NAU NORTHERN ARIZONA UNIVERSITY

INSTITUTE for TRIBAL ENVIRONMENTAL PROFESSIONALS

Introduction to Air Quality Modeling for Permitting Programs

September 28, 2021 (Webinar1)

Tribal Air Monitoring Support Center

NAH-GAH-CHI-WA-NONG FOND DU LAC RESERVATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Webinar Logistics

- Webinar is being recorded – URL for the recording will be in post-webinar email and posted at https://bit.ly/AIAQTPwebinars
- Please complete the webinar feedback survey – Link for the feedback survey will be in post-webinar email
- Certificates will be emailed to participants
- Webinar 2 will be held on September 30, 2021

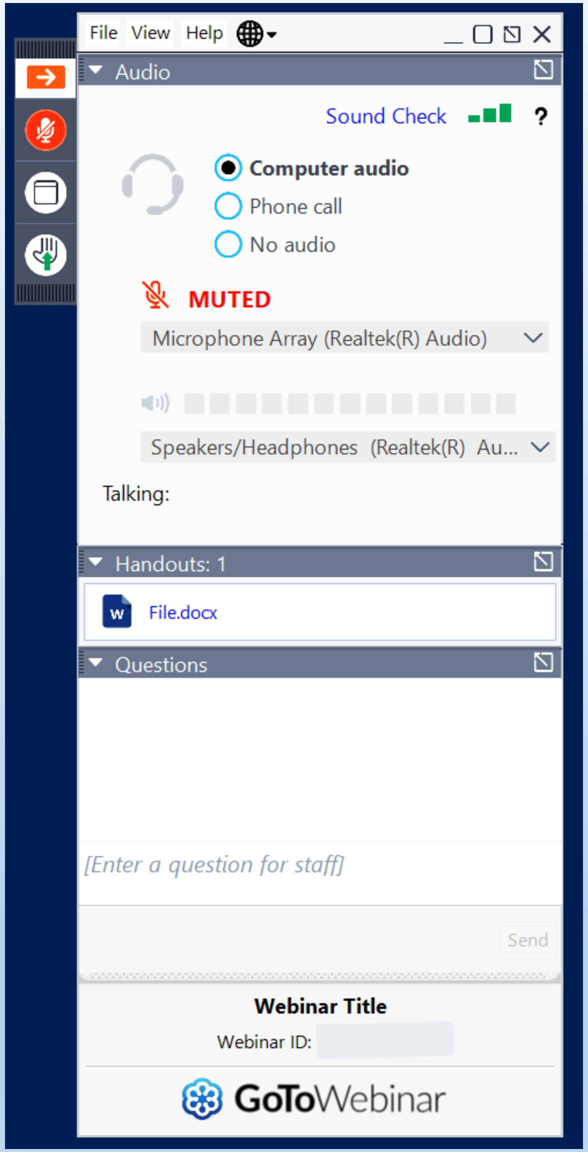
Thank you for joining the webinar

Submit questions in the "Questions" pane

Raise your hand if you would like to be unmuted

Download files from the "Handouts" pane

Presented by the Institute for Tribal Environmental Professionals
American Indian Air Quality Training Program
Questions? Contact Christal.Black@nau.edu



Polling Questions

Poll Question 1

- Which of the following best describes your role?
  - Environmental Staff
  - Community or Tribal Leader
  - Federal or State Partner
  - Other

Poll Question 2

- How many years have you worked in Air Quality?
  - Less than a year
  - 1-3 years
  - 3-5 years
  - 5-10 years
  - Over 10 years

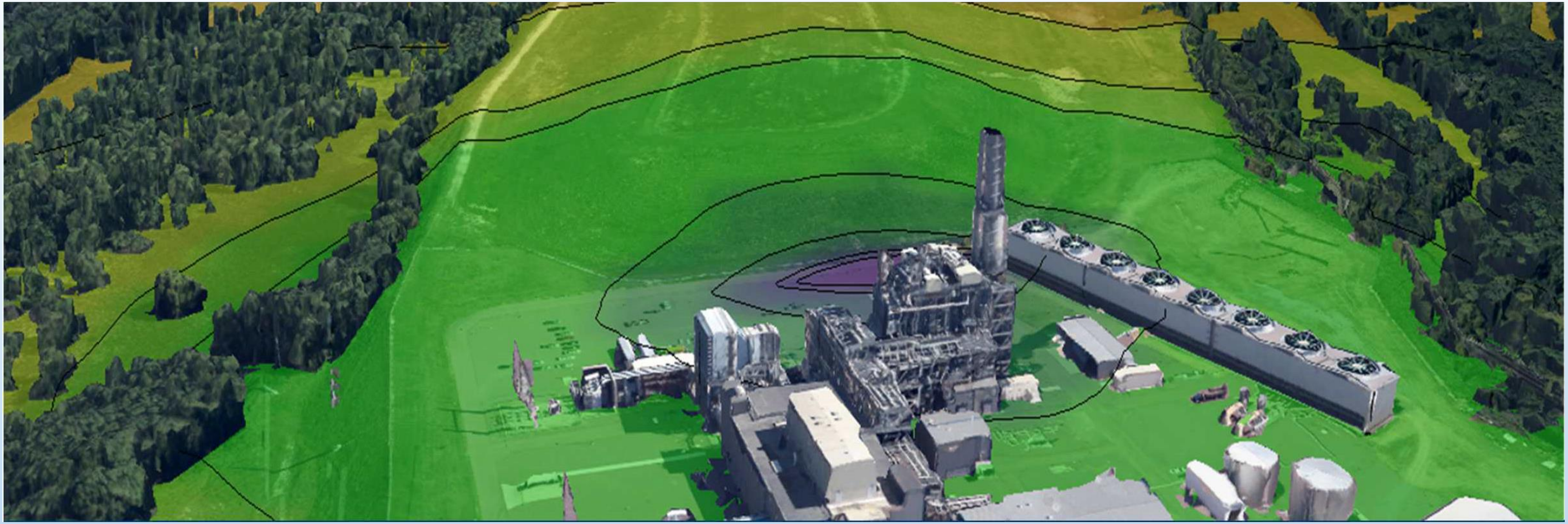
Presenters

Charles Buckler
US EPA OAQPS

Joy Wiecks
Fond du Lac Band of Lake Superior Chippewa

Webinar 1 Overview

- **What is atmospheric modeling?**
  - Why conduct air dispersion modeling instead of monitoring?
  - How does modeling differ from monitoring?
  - How are air dispersion models used in the permitting process to demonstrate compliance?
- **Facility types/activities that will require air dispersion modeling**
  - Pre-Construction Permitting – New Source Review Permitting Program
- **CFR Appendix W to Part 51 – Guideline on Air Quality Modeling**
- **How do Tribal Air Professionals Determine what to model?**
  - What questions do we need to answer (e.g., model source types, inputs and source characteristics, etc.)?
- **What type of air quality model do we use for permitting?**
  - The Gaussian model - AERMOD
- **What atmospheric and surface parameters does AERMOD assess to demonstrate compliance?**
- **Modeling example**
- **Summary**
- **Tribal case study**



Introduction To Air Quality Modeling for Permitting Programs

Chuck Buckler

US Environmental Protection Agency

Office of Air Quality Planning and Standards (OAQPS)

September 28th, 2021

What is Atmospheric Modeling?

- **Atmospheric dispersion modeling is a** mathematical simulation of how air pollutants disperse in the ambient atmosphere
  - Computer program algorithms used to solve mathematical equations that govern the pollutant dispersion.
  - Used to estimate source(s) downwind ambient concentration of air pollutants.
- **Modeling inputs:**
  - **Temperature, wind speed/direction, stability, and plume rise** all play a role in calculating the airborne pollutant(s) ambient concentration(s) at modeled locations.
- **Are there different types of models?**
  - Yes, there are different applications, equations and approaches to modeling physical processes to simulate the atmosphere.
    - For our purposes, we will focus on the **Gaussian model**, which assumes a "normal distribution." This is the most common type of model used (e.g., AERMOD) for **pre-construction** permitting programs.

Why do we conduct modeling instead of monitoring?

- **An integral part in assessing air quality values**
  - **Major source preconstruction permitting** requirements state that…"a source must demonstrate that it will not cause or contribute to a violation of any NAAQS or PSD Increment."
  - **Tribal minor source permitting** actions require modeling on a "case-by-case basis" to ensure the NAAQS and PSD increment are not violated.
- **Modeling is much more flexible then monitoring**
  - Can produce results in hours (versus months with monitoring) at a lower cost to quickly accomplish a review.
  - Facilities can assess different operating scenarios to maximize operations and minimize impacts.
- **Modeling is only as good as the data inputs**
  - Imperative that the modeled information is accurate. Modeling output is only as good as the input.
- **Monitoring is highly accurate but accurate data is dependent on:**
  - Siting - Proper siting, to adequately assess the ambient air, is sometimes difficult.
  - Collection time – It usually takes a full year to accurately assess the sources airshed. This is problematic when trying to obtain a permit.
  - Cost – Setting up and maintaining monitors can be time consuming and costly.

So, air dispersion modeling…

- Supports a wide range of air emission permit programs.
- Used to enforce permitting requirements for compliance with national and state ambient air quality standards.
- The only way to predict future air quality impacts for planned projects.

In this presentation, we will focus on the preconstruction program called New Source Review (NSR) and how air dispersion modeling is used for that program.

Facility types/activities that will require air dispersion modeling

New facility

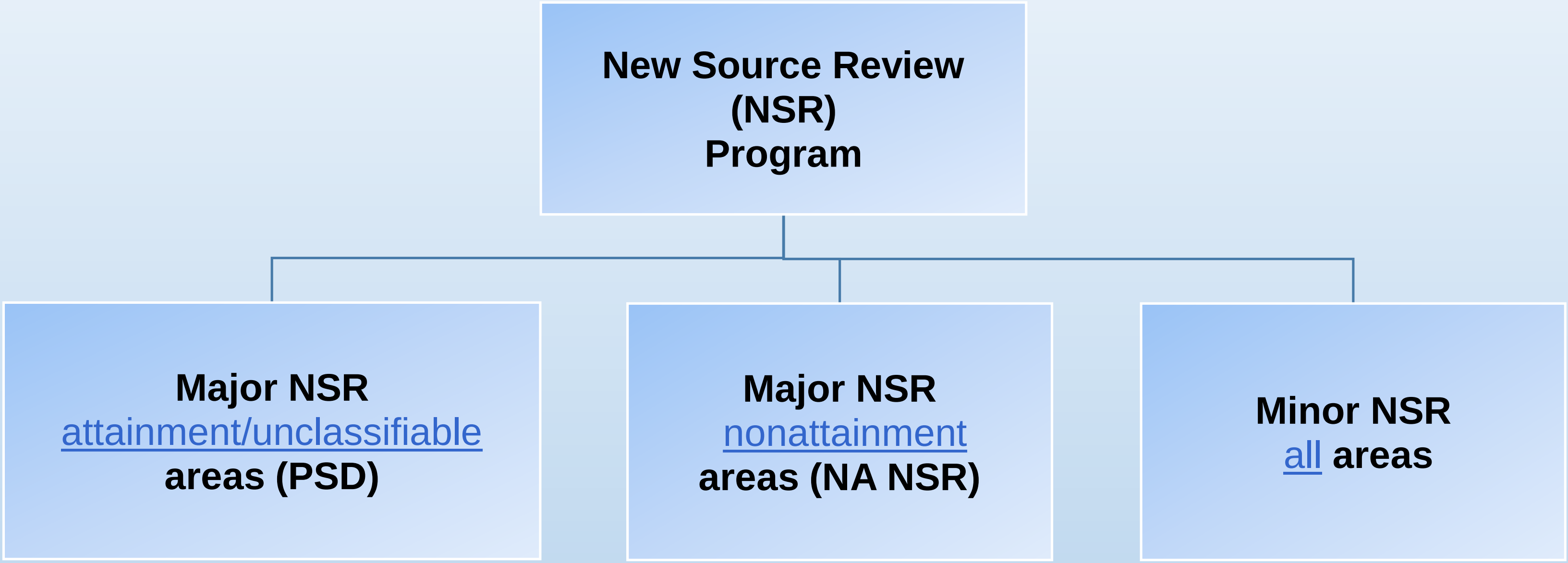
Facility changes

Permit renewal

Special projects

- Prevention of Significant Deterioration (PSD) Air Quality Permits
- Non-PSD: Federal Part 70 and Title V and State Only-Permits
- State Implementation Plan (SIP)
- Environmental Review (EAW & EIS)

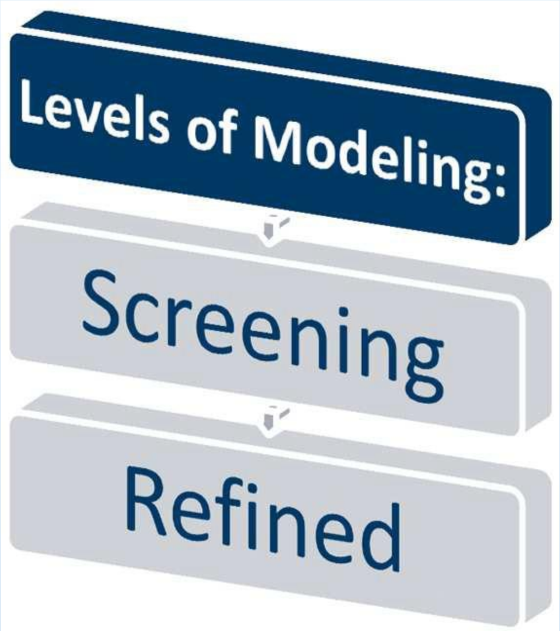
Pre-construction - New Source Review (NSR) Permitting Programs



- Major NSR applies to **major stationary sources** or to **major modifications** to existing major sources
  - NSR regulations for PSD and NA-NSR provide major source thresholds based on Potential to emit (PTE)/tons per year (TPY) emissions
- Minor NSR applies to minor sources and minor projects at major sources

Levels of modeling and compliance with air quality standards

NAAQS
PSD
SIL



Analysis of these Critical Values →

Table 1. NAAQS, PSD increments, and significant impact levels in micrograms per cubic meter (μg/m^3)

Pollutant	Averaging Period	Primary NAAQS (μg/m^3)[G]	Secondary NAAQS (μg/m^3)[G]	PSD Class II Increment (μg/m^3)	PSD Class I Increment (μg/m^3)[B]	Significant Impact Level (μg/m^3)
SO_2[A]	1-Hour	196.4[F3]	To be determined	To be determined	To be determined	7.86[F1] (EPA interim value)
	3-Hour	None	1309.3[F2]	512[F2]	25	25[F1]
	24-Hour	366.6[F2]	None	91[F2]	5	5[F1]
	Annual	78.6[F1]	None	20[F1]	2	1[F1]
PM_{10}	24-Hour	150[F4]	150	30[F2]	8	5[F1]
	Annual	-	-	17[F1]	4	1[F1]
$PM_{2.5}$[D]	24-Hour	35[F5]	35	9[F2]	2	1.2[C1]
	Annual	12[F1]	15	4[F1]	1	0.3[C1]
NO_2	1-Hour	188.0[F5]	To be determined	To be determined	To be determined	7.52[F1] (EPA interim value)
	Annual	99.7[F1]	99.7	25[F1]	2.5	1[F1]
CO	1-Hour	40,071.5[F2]	None	None	None	2,000[F1]
	8-Hour	10,304.1[F2]	None	None	None	500[F1]
O_3[D]	8-Hour	137.3	137.3	None	None	None
Pb	Rolling 3-Months	0.15[E1]	0.15[E1]	None	None	None

Minor vs. Major applicability thresholds (attainment areas)

Regulated NSR Pollutant	Minor Source Threshold (tpy)	Major Source Threshold (tpy)
Carbon Monoxide (CO)	10	100 or 250
Sulfur Dioxide (SO_2)	10	
Ozone - Oxides of Nitrogen (NO_x)	10	
Ozone - Volatile Organic Compounds (VOC)	5	
PM	10	
PM-10	5	
PM-2.5	3	
Lead	0.1	
Fluorides	1	
Sulfuric Acid Mist	2	
Hydrogen Sulfide (H_2S)	2	
Total Reduced Sulfur (including H_2S)	2	
Reduced Sulfur Compounds (including H_2S)	2	
Municipal Waste Combustor Emissions	2	
Municipal Solid Waste Landfills Emissions	10	
Greenhouse Gases (Combination of gases CO_2, CH_4, N_2O, HFC, PFC, SF_6)	N/A	75,000 + otherwise subject to PSD

EPA ‘s Modeling Guidance

- **EPA provides guidance for developing modeling demonstrations via 40 CFR Appendix W to Part 51 – Guidelines on Air Quality Models. The guideline:**
  - **Provides** EPA-recommended models, as well as guidance for their use, for predicting ambient concentrations of air pollutants.
  - **Recommends** air quality modeling techniques that should be applied to a range of programs (e.g., state implementation plan (SIP) revisions and to NSR Prevention of Significant Deterioration (PSD) actions).
  - **Promotes regulatory consistency** in the application of air quality models.

How do air professionals determine how and or what to model?

- Air dispersion **modeling protocol** is a beginning point.
  - Facilities are **required** to first submit a protocol to EPA or the state/local/tribal agency that has the permitting responsibility. The protocol:
    - Proposes the model set-up, configuration, inputs, etc.
    - Air professional will review for accuracy and may approve or request changes before the modeling begins.
- Upon protocol approval, the modeler will set up the model with the respective inputs and parameters and run the model.
    - Note: the modeler might run the model several times before reaching the final result.
- The results will then be compared to the applicable standard (major or minor source thresholds, Class I increment, etc.) to demonstrate compliance.
  - Michael King will discuss more of this in detail on Webinar 2

Questions that modelers are trying to answer…

- In asking how to best accomplish the modeling, air professionals need to ask many questions about the permitted source. For example:
  - How is the facility configured and are the facility source(s) configured properly to prevent exceedances?
    - Running boiler 1 and boiler 2 at the same time may produce issues with compliance. If they're run separately, will air quality be within standards?
    - What types of controls, if any, will be required to demonstrate compliance with the standards?
  - Does the facility have representative meteorological data that will provide an accurate assessment or does the facility need to access National Weather Service data?
  - If traffic increases with the modification, how will more dust (e.g., particulate) affect the analysis and nearby neighborhoods?
  - Is the highest concentration near a school or other critical area?
  - Will terrain be a factor in the analysis?

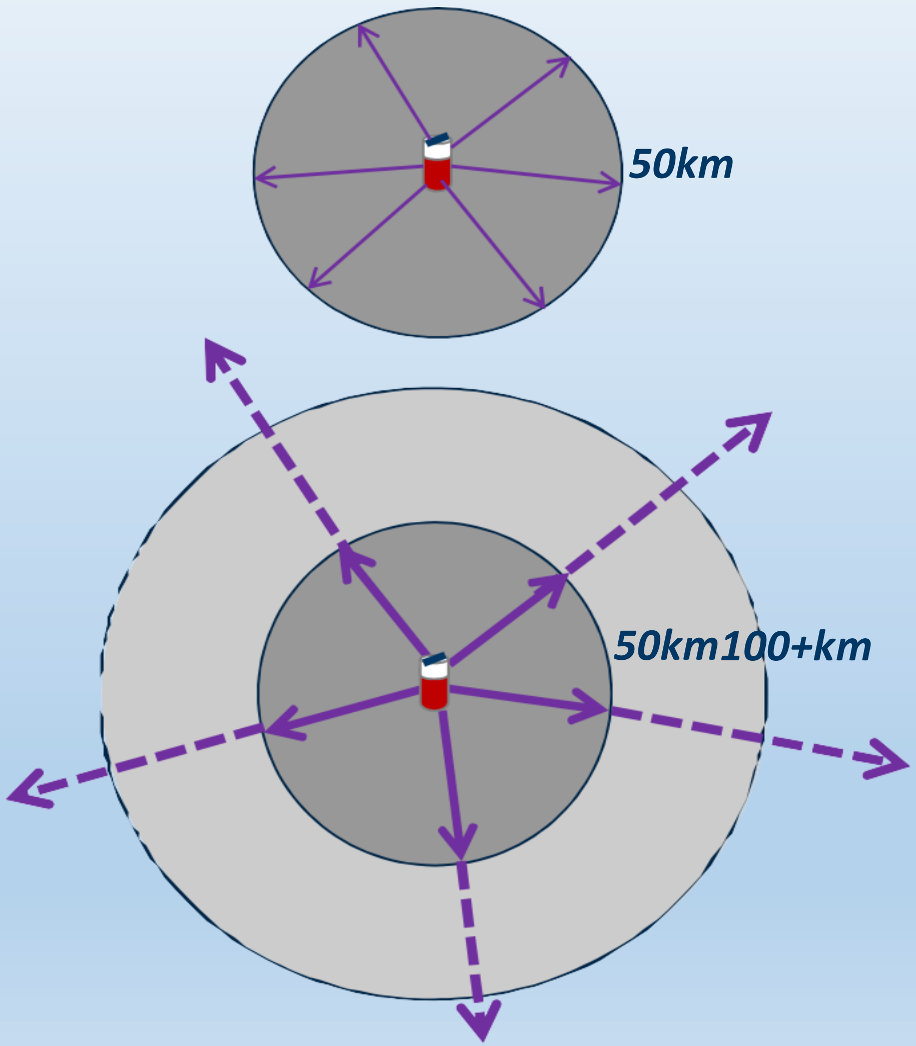
What type of air quality model will be required?

Near-field

- Single source impacts
- Dispersion of emitted pollutants
- No chemical transformation
- Air permits (New Source Review to include minor source permitting)
- *AERMOD*

Far-field

- Single or multiple source impacts
- Chemical transformations
- Class I Increment
- Air Quality Related Values (AQRVs)
- *Long range models (e.g., Lagrangian)*



What is the AERMOD Regulatory Model?

- AERMOD stands for: **American Meteorological Society/Environmental Protection Agency Regulatory Model**

  - AERMOD modeling system is an EPA approved dispersion model
    - In Regulatory use since November 2005

  - Steady-state Gaussian plume model

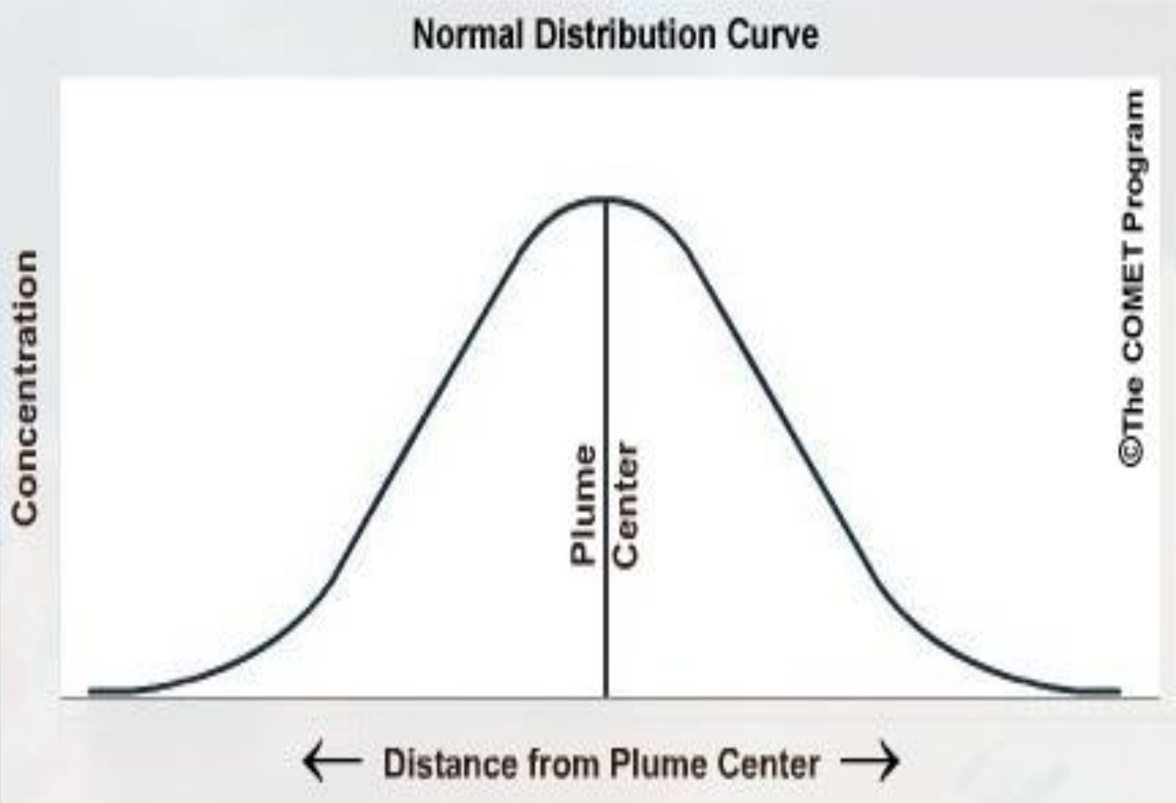
    - Simple (flat) and complex (hilly and or mountainous) terrain

    - Estimates boundary layer (near the ground) turbulence influence on dispersion

    - Relies on measured meteorological data

  - Main model used in the near field permitting program for pre-construction permitting (e.g., Major and minor source permitting programs)

Gaussian Model



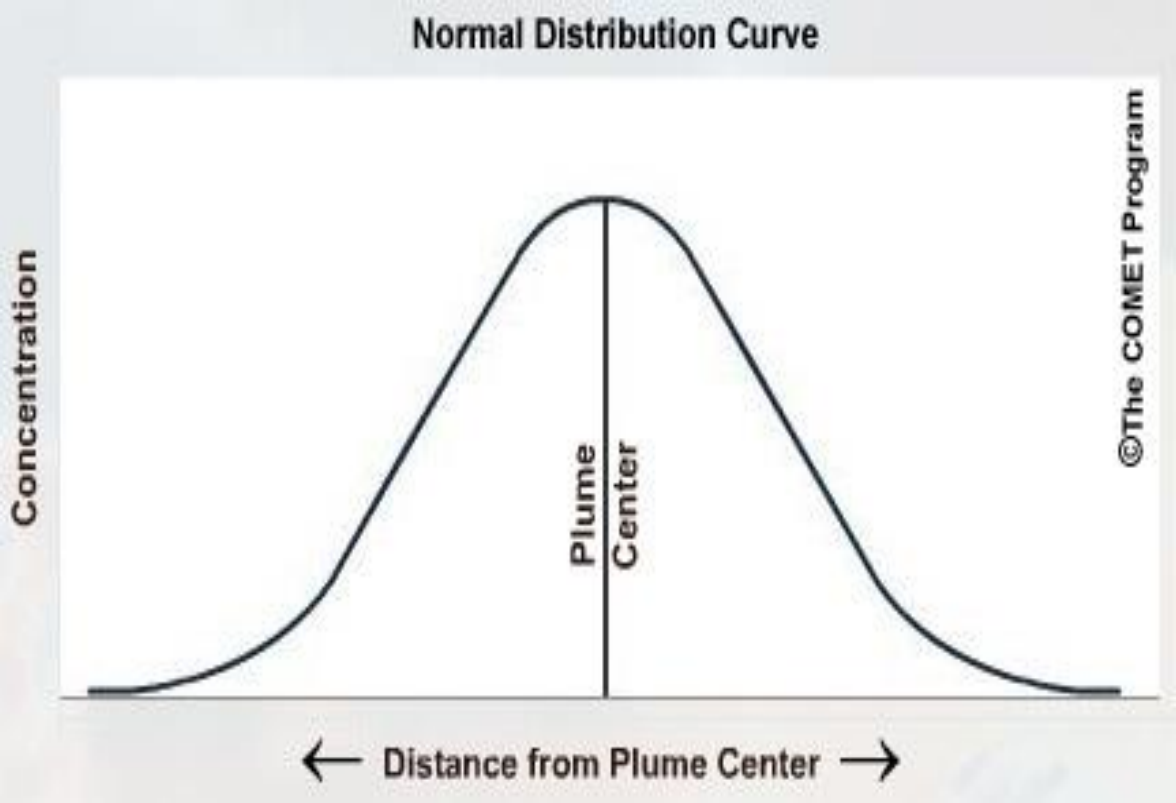
The Gaussian dispersion model approximates the dispersion process based on the classic normal curve.

Generally, the closer one is to the plume centerline, the higher the concentration. The farther from the centerline (toward the edges of the curve), the lower the concentration.

A pollutant plume has a normal distribution in both the horizontal and vertical which illustrates the plume geometry for the y- and z-axes. A plume always travels downwind along the x-axis, and you have a normal distribution in both the y and z directions.

In the atmosphere stability, wind speed, etc. act upon the plume to deviate from this distribution but the pollutant distribution is usually near the centerline.

Gaussian Model



So, what do you need to know about dispersion models? It's important to realize that:

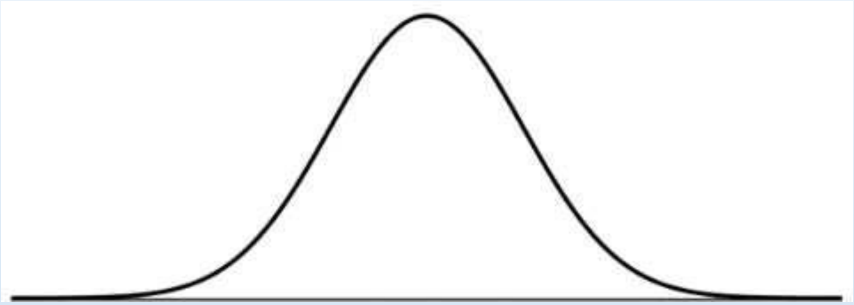
- Stability affects how plume concentrated reacts as it travels downwind
- As wind speed decreases, concentration increases
- Wind direction at the plume height determines exposure to the pollutant (downwind)
- Precipitation can affect plume concentrations

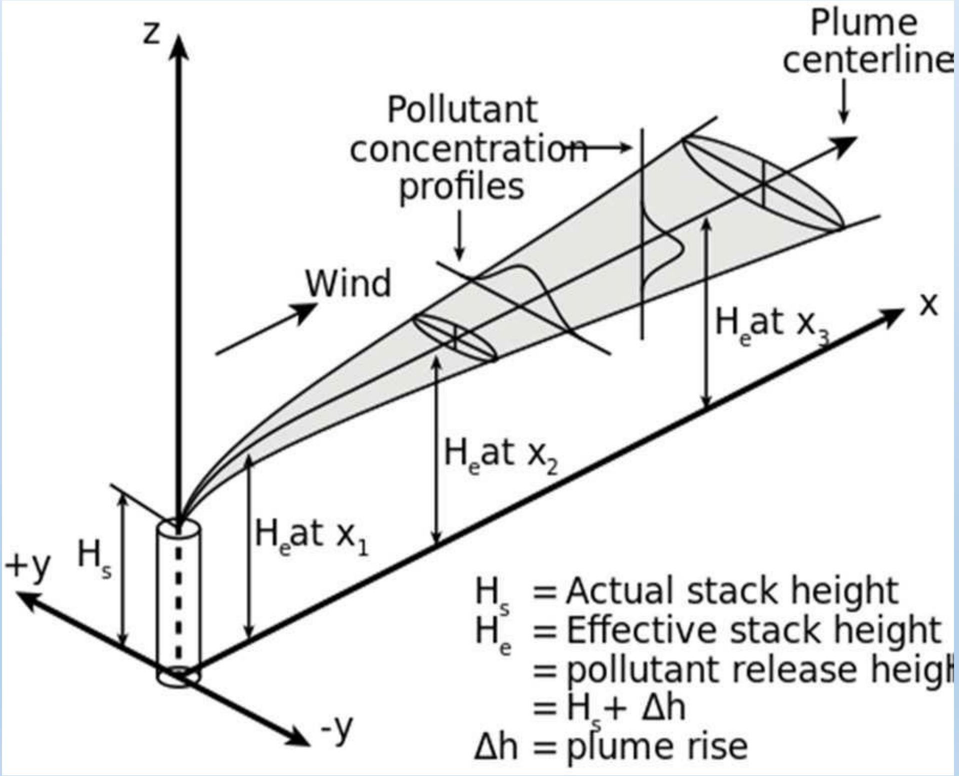
So, the information provided to the modeler is critical for calculating concentrations. If the meteorological data, stability parameters and facility information are not accurate, the modeled impacts will be incorrect.

AERMOD Dispersion Equation

$$C\{x, y, z\} = \frac{Q}{2rrua_y a_z} \exp\left(- \frac{y^2}{2a_y^2}\right)\left[\exp\left(- \frac{(z - h_s)^2}{2a_z^2}\right) + \exp\left(- \frac{(z + h_s)^2}{2a_z^2}\right)\right]$$

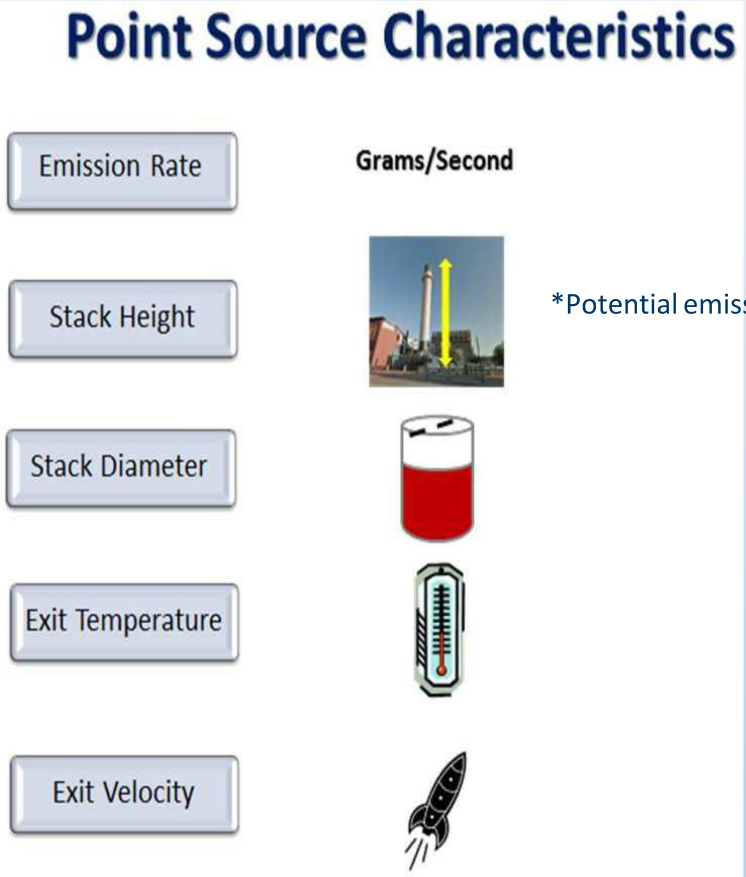
- Q = emission rate (g/s)
- u = wind speed (m/s)
- y = cross-wind distance (m)
- z = vertical height (m)
- h_s = source height (m)
- σ_y = horizontal dispersion coefficient (m)
- σ_z = vertical dispersion coefficient (m)



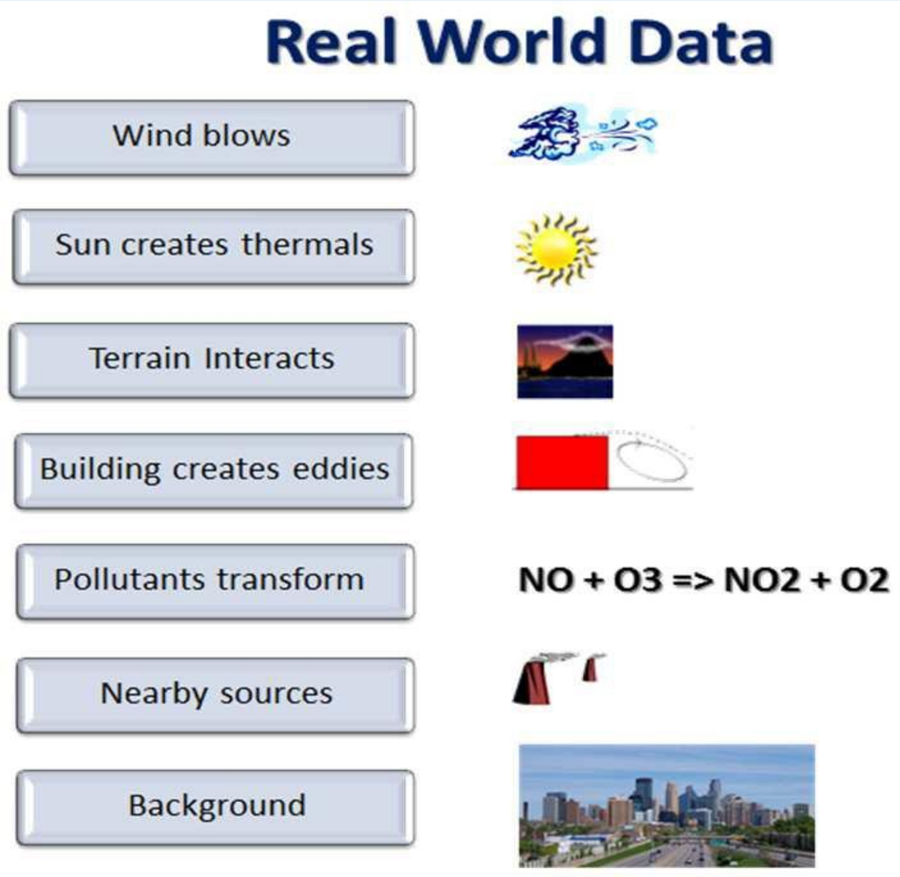


Modeled Source Types

Model inputs



*Potential emissions



Models characterize how air pollution emissions enter the atmosphere

Then they determine how weather (5 years), background pollution, buildings and terrain interact with those emissions

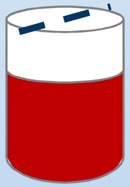
Point Source Characteristics

Emission Rate

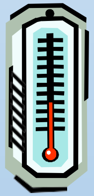
Permitted allowable or PTE (g/s)

Stack Height

Stack Diameter

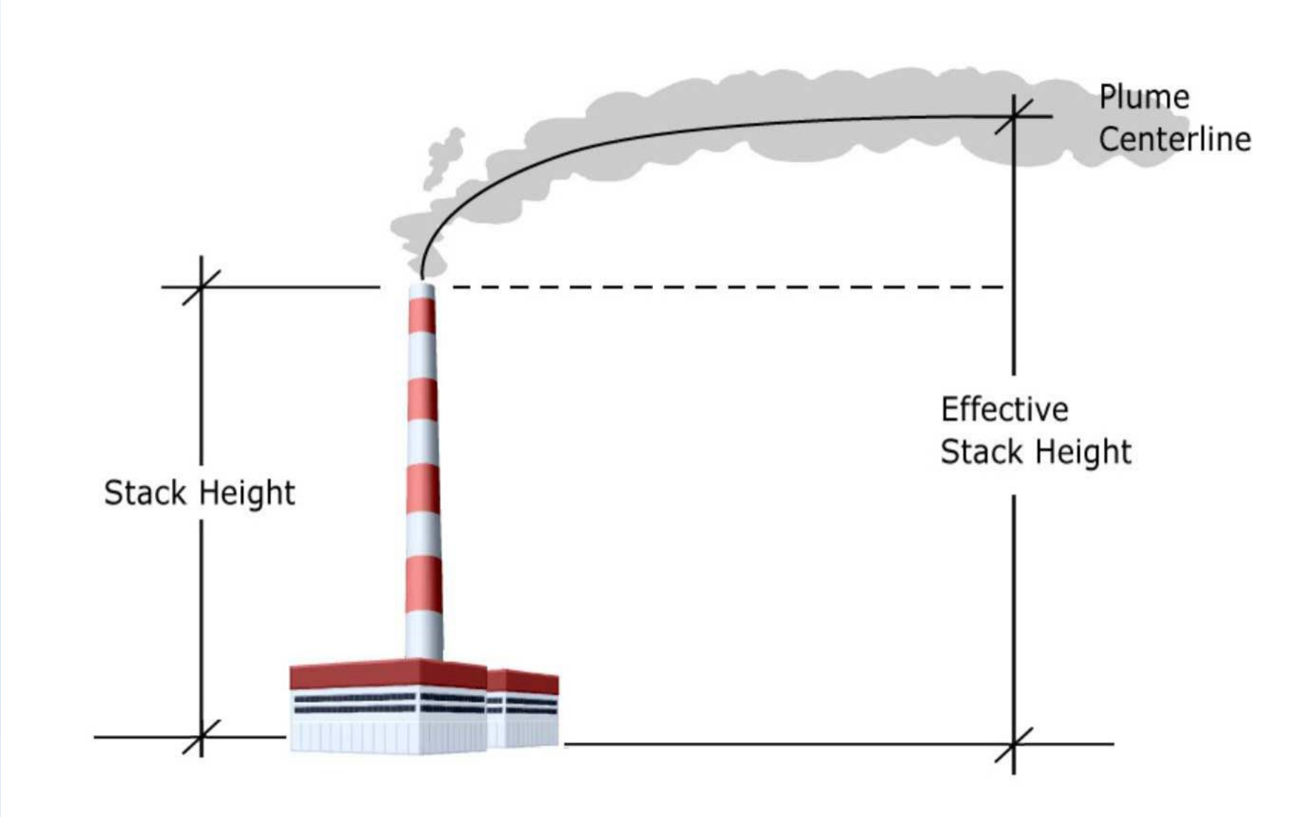


Exit Temperature

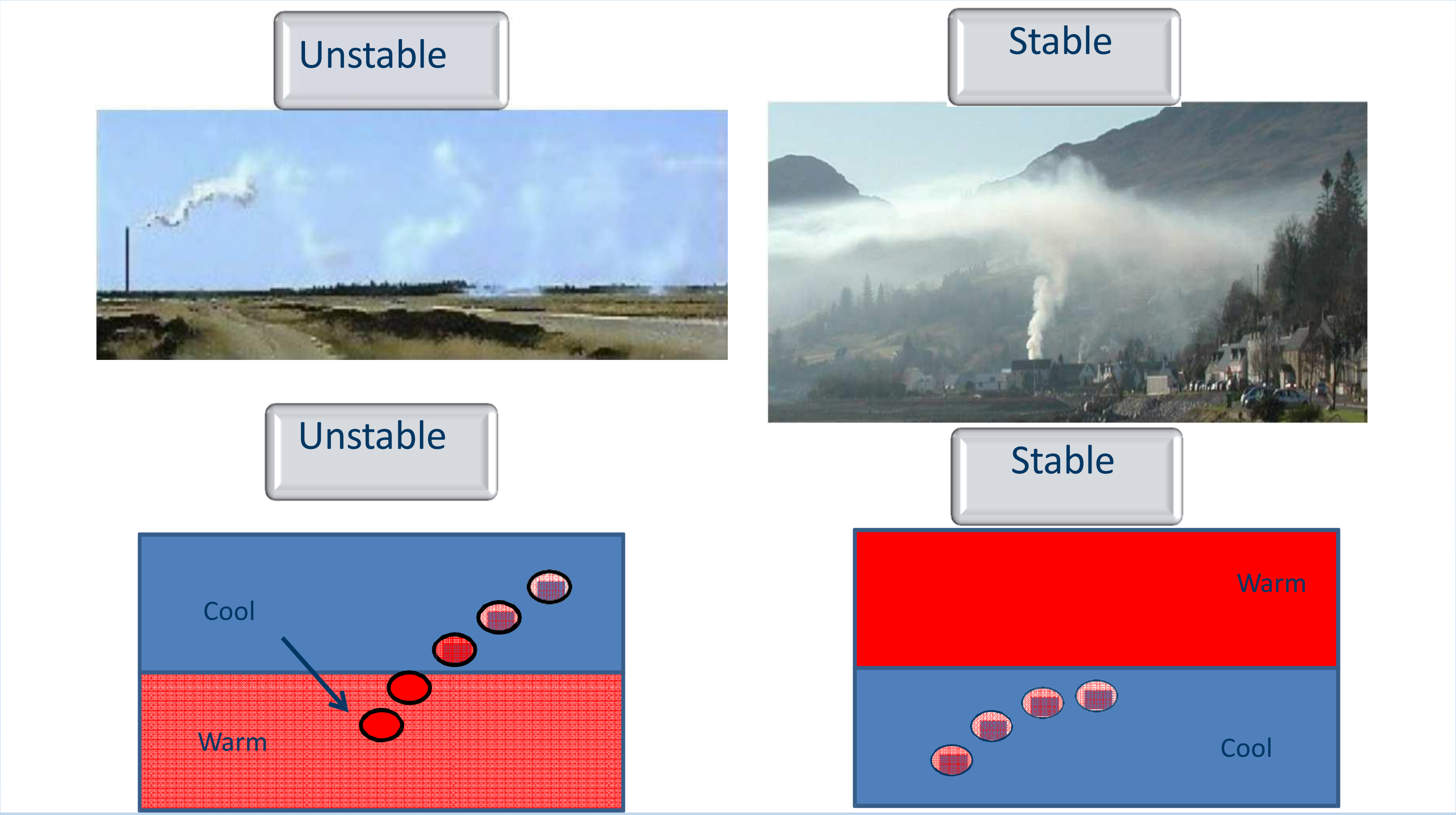


Exit Velocity

Plume rise – Buoyancy and momentum cause plumes to rise above the height of the release

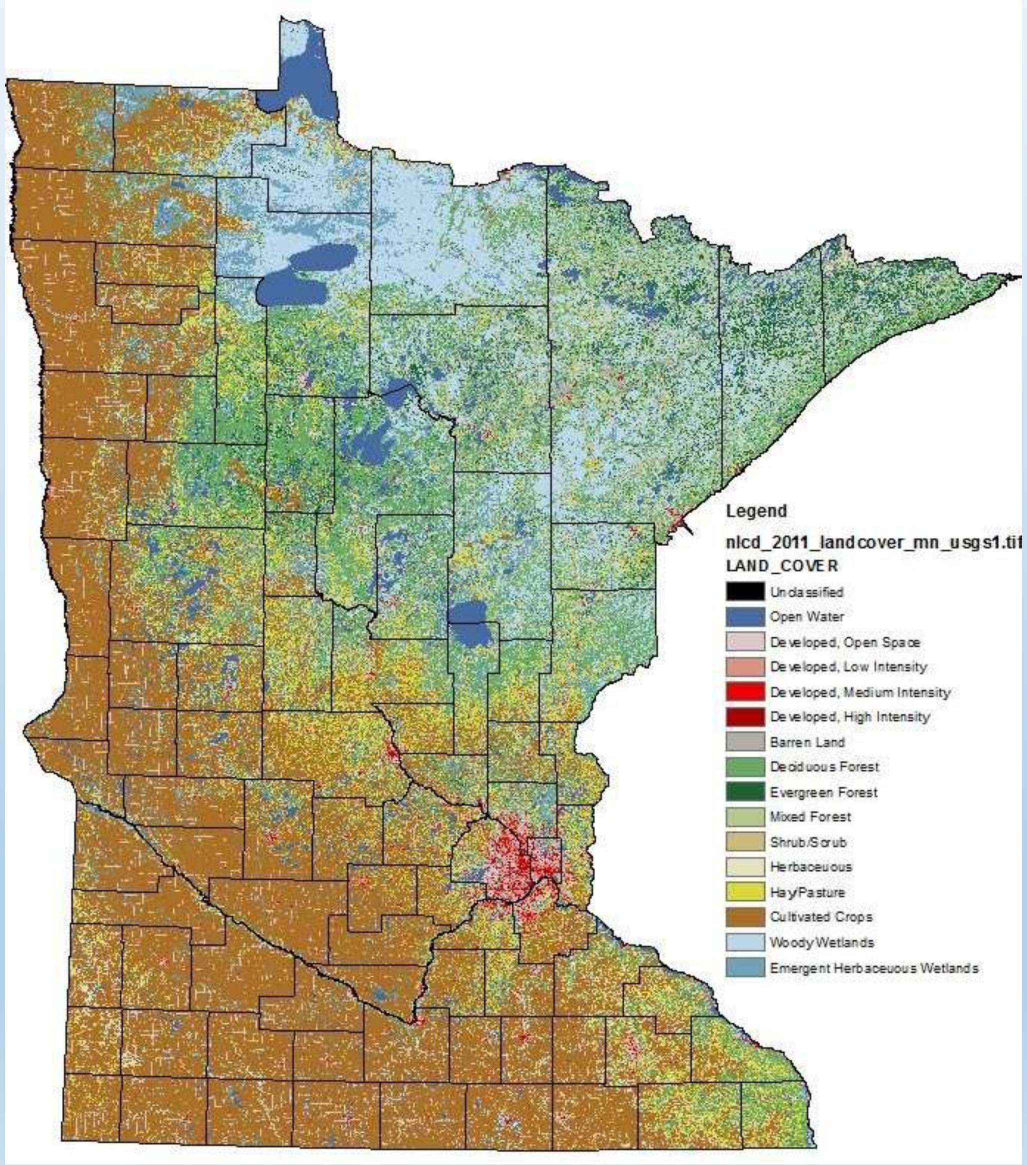


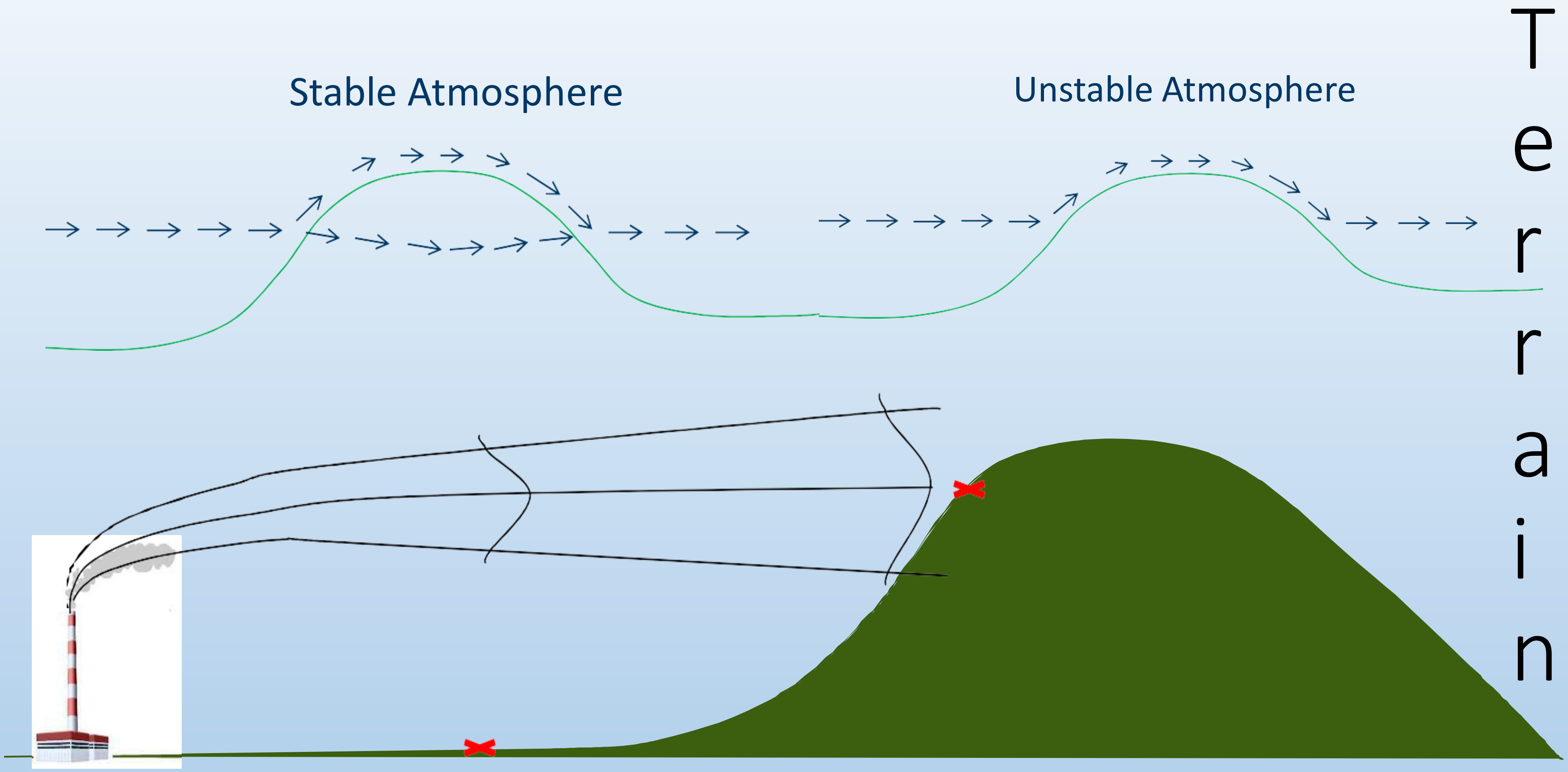
Boundary layer stability and how that affects the plume



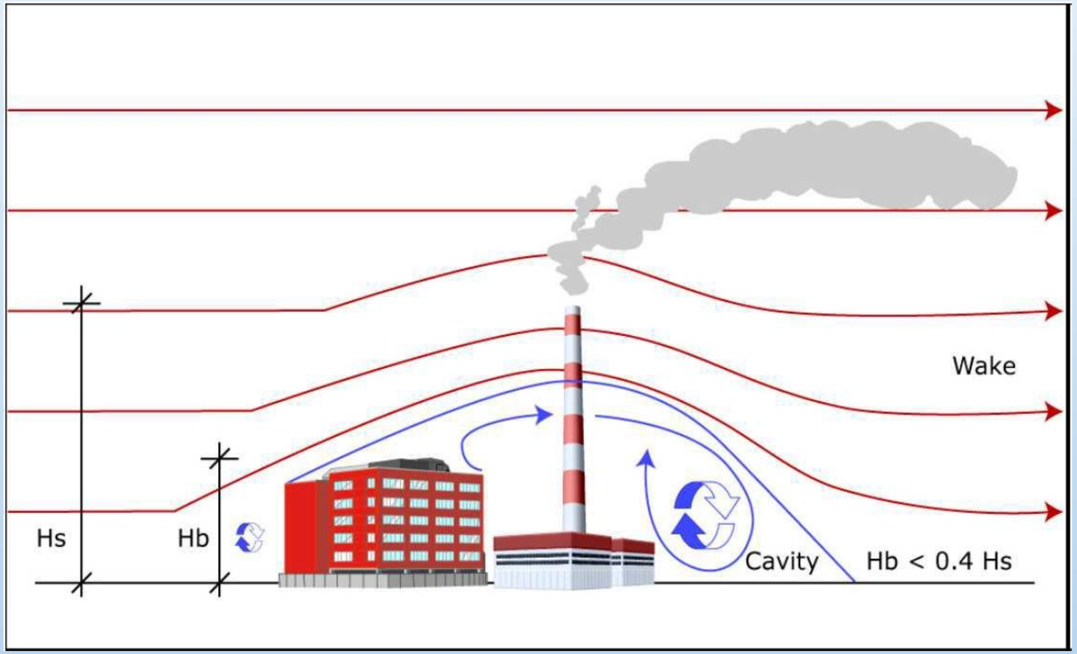
Surface Characteristics

- Surface roughness also influences dispersion
- Cropland, pasture, and water bodies are smooth
  - Less mechanical turbulence and less dispersion
- Forests and urban areas are rough
  - More mechanical turbulence and more dispersion
- Snow cover also decreases dispersion



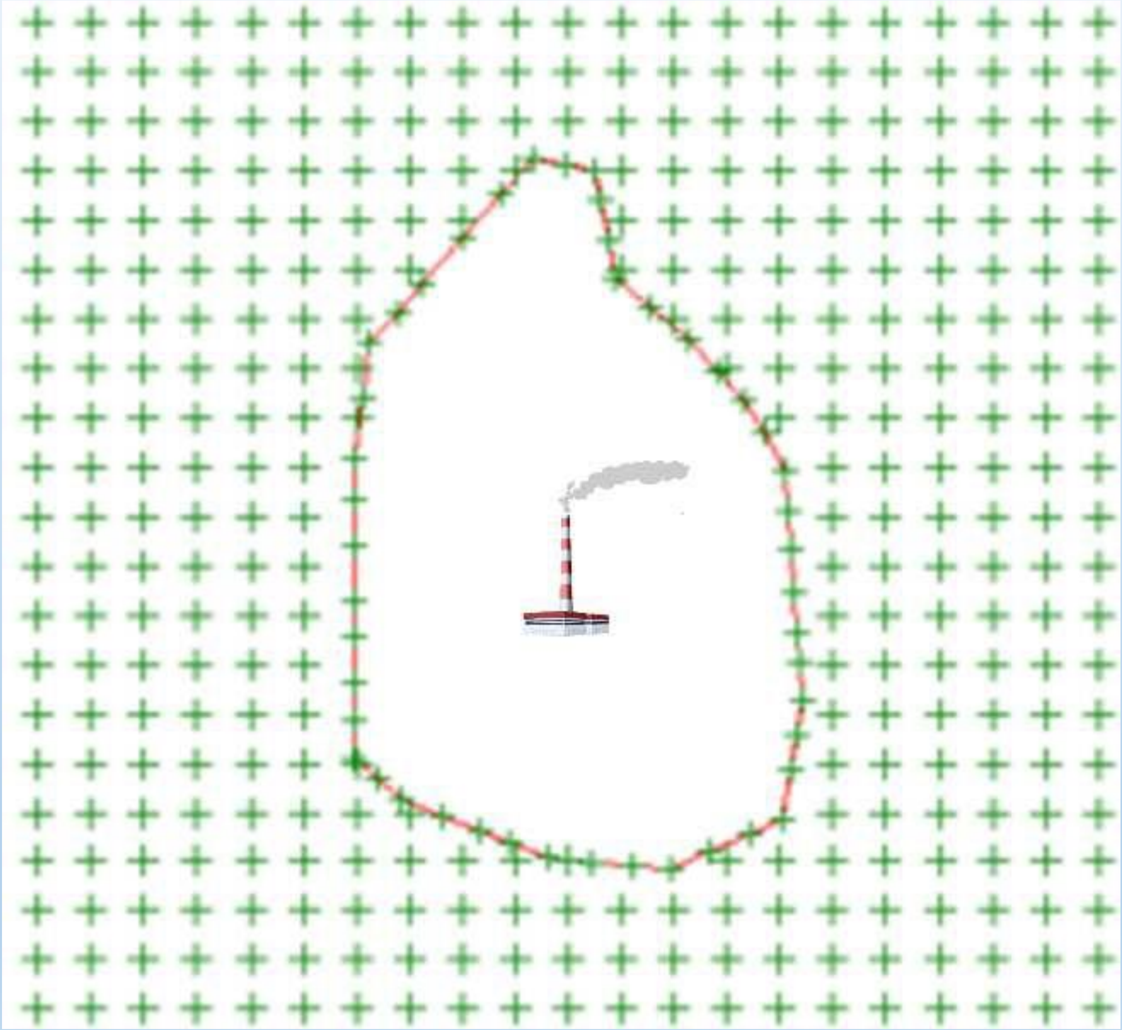

Stable Atmosphere
Unstable Atmosphere
Terrain

Building Downwash

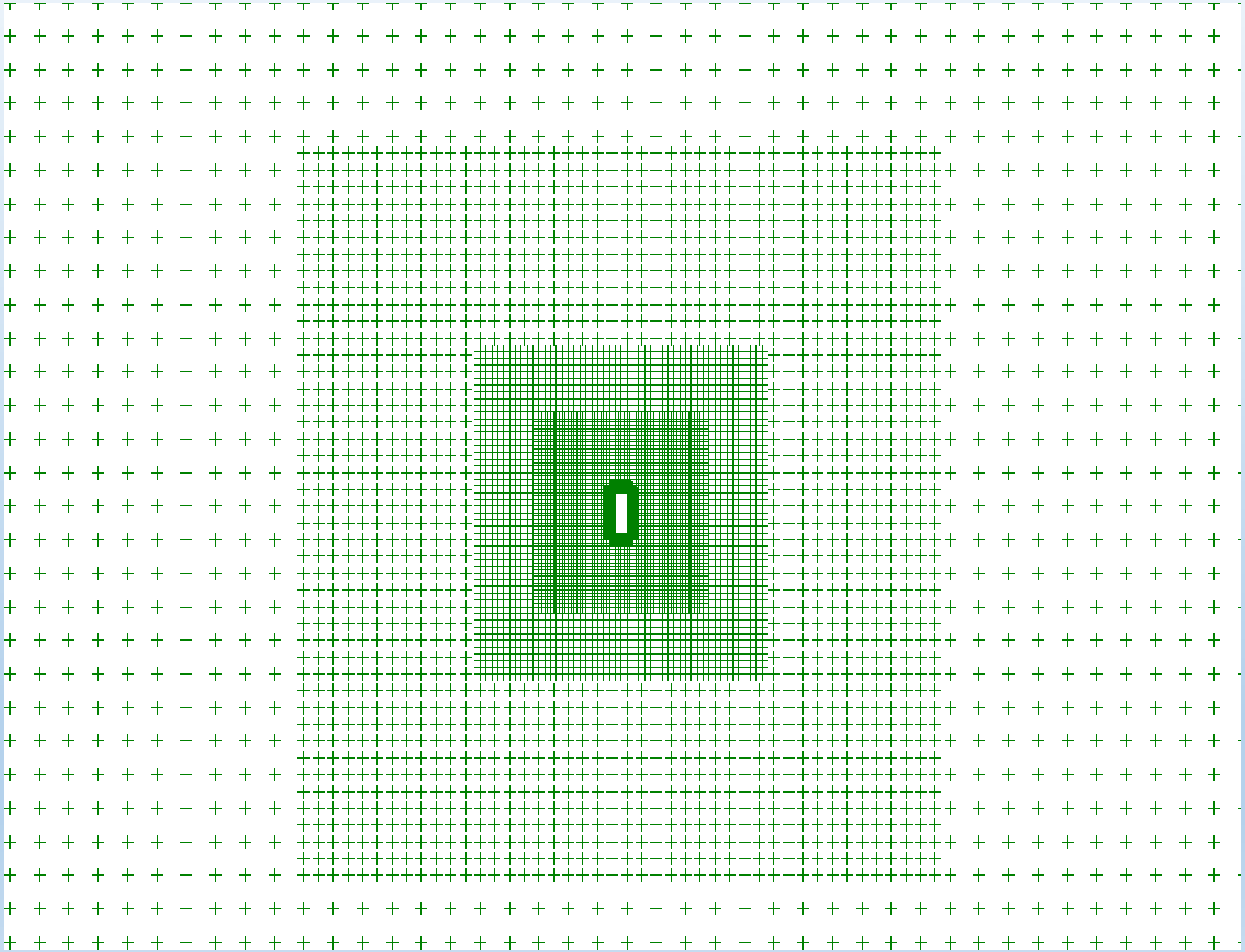


Receptors

- AERMOD calculates concentrations at discrete locations
- Receptors placed throughout modeling domain
  - Higher resolution close to source
  - Lower resolution further from source
- Both sources and receptors are assigned elevations to account for terrain
- Receptors are placed in “ambient air”
- Concentration estimates are compared to air quality standards



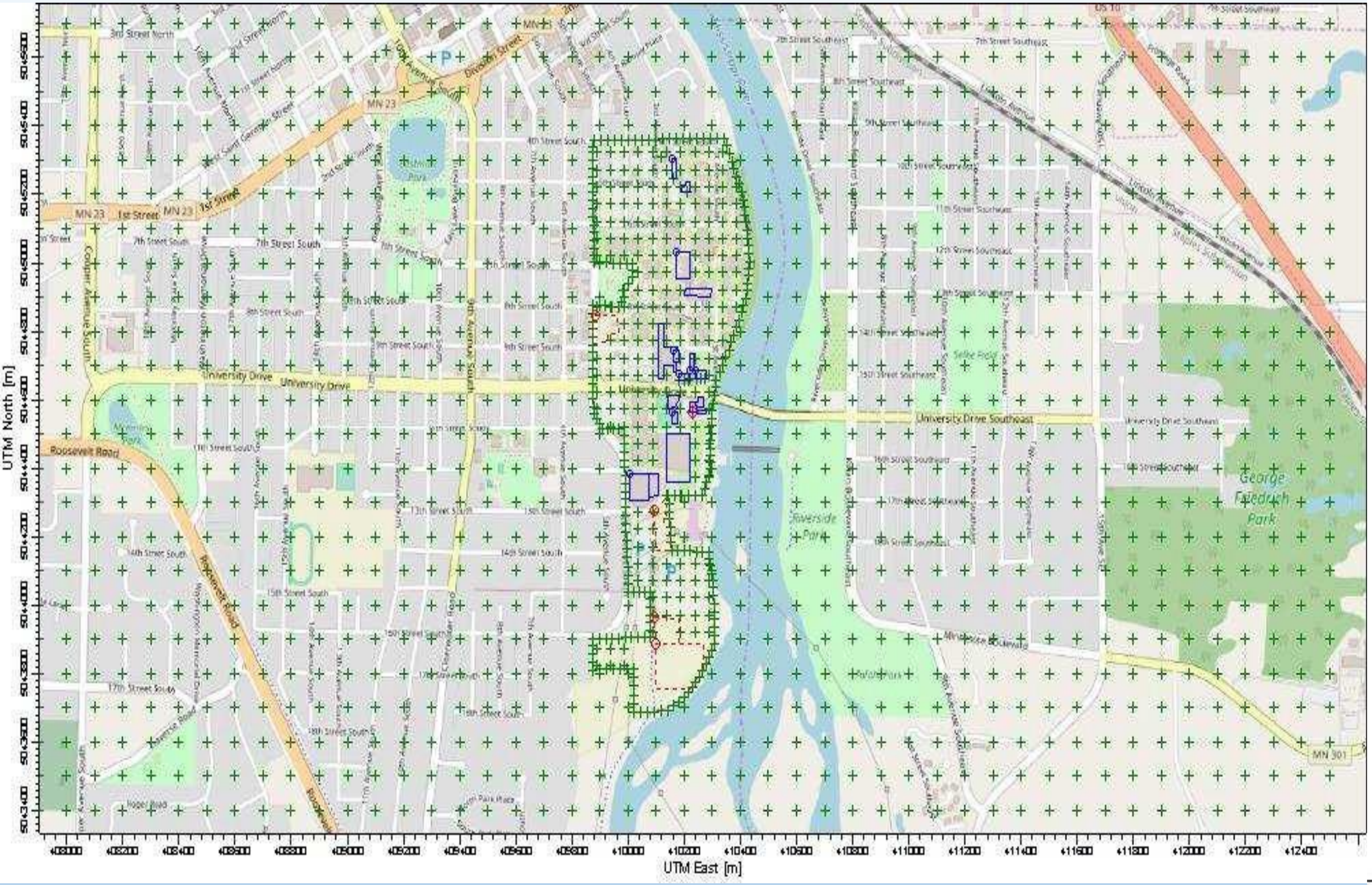
Receptor Placement (cont)

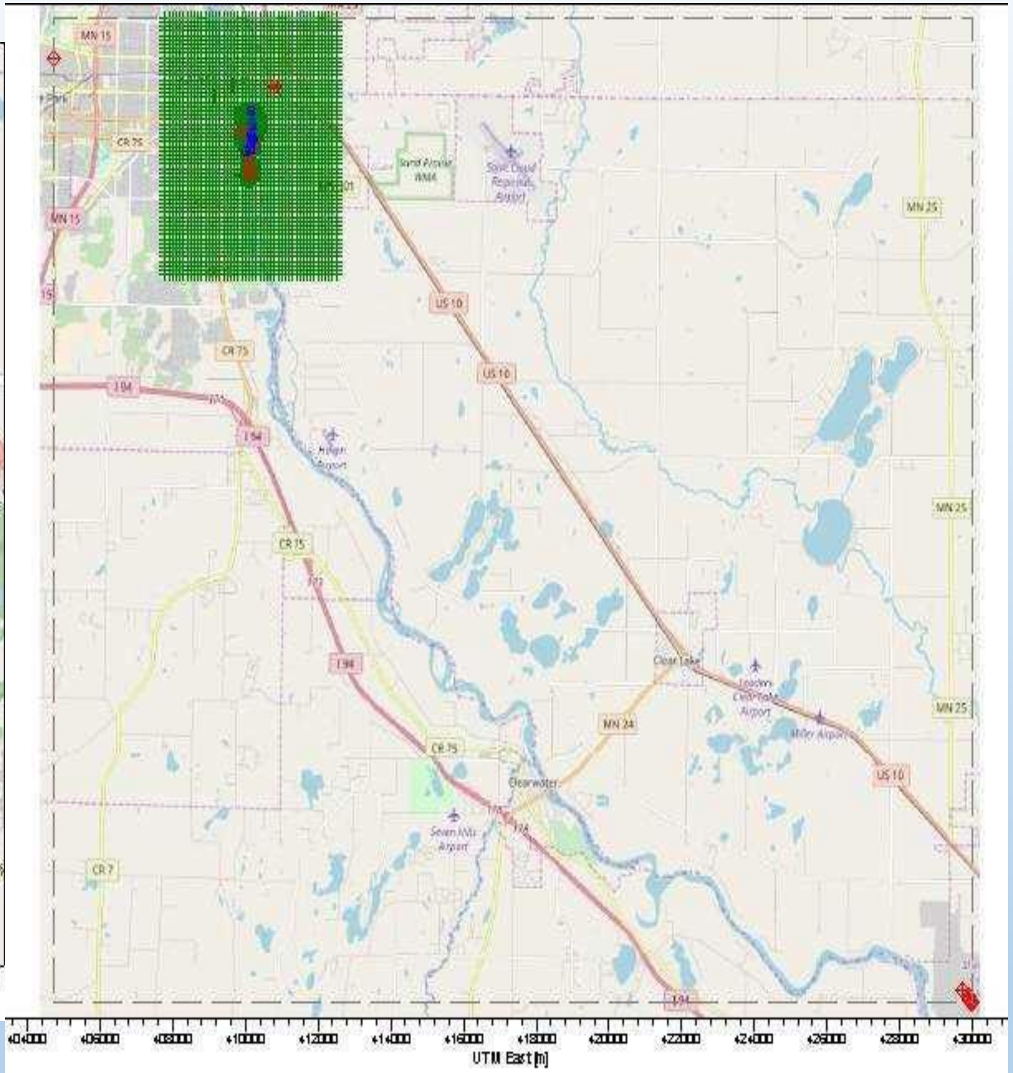


Modeling Demonstration Example

- SCSU Boiler Plant
- Title V permit modeling requirement
  - Completed in 2016
  - PM10, PM2.5, SO2
  - St. Cloud met data 2006-2010
  - Three nearby sources
  - St. Cloud monitor data

SCSU AERMOD Setup





						Easting	Northing								
Permit	AERMOD	Pollutant	Averaging Time	Operating Scenario	Release_Type	X1	Y1	Base_Elev	Emission_Rate	Emission_Rate	Height	Exit_Temp	Exit_Vel	Diam	Flow Rate
ID	ID			#		[m]	[m]	[m]	[lb/hr]	[g/sec]	[m]	[K]	[m/s]	[m]	[ACFM]
SCSSV001	SCSSV001	PM2.5	24-HR & Ann.		Vertical	410,228.3	5,044,564.6	303.9	5.050	0.6368	30.48	544.26	28.90	0.991	47,190
SCSSV001	SCSSV001	PM10	24-HR		Vertical	410,228.3	5,044,564.6	303.9	4.700	0.5883	30.48	544.26	28.90	0.991	47,190

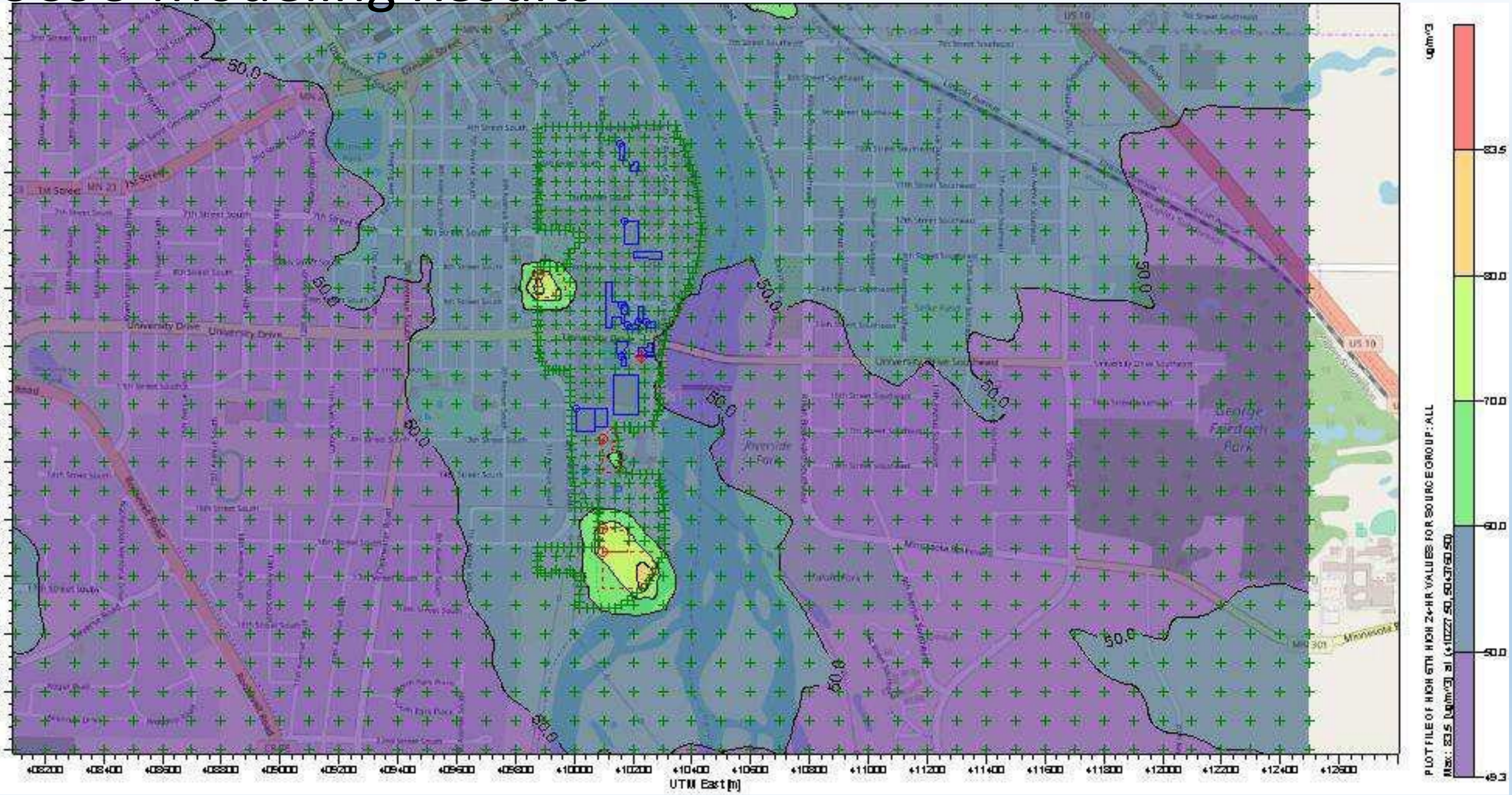
SCSU Modeling Results

Pollutant	Avg. Pd.	Rank	Sources Modeled	Modeled Design Conc. (µg/m³)	Backgd. Conc. (µg/m³)	Total Conc. (µg/m³)	SIL (µg/m³)	NAAQS or MAAQS (µg/m³)	% of Std.
SO2	1-hour	1st High	SCSU/Heating Plant	0.6	NA	NA	7.86	196.5	0.3
PM10	24-hour	6th High in 5 yrs	SCSU & Nearbys	35.5	48	83.5	5.0	150	55.7
PM10	Annual[a]	High in any year	SCSU & Nearbys	4.8	15.7	20.5	1.0	50	41.0
PM2.5	24-hour[b]	8th High (98th %)	SCSU & Nearbys	4.4	20.3	24.7	1.2	35	70.5
PM2.5	Annual	High 5-yr Avg.	SCSU & Nearbys	1.5	7	8.5	0.3	12	70.8

[a] Concentration shown is maximum for any of the five individual years (2006-2010) modeled.

[b] Concentration is the maximum at any receptor at which SCSU source group contributed significantly (at least 1.2 µg/m³).

SCSU Modeling Results



Air Dispersion Modeling Summary

- Air dispersion modeling comes in many shapes and sizes
  - It's a tool used to determine compliance with many EPA and state air programs
- It provides the means to assess a facilities in a relatively quick and inexpensive manner to determine compliance with the respective standard(s)
- Modeling is **only** as good as the input's. It's imperative the modeler work closely with the tribal air professional to ensure accurate information
  - This should be accomplished via a modeling protocol and per Appendix W requirements

Any Questions before we move onto our Tribal Presenter?

Poll Question 3

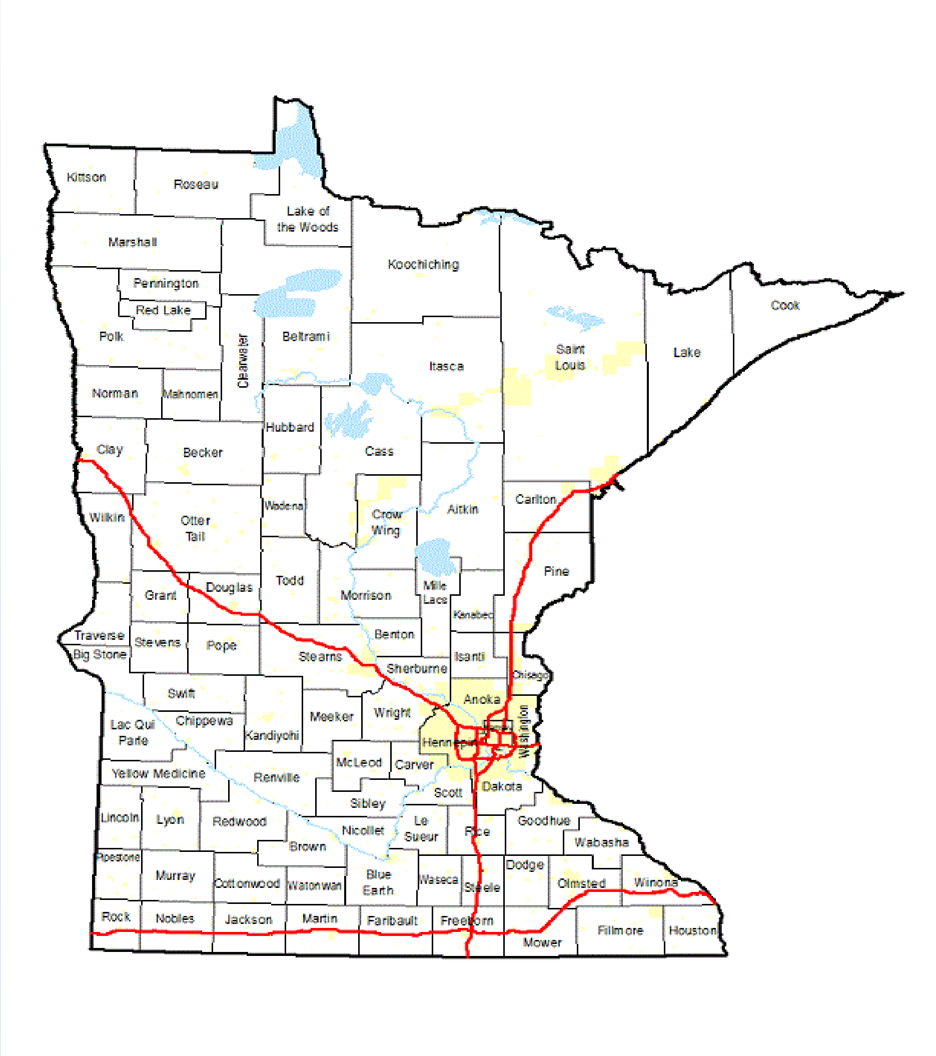
- Have you ever reviewed an Air Quality Dispersion Model or have used Air Dispersion Modeling software?
  - Yes
  - No
  - Unsure

Modeling Case Study

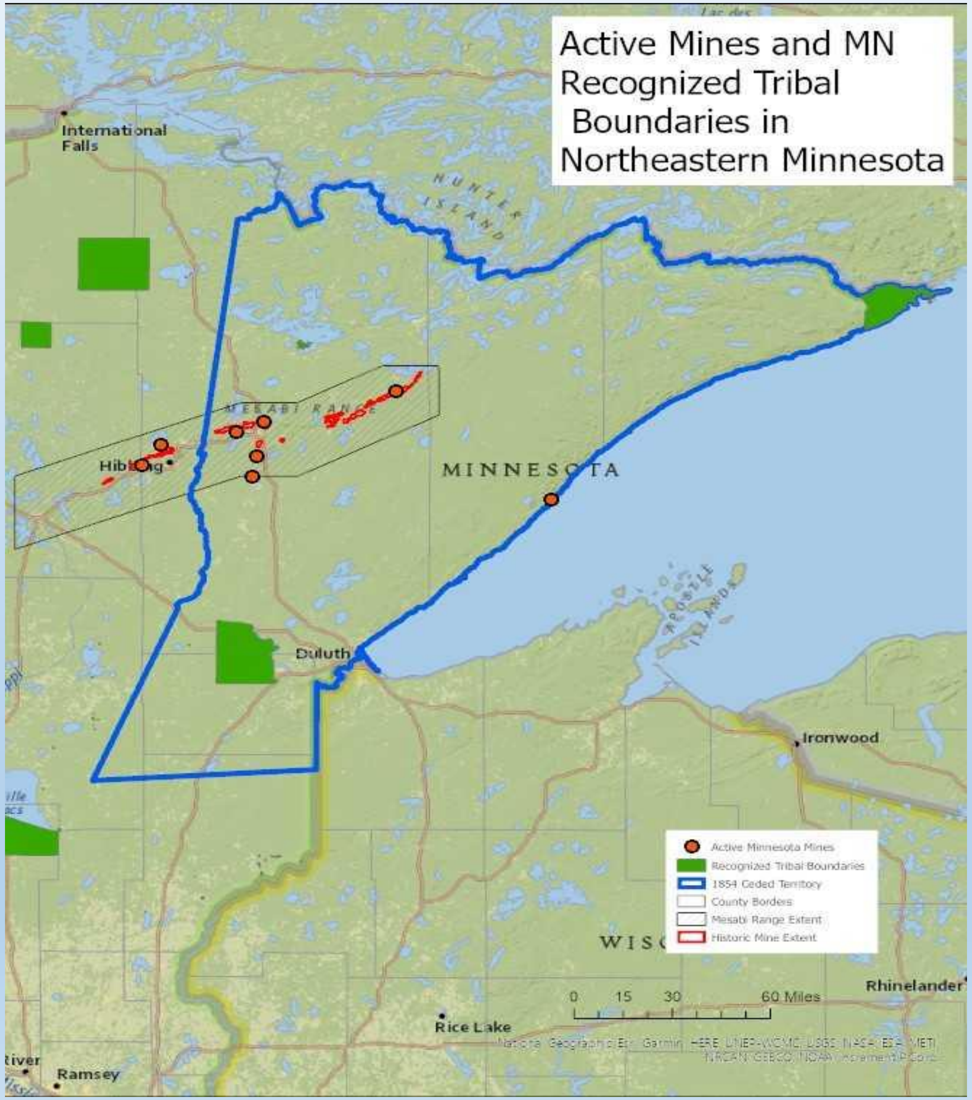
Joy Wiecks
Fond du Lac Band of
Lake Superior Chippewa, Cloquet MN

September 28, 2021

Minnesota State Map



Northeastern Minnesota



Keewatin Taconite (Keetac) 2011 Action

- Taconite mine (low-grade iron ore) surrounded by other mines
- Constructed in the 1960’s
- Major source of emissions for all criteria pollutants
- Asking for an expansion along with a Title 5 renewal
- Minnesota issues construction and operating permits as one permit
- Looking at permit, which is 1500 pages long because it includes the Technical Support Document and several appendices
- TSD gives textual explanation, tables of information can be found throughout

Emissions from Expansion

Pollutant	Emissions Increase from the Modification	Limited Emissions Increase from the Modific. (tpy)	Source-wide Contemporaneous Increases and Decreases (tpy) Net Emissions Increase (tpy)	Net Emissions Increase (tpy)	PSD/112(g) Significant Thresholds for major sources	NSR/112(g) Review Required? (Yes or No)
PM	72,348	3,399	NA	3,399	25	Yes
PM-10	34,607	1,262	NA	1,262	15	Yes
PM-2.5	30,825	478	NA	478	10	Yes
NOx	3,403	2,340	-2305	35	40	No
SO2	1,612	81	NA	81	40	Yes
CO	97	97	NA	97	100	No
Ozone (VOC)	29	29	NA	29	40	No
Lead (Pb)	0.1	0.1	NA	0.1	0.6	No
CO2-e	214,040	186,400	NA	186,400	75,000	Yes
Fluorides	<0.1	<0.1	NA	<0.1	3	
Sulfuric Acid Mist (H2SO4)	72.7	3.6	NA	3.6	7	No
Single HAP (HCL)/Total HAPs	13.0/23.3	13.0/19.7	NA	NA	10/25	NA

NAAQS Modeling Results

Pollutant	Averaging Period	Modeled Impact[1] (ug/m³)	Background Concentration [2] (ug/m³)	Predicted Ambient Air Concentration [3] (ug/m³)	MAAQS (ug/m³)	NAAQS (ug/m³)	Percent of Standard
PM-10	24-hr	58	30	88	150	150	59
	Annual	17	11	28	50	--	57
PM-2.5	24-hr	19	15.7	34.7	35	35	99
	Annual	4.9	5.6	11	15	15	70
SO_2	1-hr	181	7.7	189	197	197	96
	3-hr	109	10	119	915	1300	13
	24-hr	33	4	37	365	365	10
	Annual	4.8	2	6.8	60	80	11
NO_2	1-hr	139	28	167	188	188	89
	Annual	28	7	35	100	100	34
CO	1-hr	575	575	770	40,000	40,000	1.9
	8-hr	345	345	408	10,000	10,000	4.1
Lead	Quarterly	0.00189	Not Available	0.00189	0.15	0.15	1.2

"While the results are below the applicable NAAQS standards, they also indicate that significant limitations may need to be placed on future sources in the area. The MPCA recommends the facility accept permit conditions requiring remodeling if any future minor changes occur at the facility that affect any SO2, NOx, or particulate emission source rate, source location, or stack parameter." - MPCA

The Facts

- PM-2.5 1-hour modeled concentrations in this area are always close to the NAAQS – mines regularly take permit limitations
- EPA allows up to 99% of the NAAQS – just can't be 100%
- Look at modeling to see what sources were included (mines often include fugitives, road dust often a factor – silt assumptions)
- Compare modeling report or protocol to guidance – were receptors placed the correct distance apart and the correct distance from the facility?
- PVMRM non-default value approved?
- Were any variances from EPA guidance approved?

Class II Increment Modeling Results

Pollutant	Averaging Period	Maximum Modeled Concentration Change (ug/m^3)	Class II Increment Standard (ug/m3)	Percent of Standard
PM-10	24-hr	28	30	94
	Annual	4.8	17	28
SO_2	3-hr	39	512	7.8
	24-hr	13	91	14
	Annual	1.0	20	4.8
NO_2	Annual	10	25	42

Class I Increment Modeling (Screening)

Pollutant	Averaging Period	EPA Significant Impact Level (ug/m^3)	Modeled Results			
			BWCA (ug/m^3)	VNP (ug/m^3)	Isle Royale (ug/m^3)	Rainbow Lakes (ug/m^3)
SO_2	3-hr	1	0.649	0.329	0.079	0.195
	24-hr	0.2	0.219	0.113	0.021	0.048
	Annual	0.1	0.007	0.006	0.001	0.002
NO_2	Annual	0.1	0.010	0.007	0.001	0.003
PM-10	24-hr	0.3	0.159	0.071	0.037	0.049
	Annual	0.2	0.003	0.003	0.002	0.002

Class I Increment Modeling (Cumulative)

Pollutant	Averaging Period	PSD Class I Increment (ug/m^3)	BWCA (ug/m^3)
SO_2	24-hr	5	1.6

Sources of Information

- I pulled from the Technical Support Document and the Modeling Report
- Did a word search on “modeling”, “increment” because this document is 1500 pages long
- This method also turned up resulting permit conditions

Items to Look At More Closely

- Nearby source inventory (Class I or II only)
- What meteorological data was used, from what stations?
- Are there any years of met data that should not be included?
- What background levels were used, from what monitors?
- Was that monitor representative?
- Did EPA review and approve the modeling protocol or report?

Permit Conditions Resulting from this Modeling Exercise

- Permitted number of total mobile sources: The Permittee shall have total quantities of modeled Tier 4 and non-Tier 4 certified mobile sources no greater than the following operating at one time at the facility: (1) Diesel-driven Haul Trucks (29 total) (2) Diesel-driven Front-end Loaders (2 total) (3) Diesel-driven D10 Dozers (11 total) (4) Diesel-driven Grader (4 total) (5) Diesel-driven Mining Shovels (10 total)
- Sulfur Dioxide: less than or equal to 23.3 lbs/hour using 1-Hour Average
- Nitrogen Oxides: less than or equal to 750 lbs/hour using 1-Hour Average
- Emissions Monitoring: The owner or operator shall use an SO2 CEMS to measure mass emissions of SO2 from SV058
- Emissions Monitoring: The owner or operator shall use a NOx CEMS to measure NOx emissions from SV058
- There can be access restrictions (fencing, drones) placed to keep area from being “ambient”
- These mines should have fugitive dust plans

Best Tips

- Use word searches to find information that may be scattered throughout a report
- Check to see whether guidance and protocols were followed
- Make sure that permit limitations and compliance demonstration are strong enough to keep emissions under control
- Understand the differences between Class I and II modeling and NAAQS modeling

Resources

US EPA SCRAM

- https://www.epa.gov/scram

US EPA AERMOD

- https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

Lakes Environmental AERMOD Training (online)

- https://www.weblakes.com/training/upcoming-courses/

40 CFR Appendix W to Part 51 – Guideline on Air Quality Model

- https://www.epa.gov/scram/clean-air-act-permit-modeling-guidance

Thank you for joining todays webinar!