Ammonia:

What's all the fuss?

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Nutrient Losses in Storage

Table 20-3. Nitrogen lost and retained in various types of manure handling and storage systems.

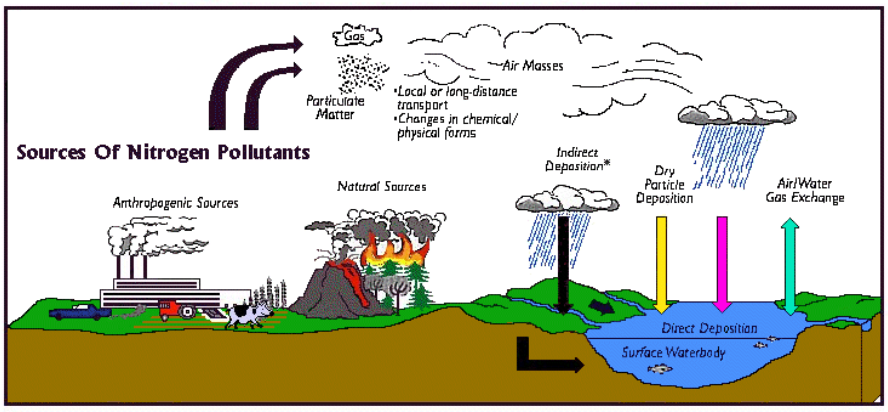
System	Nitrogen Lost, %	Nitrogen Retained, %
Daily scrape and haul	20-35	65-80
Manure pack	20-40	60-80
Open lot	40-55	45-60
Deep pit (poultry)	25-50	50-75
Litter	25-50	50-75
Under floor pit	15-30	70-85
Above-ground tank	10-30	70-90
Holding pond	20-40	60-80
Anaerobic lagoon	70-85	15-30

Adapted from MWPS-18, Livestock Waste Facilities Handbook.

Example: In an dairy storage pond, 20 - 40% of excreted nitrogen may be lost through volatilization.

Atmospheric Ammonia

Atmospheric Emissions, Transport, Transformation And Depostion Of Trace Gases.

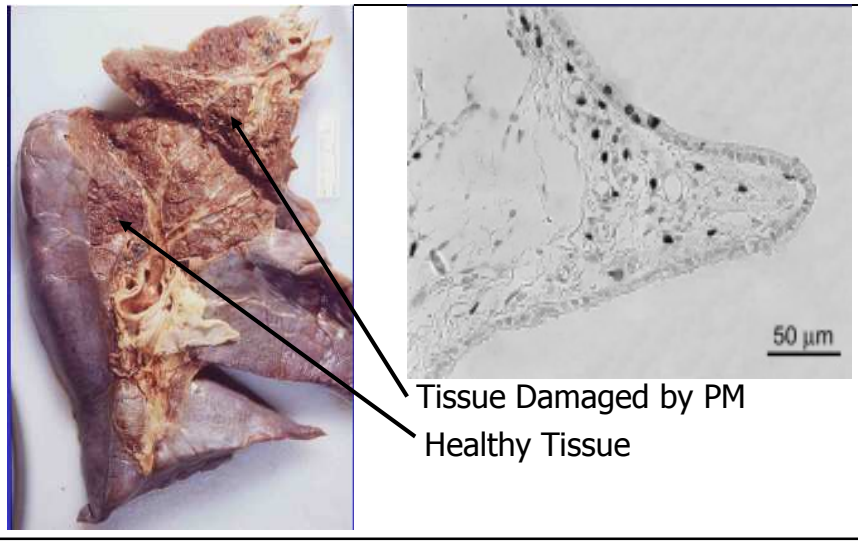


*Indirect deposition is direct deposition to land followed by runoff or seepage through groundwater to a surface waterbody.

Ammonia Emissions

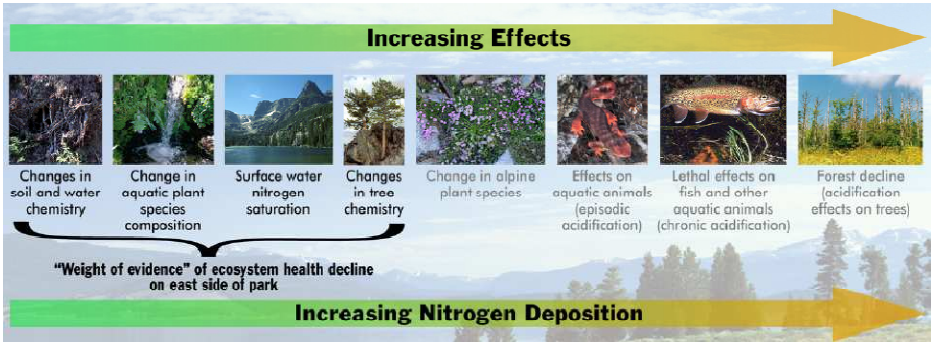
- Direct Deposition
- Secondary Particulate Formation
  - Treasure Valley Airshed – ID *(also San Joaquin Valley, CA)*
    - NH_3, in combination with NO_x and SO_x, combine to form PM2.5 particles during wintertime inversions
    - PM2.5 = respiratory pollutant
  - Pamlico Sound, NC; Puget Sound, WA; RMNP, CO
    - NH_3, in combination with NO_x and SO_x, combine to form PM2.5 particles deposit (wet & dry)

Health Effects



Environmental Effects

Sensitive mountain ecosystems



Ammonia Emissions: *Recent Activities*

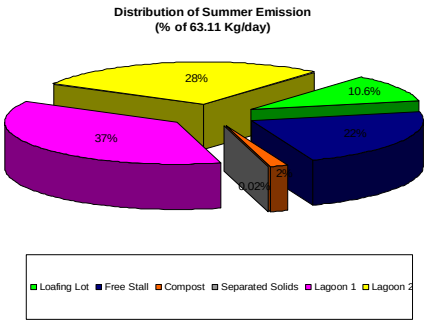
- Law Suits – ID,KY & NE
  - The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund/Emergency Planning & Community Right-To-Know Act (EPCRA)

    100 lb/day reporting limit
  - Clean Air Act: Major Source 100 Tons/yr

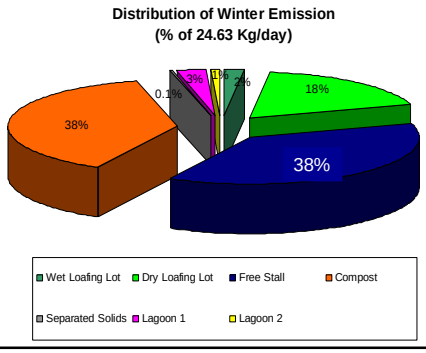
NH_3 Losses: Lagoons & Basins

- Surface area
- Temperature/Season
- Wind Speed
- Supernatant NH_3 concentration
  - pH
- Treatment Volume (design and current)
- Sludge depth

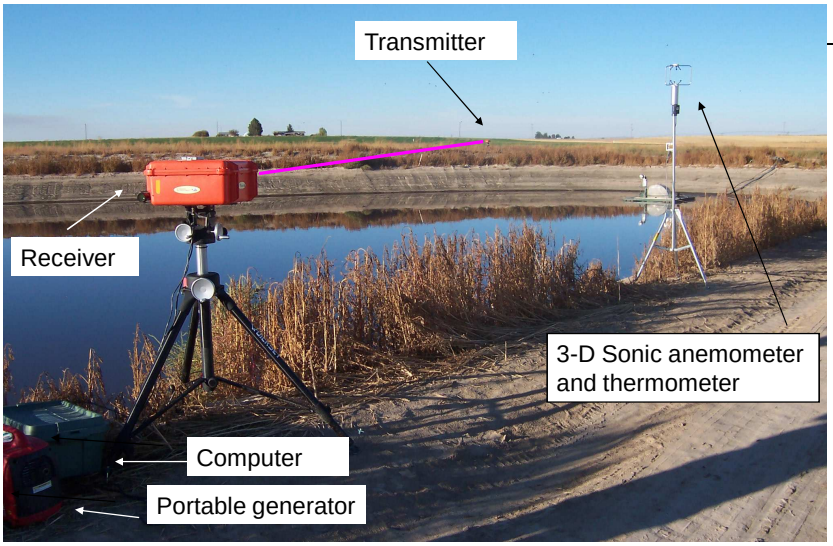
Seasonal Emissions from 1840-hd flush freestall in Texas

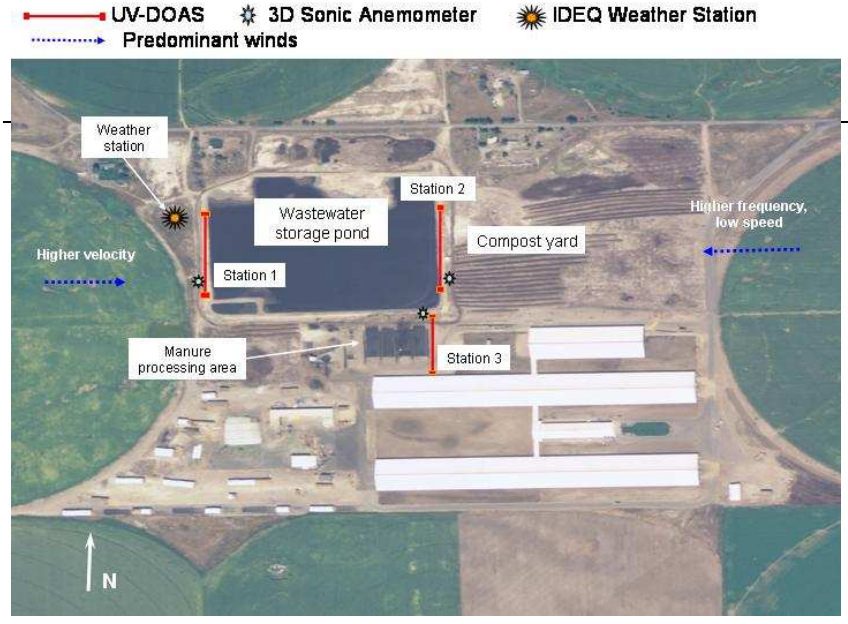


Season – Temperature - Surface area



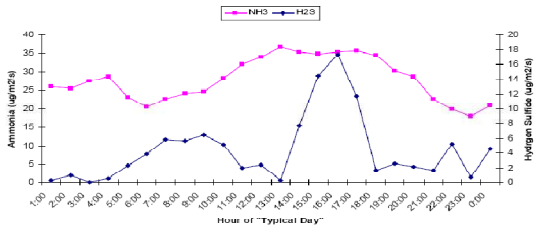
Methodology: **UV-DOAS**



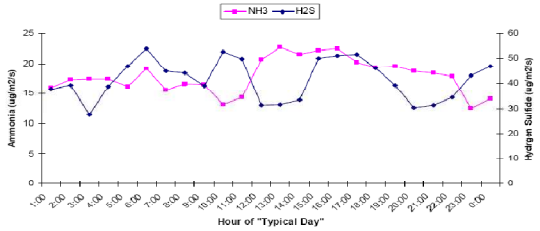


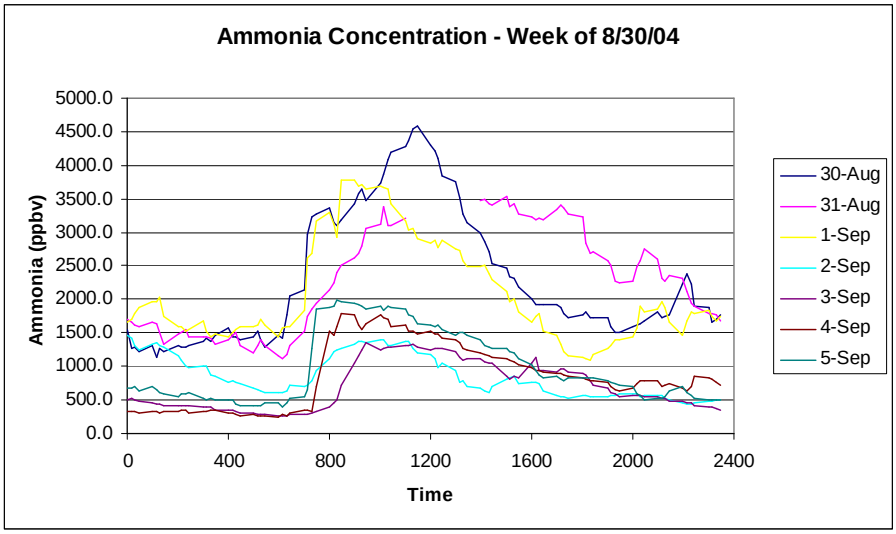
Hourly variation of NH_3 and H_2S emission rate on a "Typical day": Storage pond

Season= Warm



Season= Cold



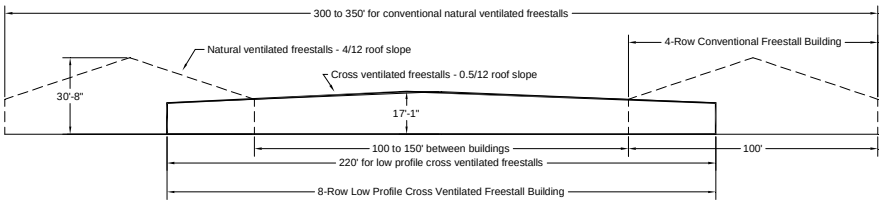


Comparison of emissions calculated versus "as fed" content

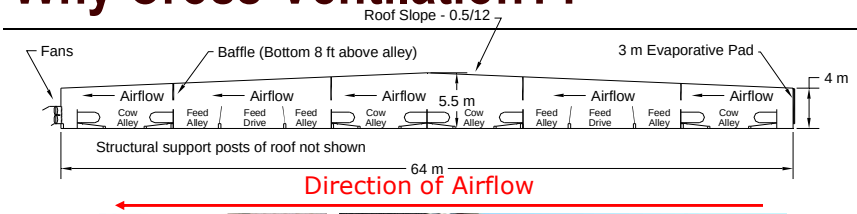
Location	NH_3 % of as fed N
Storage pond	5.4
Processing area	1.8
Compost yard	7.8
Total	15

Low-Profile, Cross-Ventilation Freestalls

Why Low-Profile??



Why Cross-Ventilation??



Direction of Airflow

Emission Rates for LPCV

Emission Rate as g/day		NH_3	NO
Spring	Low	14,882.2	153.7
	Medium	23,598.7	956.8
	High	32,648.3	0.0
Summer	Low	11,787.2	0.0
	Medium	23,206.7	135.8
	High	32,762.0	0.0
Emission Rate as g/cow/day			
Spring	Low	18.60	0.19
	Medium	29.50	1.20
	High	40.81	0.00
Summer	Low	14.73	0.00
	Medium	29.01	0.17
	High	40.95	0.00

LPCV Nitrogen Mass Balance

- Dairy Cows: 24.5 kg-DM/cow/day
  17% CP
  0.67 kg-N/cow/day
- Average NH_3:29.6 g/cow/day (Spring)
  28.2 g/cow/day (Summer)
- % Loss as Fed:4.4% (Spring)
  4.2% (Summer)

Idaho Permit Thresholds

System	Drylot	Free Stall/Scrape	Free Stall/Flush
AU (100 t NH_3) threshold			
No land app	7089	3893	2293
27% volatilization [1]	6842	3827	
80% volatilization [2]	6397	3700	
Total cows (100 t NH_3) threshold			
No land app	5063	2781	1638
27% volatilization [1]	4887	2733	
80% volatilization [2]	4569	2643	

Idaho Rule Structure

- Permit by Rule
- Farm Registration
- Education Program for Producers
- Initial Inspection
- “Performance-Based” BMP utilization

Ammonia BMPs

- Year-round BMP Plan
- Points allocated based on 20 point system
  - 20 points = extremely effective NH_3 reduction
  - 20 points = >75% reduction for that practice
- Points reflect year-around use and/or effectiveness of BMP
- Min. 27 points to be within the rule.

Points for Ammonia BMPs

System	Component	Ammonia Control Effectiveness [1]			Compliance Method[3]
		Open Lot	Freestall Scrape	Freestall Flush	
Waste Storage and Treatment Systems	Synthetic Lagoon Cover	15	20	20	1
	GeoteXtile Covers	10	13	13	1
	Solids Separation	3	3	3	3, 4
	Composting	4	4	4	1
	Separate Slurry and Liquid Manure Basins	6	10	-	1
	In-House Separation	0	12	0	1
	Direct Utilization of Collected Slurry	6	10	-	1, 3, 4
	Direct Utilization of Parlor Wastewater	10	10	10	1
	Direct Utilization of Flush Water	8	0	13	3, 4
	Anaerobic Digester	-	-	-	-
	Anaerobic Lagoon	-	-	-	-
	Aerated Lagoon	10	12	15	2
	Sequencing-Batch Reactor	15	20	20	2
	Lagoon Nitrification/Denitrification Systems	15	20	20	2
	Fixed-Media Aeration Systems	15	20	20	2
General Practices	Vegetative or Wooded Buffers (established)	7	7	7	1
	Vegetative or Wooded Buffers (establishing)	2	2	2	1

2006 Ammonia Inspections

	All Dairies	Open Lot Dairies	Freestall Scrape Dairies	Freestall Flush Dairies
Number of Dairies	**38**	**17**	**14**	**7**
Number of Dairies in Compliance	**36 (95%)**	**17 (100%)**	**13 (93%)**	**6 (86%)**
Average Points[1]	**32.9 ± 6.1**	**34.0 ± 6.2**	**31.6 ± 6.3**	**32.9 ± 5.2**

[1] Standard Error

Areas for improvement

- 1 freestall scrape dairy injects manure slurry
- 4 freestall scrape dairies (11% of all dairies) incorporated manure within 24 hours of application.
- Twenty-six percent (26%) of all dairies reported to incorporate manure within 48 hours of application.
- Freshwater dilution of stored manure and wastewater: 61% of all dairies; 5:1 to 9:1 of fresh to wastewater was most common.

National Air Emissions Monitoring Study (NAEMS)

- EPA Consent Agreement Research
- Nationwide Focus
- Monitoring
  - 6 sites ($7.5M)
  - 2 years
  - Barns (continuous) Manure Storage (seasonally)
- Environmental Chambers – UC Davis ($1M)
- System Modeling – ARS/Penn State ($0.5M)

NAEMS Dairy Sites

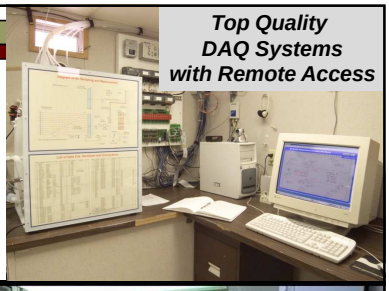
SMP #	Site Type	Ventilation Type	# of Units Measured	Manure Collection	Manure Storage[4]	Bedding Type[5]	PI
Northeast							
NY	Freestall	MV	2[3]	Scrape	Digester/SS/Basin	SDS	Gooch
Midwest							
IN	Freestall	MV	2	Scrape	Digester/SS/Basin	SDS	Lim
WI	Freestall	MV	3[3]	Flush	SP/Basin	Mattress/ shavings	Jacobson
West							
CA	Open Freestall[2]	NV	2	Flush	SP/Basin	Soil/MS/ Almond shells	Mitloehner
WA	Open Freestall[2] & Basin	NV	2	Flush	SP/SS/Basin	MS	Ndegwa

[1]Barn sites that also have measured area sources, which are described in the open-source QAPP
[2]Cattle are free to walk from open freestall barn into dry lots between the barns.
[3]Monitored units include the milking center.
[4]SP = settling pond
[5]MS = Manure solids; SDS = Separated digested solids

On-Farm Instrument Shelter

- NH_3
- H_2S
- PM_{10} & $PM_{2.5}$ Capability

Top Quality DAQ Systems with Remote Access



What to Measure/Record

- Feed diet/ration.
  - Include weigh backs
- Milk production
- Feed consumption
- Manure: pH, TS, TKN, N fractions
- Milk urea
- Water analysis

Emissions Methodology Evaluation

- Compare open-area emissions monitoring methods
- 6000-head Dairy
- Oct 1 – 7, 2007

- UV-DOAS
- FTIR
- Wind Tunnel w/ chemiluminescence
- Passive NH_3
- Mass-balance & existing table values

University of Idaho

USDA ARS

Space Dynamics Laboratory
Utah State University Research Foundation

Summary

- Ammonia is of regulatory concern by EPA and many states
- Previous studies have concentrated on animal production impacts rather than environmental emissions
- Lack of testing procedures for quantifying emission rates to evaluate/develop technologies
- Emissions monitoring and estimates must account for the differences in manure collection and building ventilation systems.

Questions???

Who said a manure pond couldn't be beautiful??