

**National Air Emissions  
Monitoring Study**

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[www.naems.info](http://www.naems.info)

**Purdue Agricultural Air  
Quality Laboratory**

**Agricultural and  
Biological Engineering**

**PURDUE  
UNIVERSITY**

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**Objective**

*Evaluate whether livestock operations emit PM and VOC > CAA thresholds, or NH<sub>3</sub> and H<sub>2</sub>S > CERCLA and EPCRA reporting requirements.*



- > \$14.6M
- > Eight (8) states across the U.S.
- > Two (2) years of monitoring

Air emissions from two to three barns per site are being measured for 24 months using EPA-approved methods.

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**Study Design**

- > Twenty representative livestock production sites.
- > Outdoor manure facilities (9) and corral (1) monitored every season
  - > Hydrogen sulfide (UVDOAS or pulsed fluorescence w/ S-OP).
  - > Ammonia (TDLAS, UVDOAS, photoacoustic spectroscopy)
  - > Ethanol, methanol (photoacoustic spectroscopy w/ S-OP)
  - > Radial Plume Mapping with TDLAS
  - > Backward Lagrangian stochastic (bLS) modeling with S-OP
- > Barns (38) monitored continuously
  - > Hydrogen sulfide (pulsed fluorescence)
  - > Ammonia (photoacoustic spectroscopy)
  - > Ethanol, methanol (photoacoustic spectroscopy)
  - > Non-methane hydrocarbons (GC-FID)
  - > Carbon dioxide (photoacoustic spectroscopy)
  - > TSP, PM<sub>2.5</sub>, PM<sub>10</sub> (TEOM)
  - > Barn airflow (fan speed, pressure, velocity, portable fan tester)
- > Integrated sampling at barns
  - > VOCs: GC-MS (canisters, tubes), IC (impingers)
- > EPA-approved standard operating procedures

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**General Timeline of NAEMS**

- 2004 *Development of Protocol*
- 2005 *PI Selection, Staffing, Budgeting*
- 2006 *Site Selection, Quality Assurance Project Plan*
- 2007 *Setup of Barn and Open Source Emission Monitoring*
- 2008 *Data Collection, Analysis and Reporting*
- 2009 *Data Collection, Analysis and Reporting*
- 2010 *Submit Final Report of NAEMS to EPA*
- 2011 *EPA Develops Emissions Estimating Methodologies*

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**Equipment Acquisition and Site Setup 2007**




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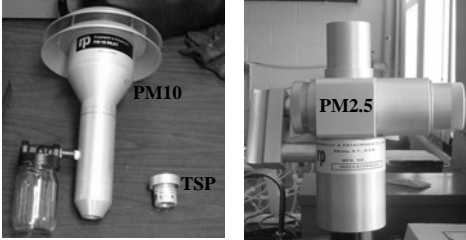
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**Real-Time PM Measurements**

- > *PM2.5 (very fine particles)*
- > *PM10 (fine particles)*
- > *TSP (total suspended particles)*




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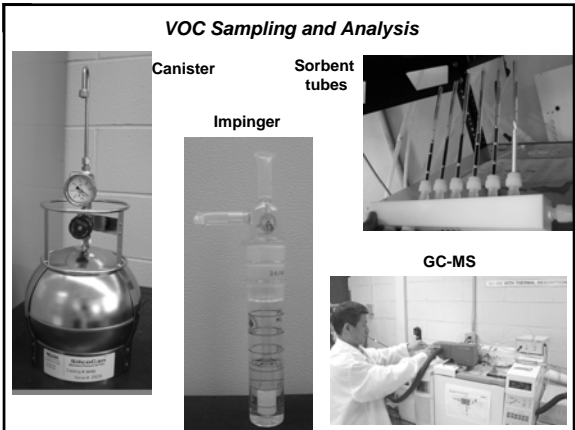
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**NH3, CO2 and VOC Measurements**

Species	Site	1	2	3	4	5	NMHC	VOC
Broilers	CA1B	NH3	CO2	Eth	-	CH4		IC/GC-MS
Dairy	NY5B	NH3	CO2	-	-	-		ic/gc-ms*
	WA5B	"	CO2	-	-	-		ic/gc-ms*
	WI5B	"	CO2	N2O	-	CH4	GC-FID	ic/gc-ms*
	CA5B	"	Meth	Eth	-	CH4	GC-FID	ic/gc-ms*
	IN5B	"	CO2	Eth	-	CH4		IC/GC-MS
Layers	CA2B	NH3	CO2	Eth	N2O	CH4		ic/gc-ms
	IN2B	"	CO2	-	-	-		ic/gc-ms*
	NC2B	"	CO2	-	-	-		ic/gc-ms*
	IN2H	"	CO2	Eth	-	CH4		IC/GC-MS
Swine	NC3B	NH3	CO2	-	-	-		ic/gc-ms*
	NC4B	"	CO2	-	-	-		ic/gc-ms*
	OK4B	"	CO2	-	-	-		ic/gc-ms*
	IA4B	"	CO2	N2O	-	CH4		ic/gc-ms*
	IN3B	"	Meth	Eth	-	CH4	GC-FID	IC/GC-MS

\*Every quarter after initial characterization.

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**Summary of NAEMS Sites**

Species	Barns per Site			Total number		Number of Area Sites			
	2-b	3-b	4-b	Sites	Barns	Corrals	Lagoons	Basins	Total
Swine	0	4	1	5	16	0	5	1	6
Dairy	3	2	0	5	12	1	3	0	4
Layers	2	0	1	3	8	0	0	0	0
Broilers	1	0	0	1	2	0	0	0	0
<b>Total</b>	<b>6</b>	<b>6</b>	<b>2</b>	<b>14</b>	<b>38</b>	<b>1</b>	<b>8</b>	<b>1</b>	<b>10</b>

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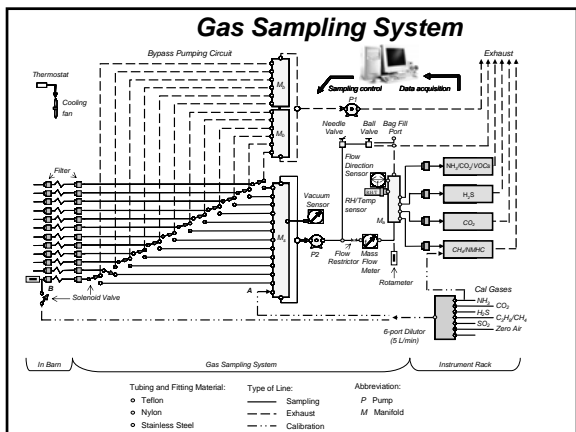
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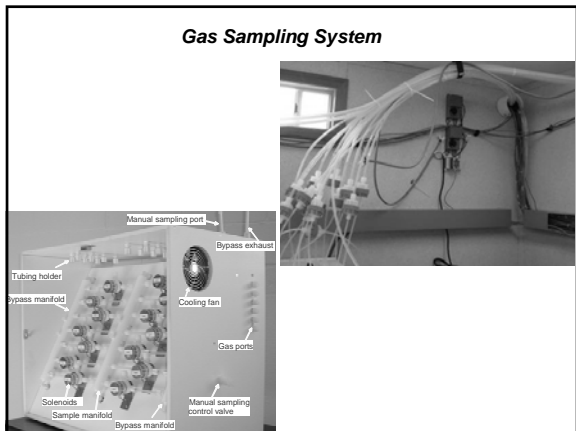
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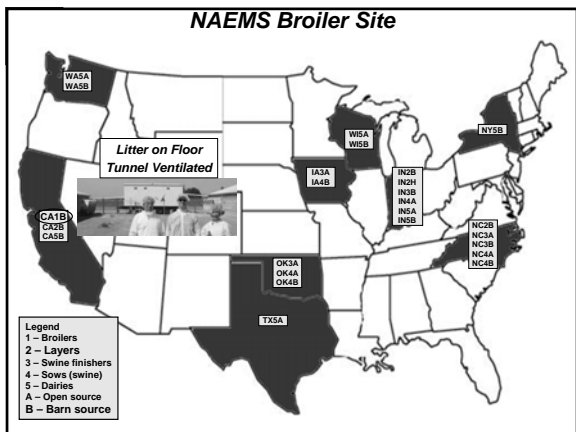
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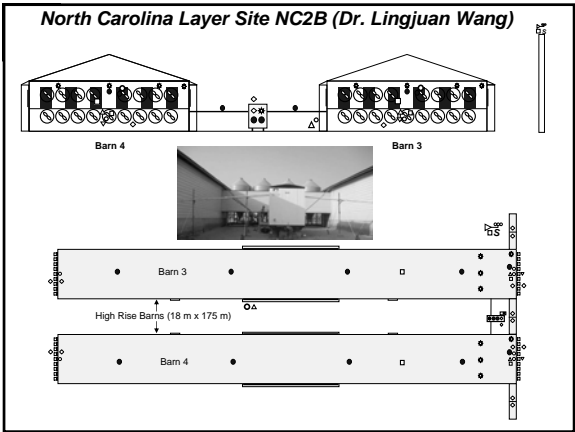
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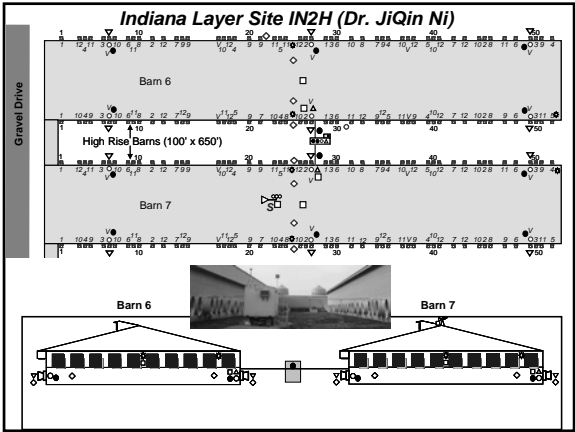
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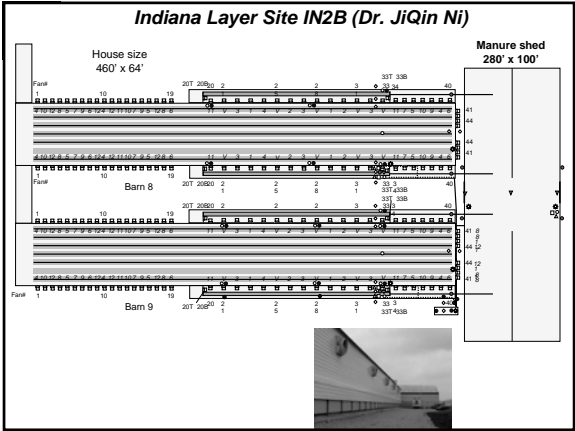
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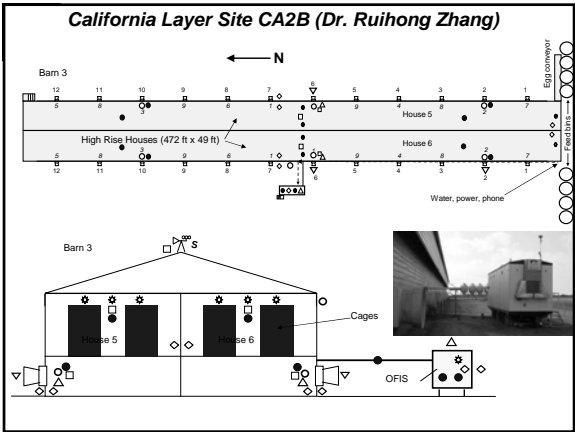
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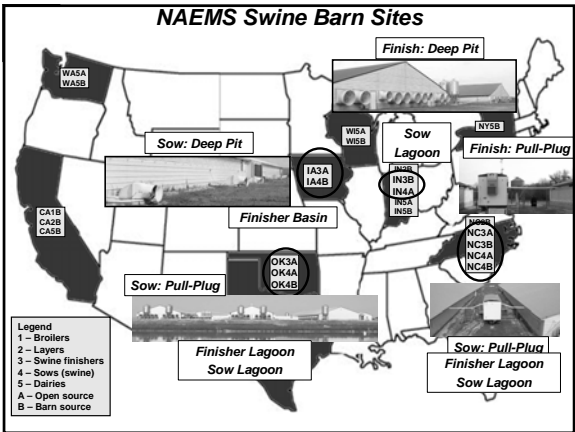
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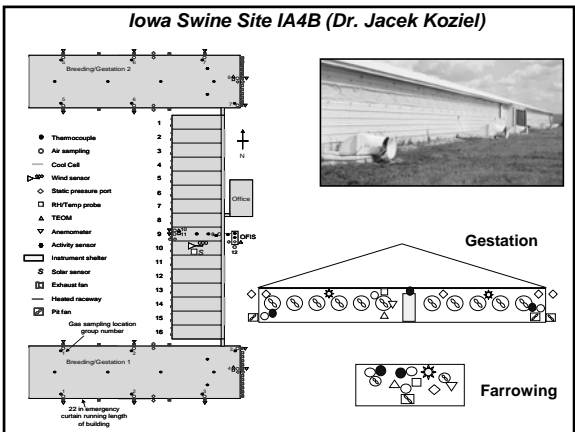
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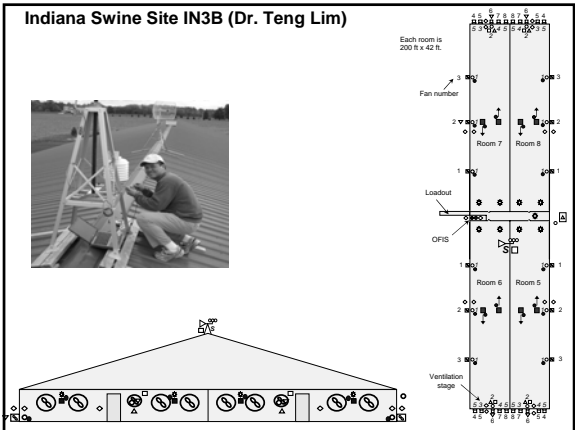
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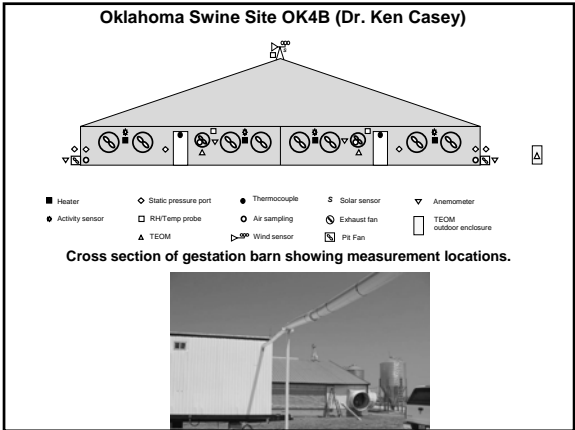
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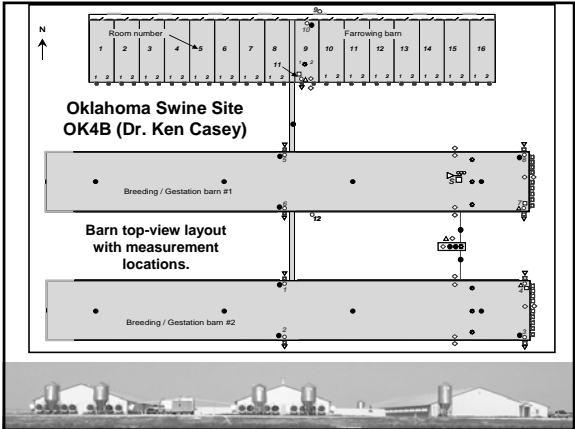
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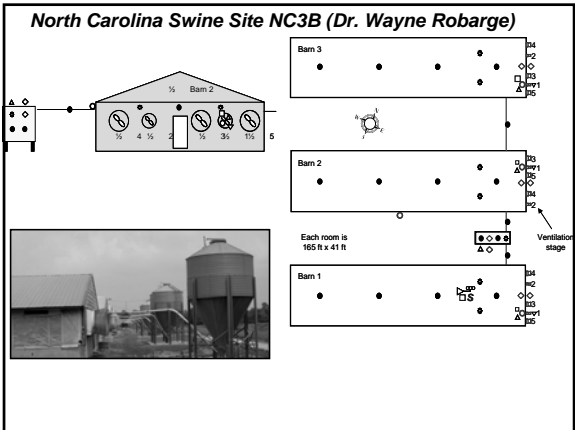
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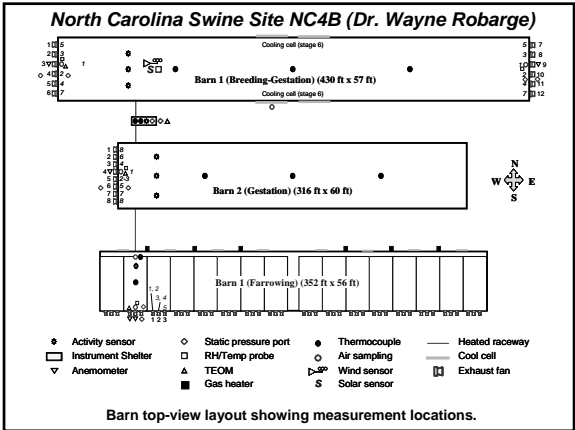
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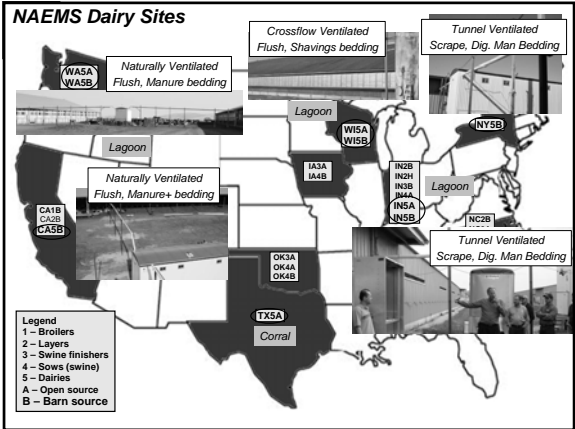
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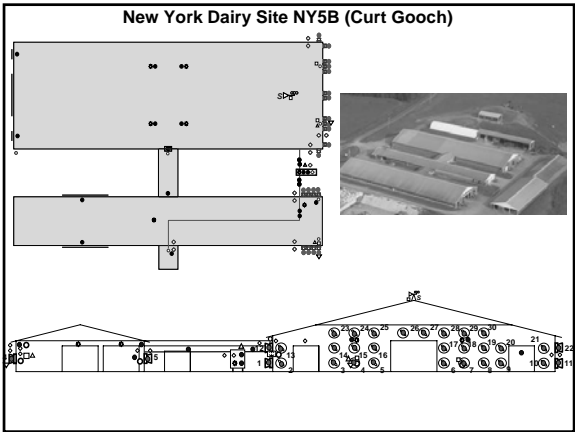
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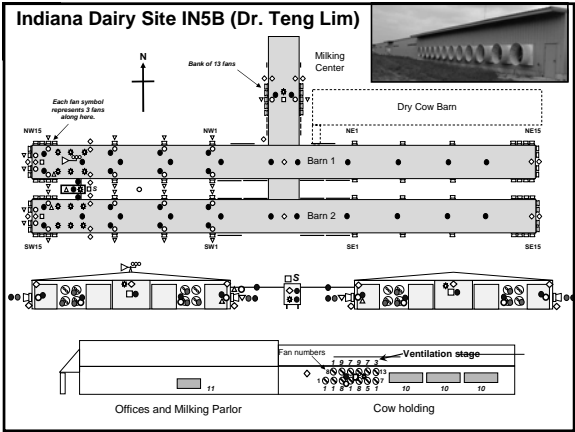
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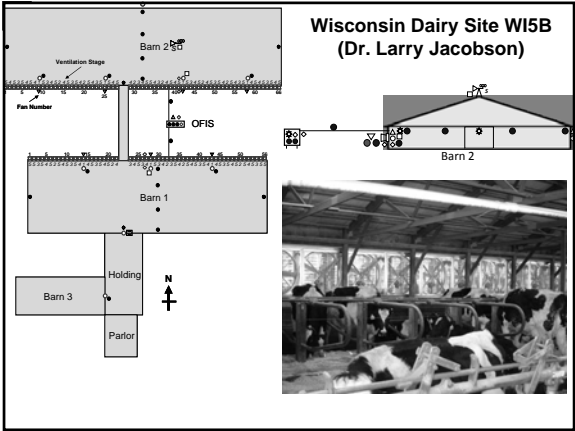
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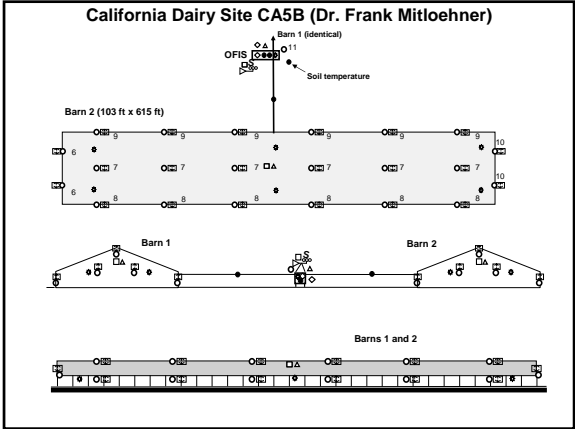
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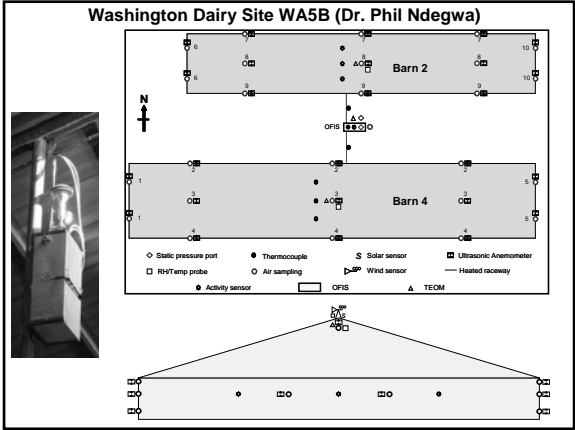
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**Summary of Site Setup Milestones**

Site	Day 1	Sensors	EPA Audit
CA1B	9/28/07	125	6/5/08
CA2B	10/17/07	104	-
IN2B	11/2/07	297	-
IN2H	5/9/07	169	9/26/07
NC2B	9/24/07	140	-
IN3B	7/13/07	154	9/27/07
NC3B	11/30/07	98	-
NC4B	12/14/07	85	-
IA4B	7/19/07	147	-
OK4B	7/20/07	121	-
CA5B	9/27/07	239	6/3/08
IN5B	8/24/07	186	9/25/07
NY5B	10/24/07	107	6/25/08
WA5B	9/28/07	214	-
WI5B	9/12/07	121	-

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### Open Source Measurement Sites (Dr. Rich Grant)

Type	Region
Dairy	Southwest- TX
Dairy	East- IN
Dairy	Midwest- WI
Dairy	Northwest- WA
Pork-sow	Southeast- NC
Pork-finisher	Southeast- NC
Pork-sow	Midwest- IN
Pork-finisher	Midwest- IA
Pork-sow	West- OK
Pork-finisher	West- OK

**Roving teams visit each area source once each quarter**

Source: Dr. Rich Grant, Purdue University, April, 2008

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### NH<sub>3</sub> Measurements: TDLAS

[NH<sub>3</sub>] : 50 ppb–100m (5 ppm-m MDL)

150 m  
Up to 300 m

1,715

1,715

TDLAS reflector ■  
TDLAS ■

Source: Dr. Rich Grant, Purdue University, April, 2008

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### RPM emissions

Wind Direction

Source

Directly measured downwind

TDLAS

Directly measured upwind

If all four sides valid

$$Q = \frac{\sum_{i=1}^n (C_i - C_u) V_i}{S}$$

If 2 downwind sides valid and 1 upwind path valid

$$Q = \frac{\sum_{i=1}^n (C_i - C_u) V_i}{S}$$

A plume of some area with measured concentration traveling at some speed is the emission from the lagoon

Source: Dr. Rich Grant, Purdue University, April, 2008

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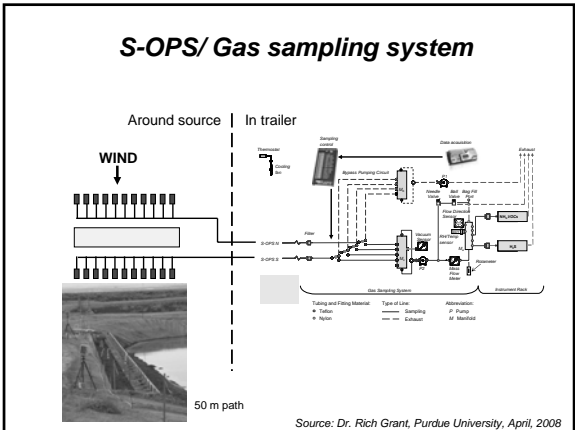
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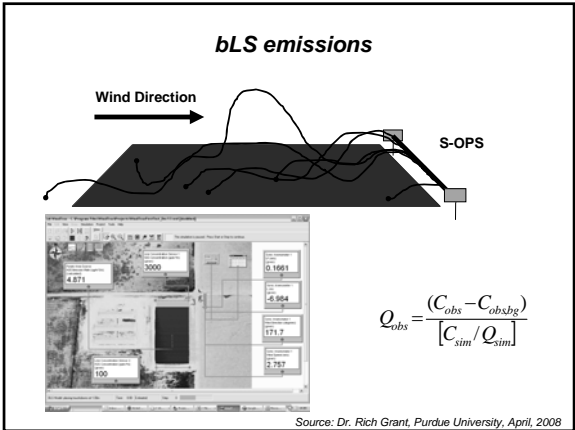
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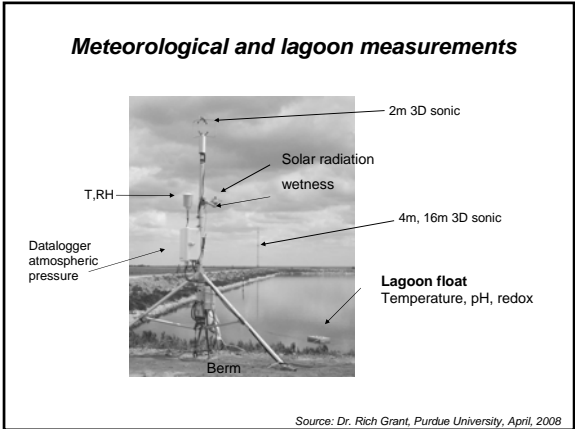
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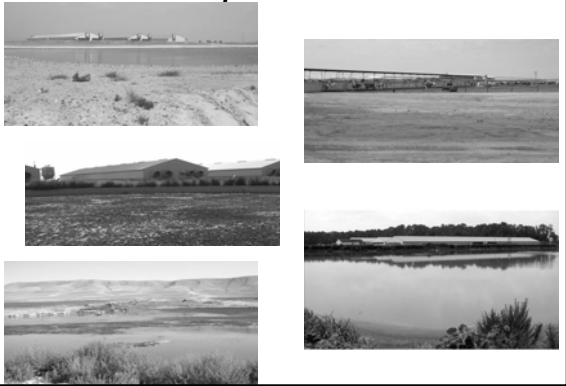
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**Open Sources**



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**Funded Add-On Studies**

- **Odor measurement**
- **Greenhouse gas measurement**
- **PM size distribution measurement**
- **Tests of exhaust air treatment**



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**Summary of NAEMS Progress**

- **All sites were selected in 2006**
- **All sites were set up in 2007**
- **Emission monitoring at all sites in 2008.**
- **2007 data is being reviewed internally.**

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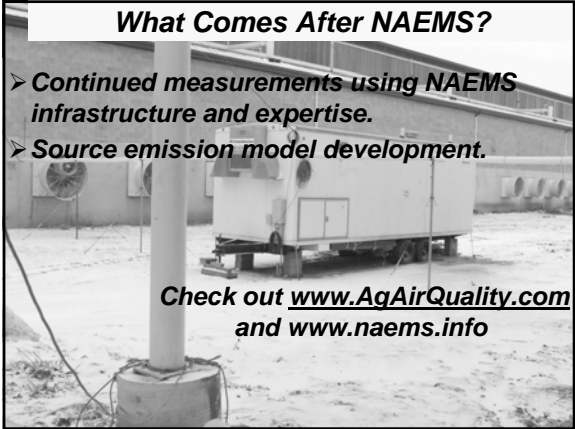
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