance upwards of 99.9%
- Information is public – EPA/MPCA Websites

QUESTIONS?