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# Strategy for Continuous PM Mass Monitoring

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Providing a Framework for  
Acceptance of PM Continuous  
Methods

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# Topics

- Background/Motivation
- Basic Approach
- Implementation Options
- Data Quality Objectives
- Current PM<sub>2.5</sub> Continuous Monitoring Network
- PM<sub>2.5</sub> Continuous Monitoring Analyses
- PM Continuous Methods Summary
- Linkage to National Monitoring Strategy
- Summary of Next Steps and Timetable



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# Background/Motivation

- Large network of FRMs with limited data use versus relatively small network of PM2.5 continuous monitors with potential for many data uses:
  - ▶ 1054 FRM sites operational in '00
  - ▶ ~200 PM2.5 Continuous monitors operational in '01
- Reduce operator burden associated with filter based methods
  - ▶ major request from STAPPA/ALAPCO
  - ▶ implies FRM reduction through monitoring strategy/assessments
- CASAC Particle Monitoring Subcommittee has specifically requested that this be addressed



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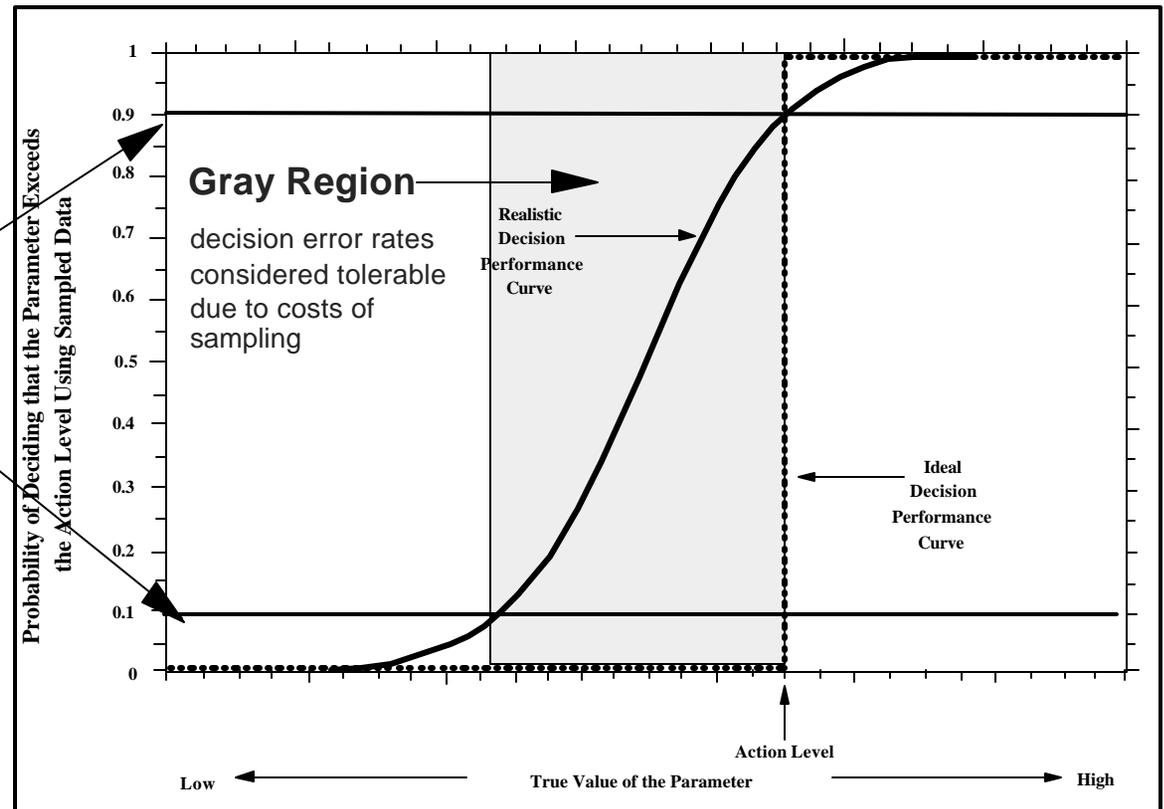
# Data Utility PM2.5 FRM vs. Continuous Monitors

Monitoring Objective	FRM	Continuous
NAAQS Attainment Decisions	Yes	<i>No</i>
Public Reporting (Air Quality Index)	No	Yes
Assess SIP Trends	Yes	Yes, if a consistent method is applied.
Diurnal Variation	No	Yes
Peak short term exposure	No	Yes
Model Evaluation	Limited	Robust
Sector Sampling	Extremely limited	Yes

# Basic Approach

- Utilize DQO's to define performance based criteria for acceptance of methods
  - Limit acceptance to areas where testing demonstrates success

Decision error limits  
risk decision maker  
is willing to assume of  
making an incorrect decision





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# Existing vs. New Paradigm to Approve PM Continuous Monitors

Topic	Existing	New
Spatial Scale of Approval	Nationally	By site or network of sites
Location of Test Sites	Specific areas required to be covered so as to include range of aerosol and environmental conditions	In the areas that the instruments are intended to be operated
Field Testing	Generally rely on vendors to initiate	Empower State and local agencies to initiate
Performance Criteria	Slope of 1 +/- 0.05 Intercept of 1 ug/m <sup>3</sup> Correlation of >=0.97	Bias +/- 10% Precision 20% CV



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# Implementation Options

- What's being considered:
  - ▶ Two types of PM continuous monitors are being considered
    - Regionally Equivalent Monitors (REMs)
      - Can be used for all applicable monitoring objectives
    - Revised Correlated Acceptable Continuous (CACs) Monitors
      - More flexible in approval than REMs
      - Can be used for all applicable monitoring objectives, except NAAQS decisions
- Why two approaches?
  - ▶ REM - Need to have an approved PM continuous monitor that can be used to replace a portion of the FRMs in areas where the performance criteria are met.
  - ▶ CAC - Need to have an approved PM continuous monitor that can be used to replace a portion of the FRMs that are not needed for NAAQS; however, the data are used for other monitoring objectives.



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# Implementation Option - Regional Equivalent Monitors

- Regional Equivalent Monitor (REM) option:
  - ▶ Must meet performance criteria to be approved
  - ▶ Performance criteria is a "goal" for ongoing assessment
  - ▶ Only simple (1 variable) transformations may be used, if applicable.
  - ▶ Are used for attainment purposes
  - ▶ Network design requires a minimum number of FRM/FEMs to be retained (*e.g. 1/3 of the required sites*)
  - ▶ Retained FRM/FEMs to be collocated with continuous monitors to provide the performance data for ongoing assessment
  - ▶ Initiated by States/locals/Tribes



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# Implementation Option - Revised Correlated Acceptable Continuous Monitors

- Correlated Acceptable Continuous (CAC) option:
  - ▶ Site or network of sites to meet all applicable monitoring objectives except direct NAAQS decisions
    - Example locations would be sites that are substantially below the standard or any supplemental site that is not required to have a FRM/FEM
  - ▶ Performance criteria for approval are "Goals"
    - Monitoring agencies that can demonstrate data are "FRM" like even if they do not meet specific +/- 10% bias and 20% CV are eligible for approval. Complex transformations may be used, if applicable.
  - ▶ Performance criteria is a "goal" for ongoing assessment
  - ▶ Network design requires a minimum number of FRM/FEMs to be retained (*e.g. at least 1/3 of the required sites*)
  - ▶ Retained FRM/FEMs to be collocated with continuous monitors to provide the performance data for ongoing assessment
  - ▶ Initiated by States/locals/Tribes



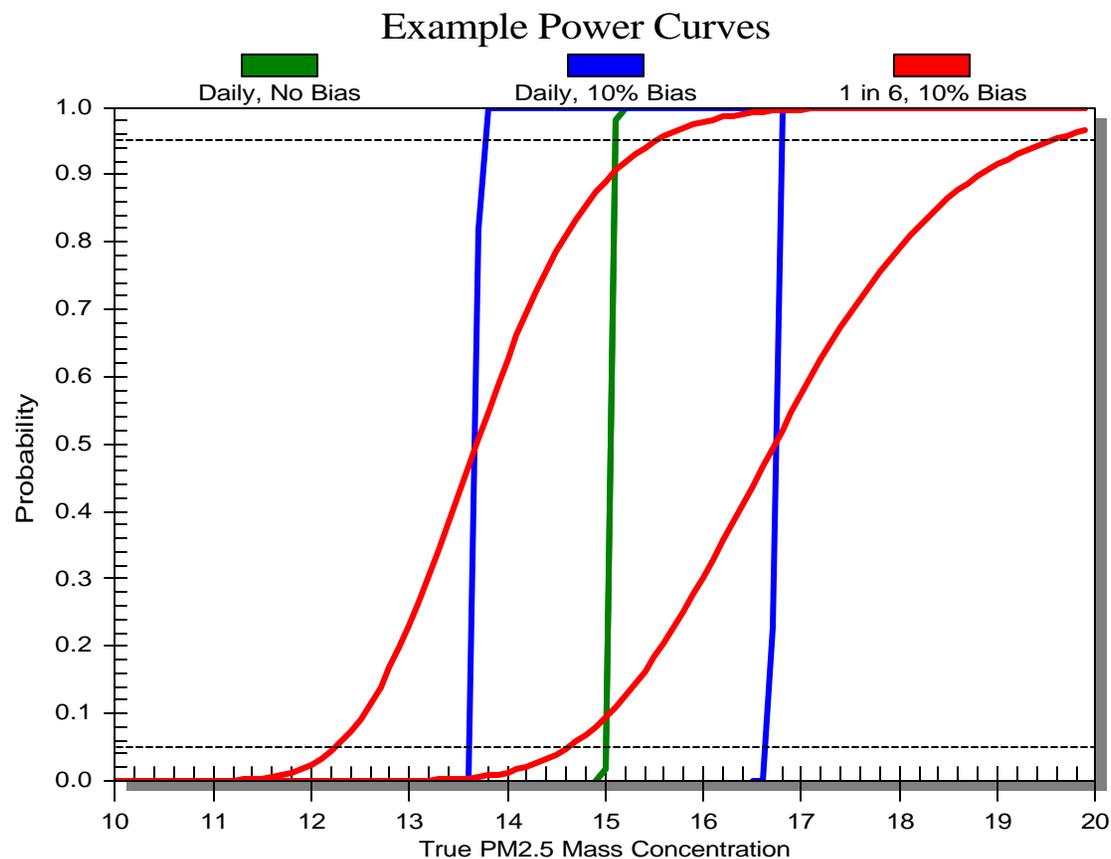
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# Implementation Options - Network Design Elements

- Retain minimum number of FRMs (*e.g. 1/3 of the required sites in each network*) to:
  - ▶ Provide the closest link possible to the historical health studies
  - ▶ Consistency with the currently deployed network of FRMs
  - ▶ Provide a baseline set of data for ongoing evaluation of the continuous monitoring technologies
  - ▶ Minimums apply to each monitoring agencies network
- Only allow continuous monitoring technologies into the network that meet performance specifications as defined in the DQO process
- Retain minimum number of total sites operating in hybrid network of FRM/FEMs and PM2.5 continuous monitors
  - ▶ *Assume the currently required 850 sites are reasonable to meet multiple monitoring objectives*
  - ▶ Addressing the correct number of required sites is not otherwise addressed in this part of the strategy
- Mature Hybrid Network of FRM/FEMs and PM2.5 continuous monitors all meeting the DQOs goals for Precision and Bias can accomplish several monitoring objectives:
  - ▶ NAAQS, AQI, Mapping, Exposure, Model Evaluation

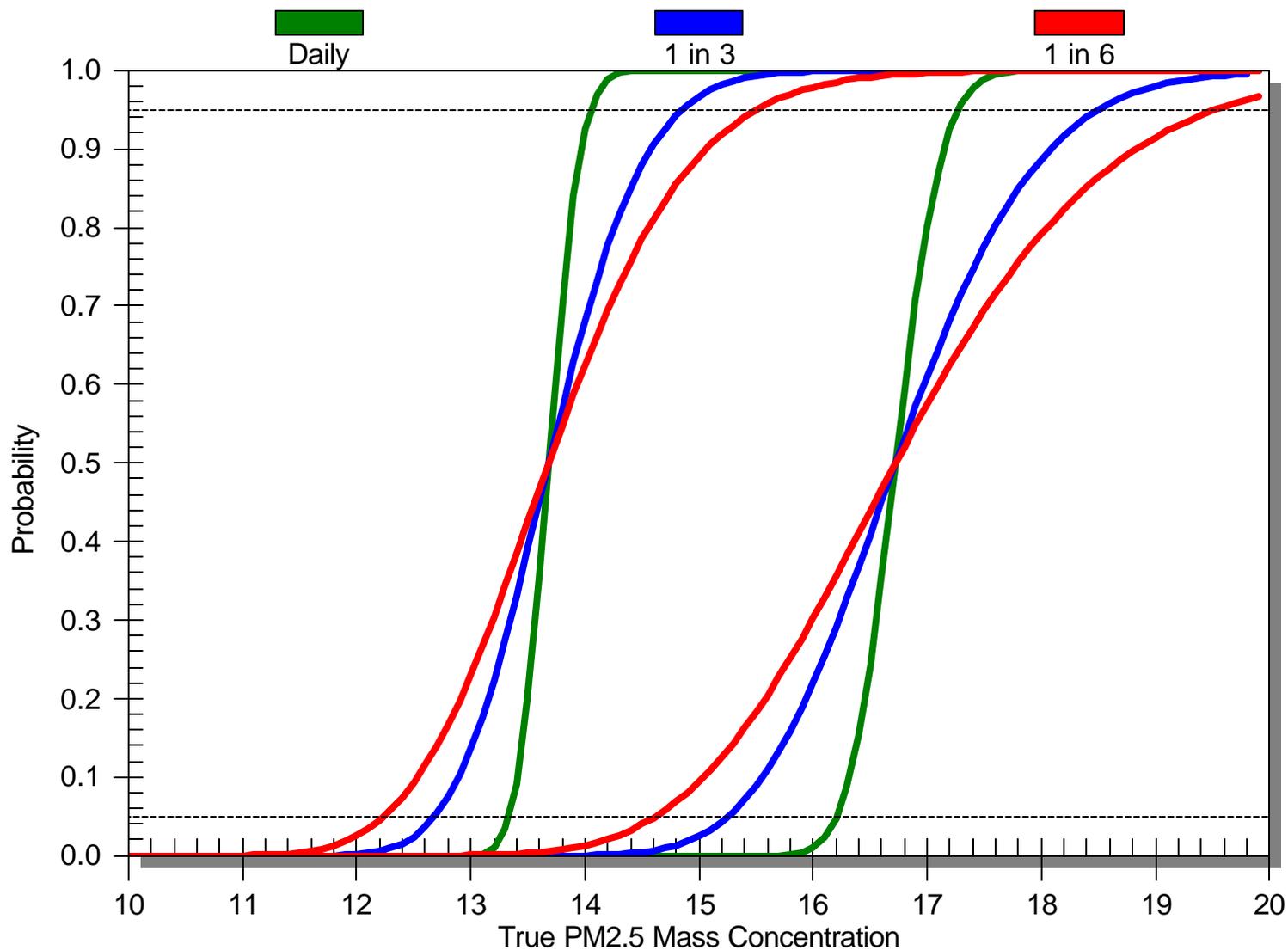
# Data Quality Objectives - What is a power curve?

- Graphically presents decision errors. Demonstrates factors that most influence the decision errors, such as
  - ▶ sample frequency
  - ▶ sample completeness
  - ▶ bias
  - ▶ measurement CV
  - ▶ population CV



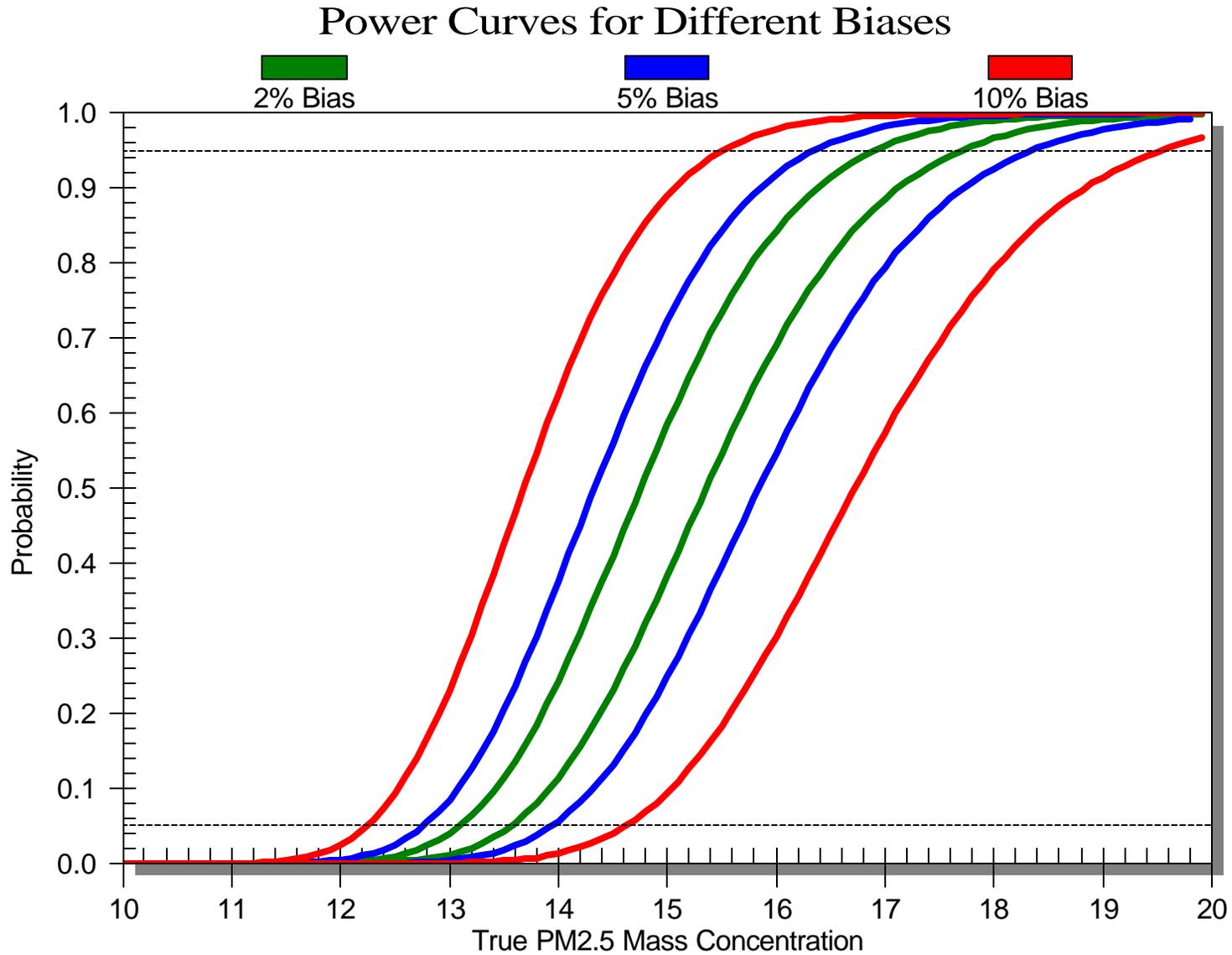
# Impact of Sampling Frequency

Power Curves for Different Samp Freq





# Impact of Bias





# Summary of Key Scenarios

		Gray Region (Type I & II Errors = 5%)	
		Lower Bound	Upper Bound
<b>Impact of Sampling Frequency</b> (75% comp, 80% popn cv, 10% bias, 10% meas cv, indep)	<b>Daily</b>	13.5	17.1
	<b>1 in 3</b>	12.8	17.9
	<b>1 in 6</b>	12.2	18.8
<b>Impact of Bias</b> (1 in 6, 75% comp, 80% popn cv, 10% meas cv, indep)	<b>5%</b>	13.0	17.7
	<b>10%</b>	12.2	18.8
	<b>20%</b>	11.3	21.1
<b>Impact of Measurement CV</b> (1 in 6, 75% comp, 80% popn cv, 10% bias, indep)	<b>10% CV</b>	12.2	18.8
	<b>20% CV</b>	12.2	18.8
	<b>50% CV</b>	12.2	19.0



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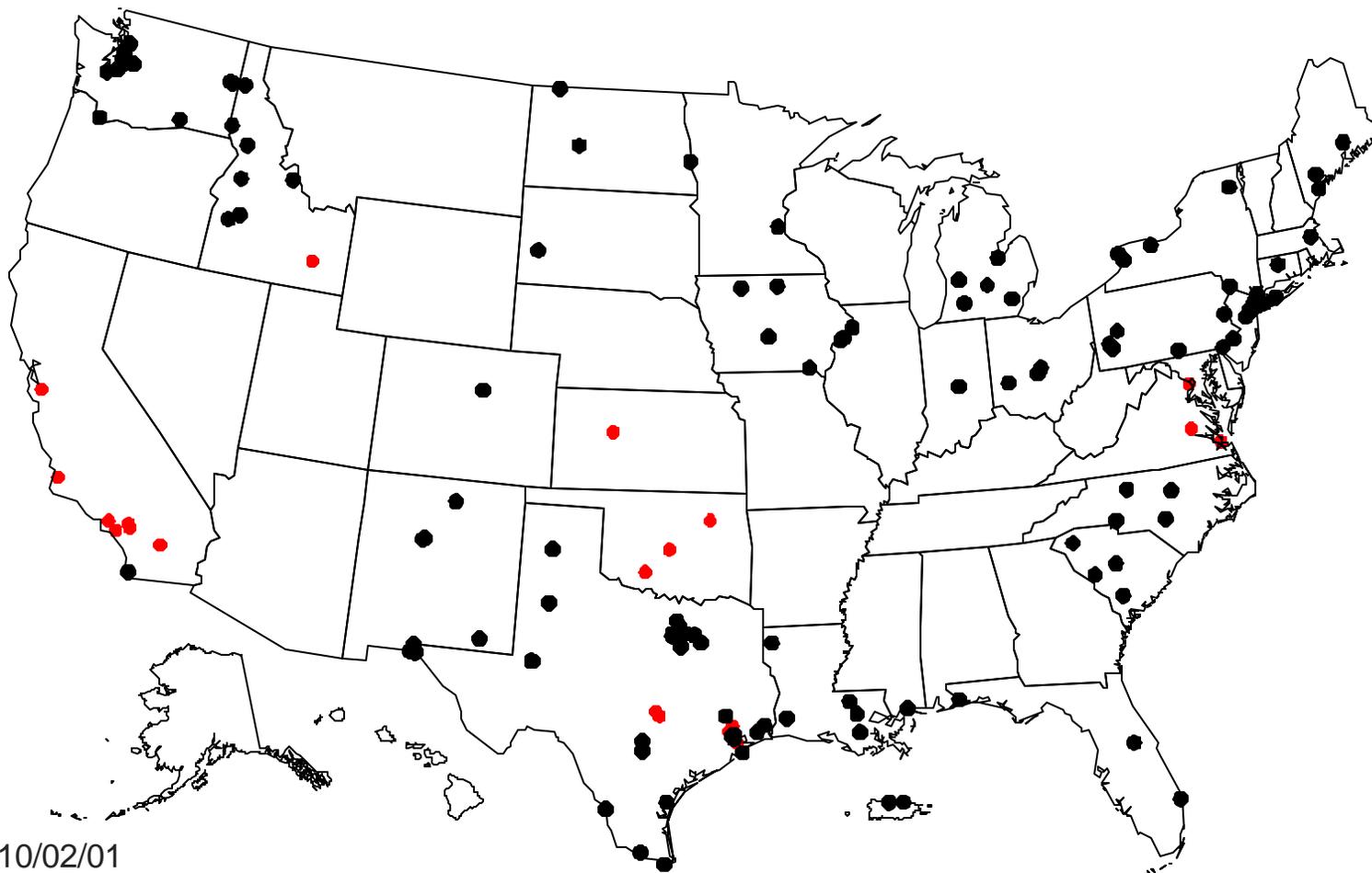
# Summary of Key Points for DQOs and PM2.5 Continuous Methods

- Sample Frequency
  - ▶ Gray zone becomes smaller as sites move from 1 in 6 day or 1 in 3 day to daily sample frequency, all other things being equal
- Bias
  - ▶ Changes in bias have large effect on size of gray region
  - ▶ Recommend keeping goal for bias the same as currently defined (+/- 10%)
- Measurement CV
  - ▶ Can allow for more imprecision as long as annual average is the driver for NAAQS
    - Changes to gray zone are negligible
    - Other uses of the data necessitate controlling precision to some degree
  - ▶ *Recommend establishing goal of 20% measurement CV*



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# Current PM2.5 Continuous Monitoring Network



AIRS, 10/02/01

Black = Data reported in AIRS (132)

Red = Site registered in AIRS but no data (20)



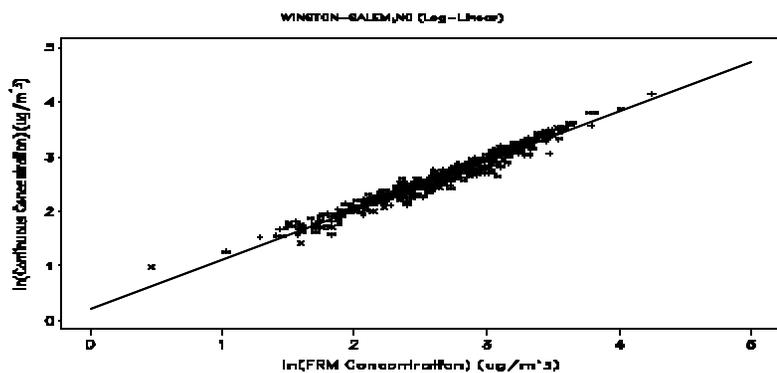
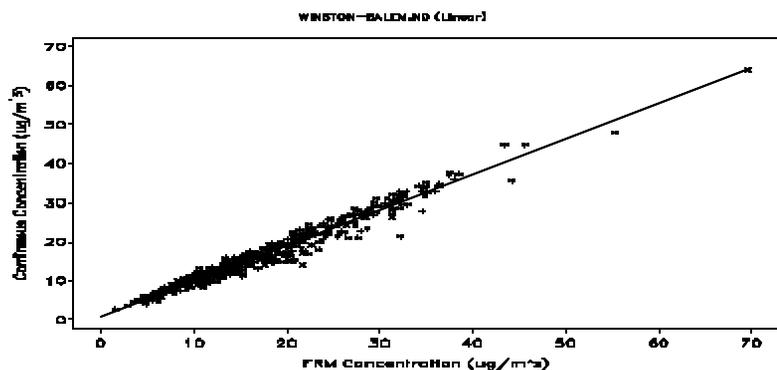
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# **PM2.5 Continuous Monitoring Data Analyses**

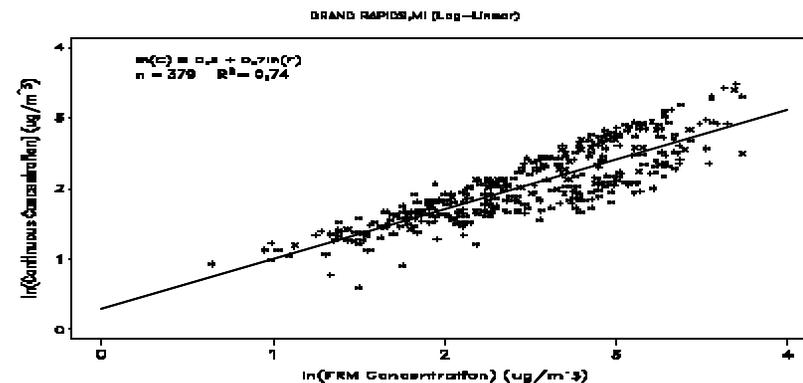
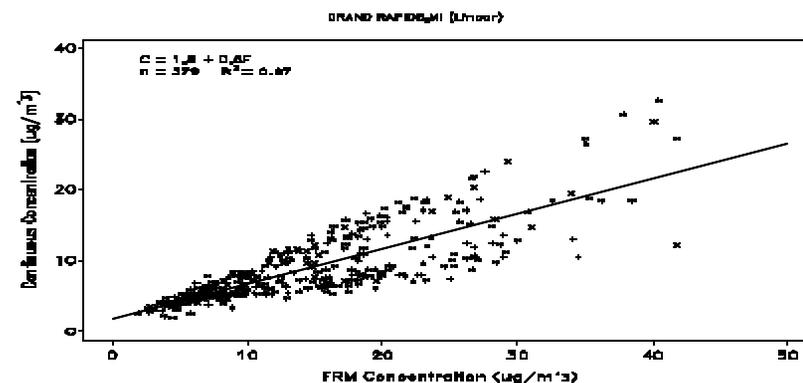
- Scatterplots
- Seasonal bias by location
- Evaluation of 160 PM2.5 FRM/FRM sites
- Evaluation of 47 Collocated FRM/Continuous sites

# Scatterplots of PM2.5 FRM/Continuous data

## Winston-Salem, NC



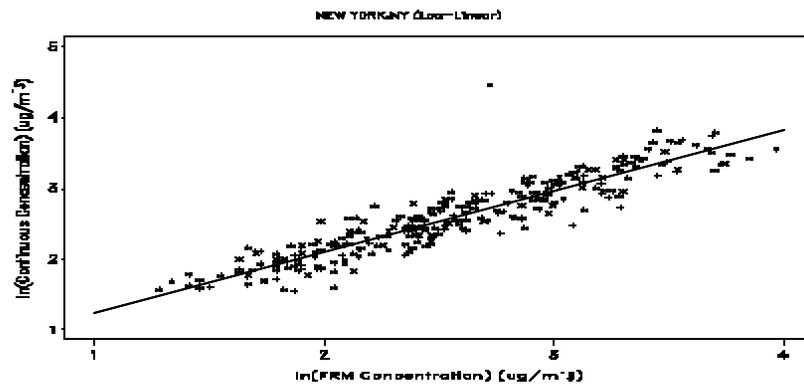
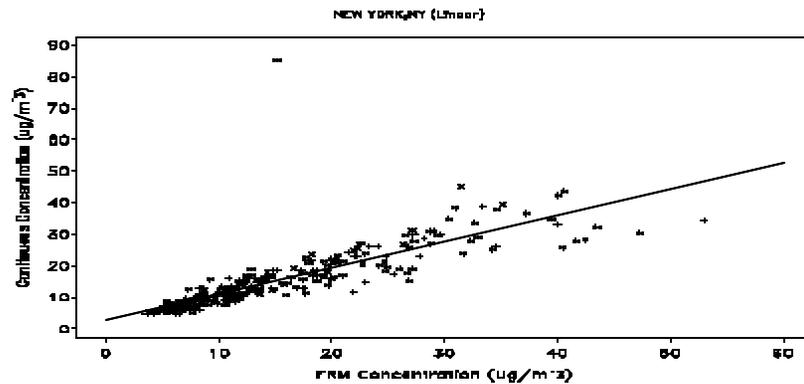
## Grand Rapids, MI



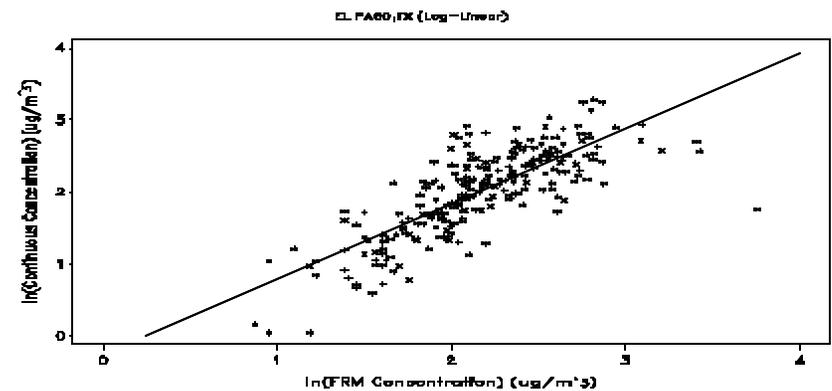
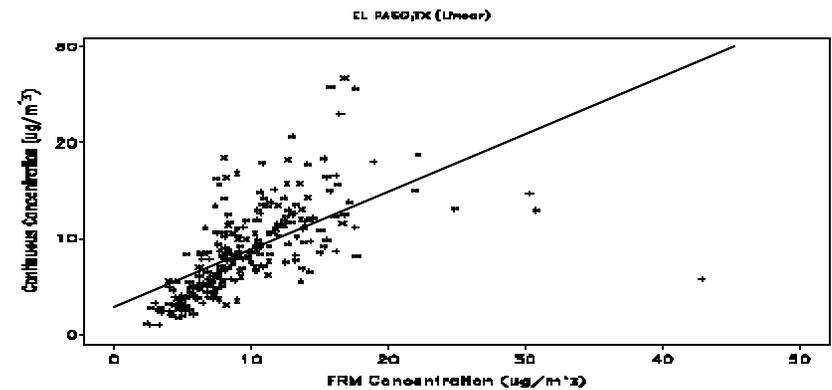


# Scatterplots of PM2.5 FRM/Continuous data

## New York, NY



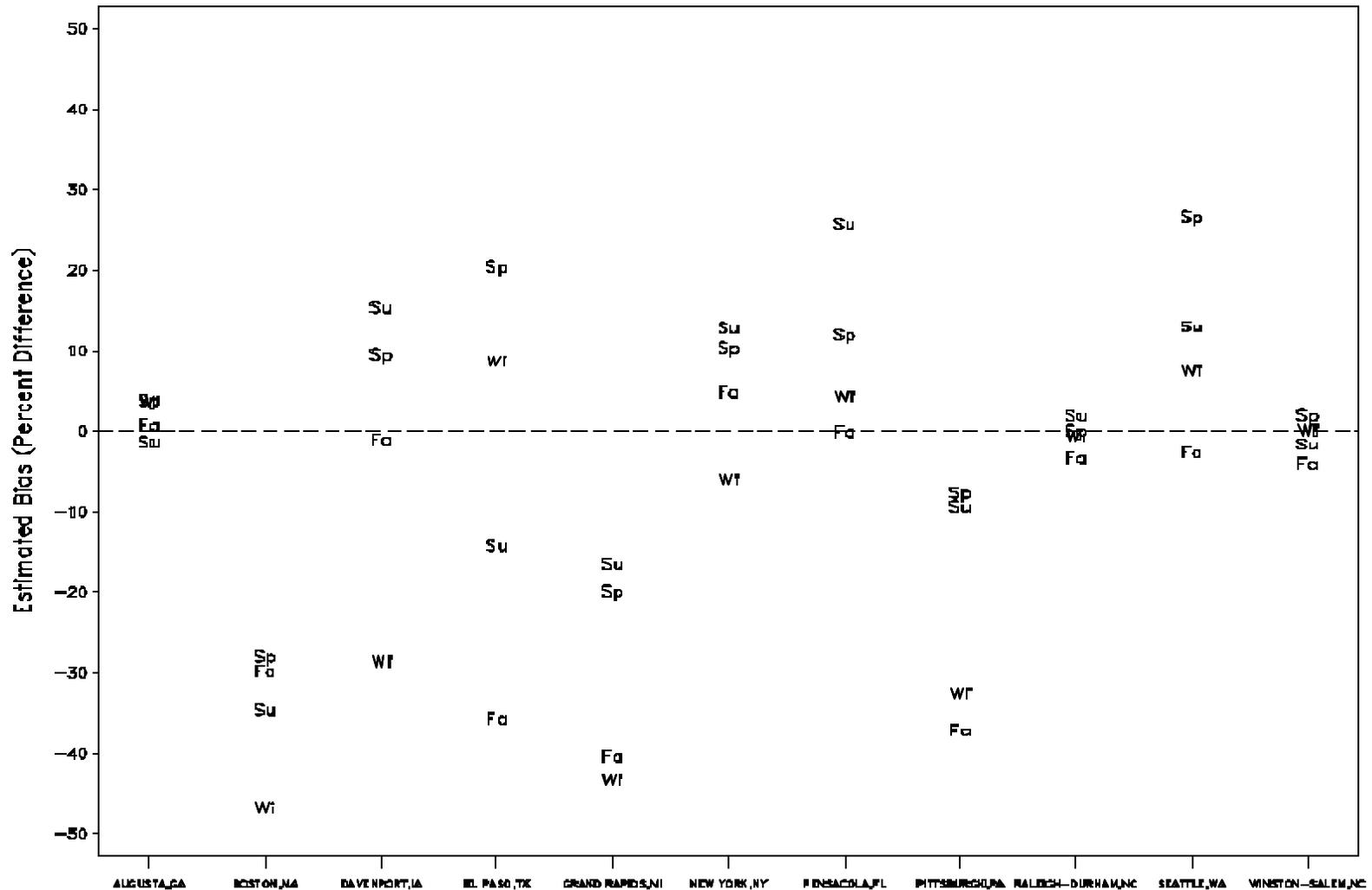
## El Paso, TX





# Seasonal Bias by Location

- Issue with correction factors





# Evaluation of 160 Collocated PM2.5 FRM/FRM Sites to Class III Equivalency & DQOs

Requirement	All Data	Eliminated Obs. With RE >50%	Eliminated Obs. In Highest and Lowest 2% of RE's
Bias 10%	97.5	99.4	100.0
Bias 5%	86.9	92.5	92.5
Precision 10%	68.8	95.0	90.6
Precision 5%	28.1	48.1	52.5
Slope (1±0.05)	77.5	88.8	88.8
Intercept	82.5	95.6	96.2
Correlation	66.2	90.6	89.4
<b>DQO</b>	<b>68.1</b>	<b>94.4</b>	<b>90.6</b>
<b>Class III</b>	<b>27.5</b>	<b>46.9</b>	<b>52.5</b>
Both DQO and Class III	27.5	46.9	52.5
DQO but not Class III	40.6	47.5	38.1
Not DQO but Class III	0.0	0.0	0.0
Not DQO and not Class III	31.9	5.6	9.4



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# Evaluation of 47 collocated FRM/Continuous sites to Class III equivalency & DQOs

(almost exclusively TEOM data with correction factors)

Requirement	All Data	Eliminated Obs. With RE > 50%	Eliminated Obs. In Highest and Lowest 2% of RE's
Bias 14%	63.8	87.2	66.0
Bias 10%	53.2	72.3	59.6
Bias 5%	34.0	44.7	36.2
Precision 20%	61.7	97.9	68.1
Precision 10%	12.8	34.0	17.0
Precision 5%	0.0	0.0	0.0
Slope (1± 0.14)	97.9	100.0	97.9
Slope (1± 0.1)	95.7	97.9	97.9
Slope (1± 0.05)	91.5	93.6	91.5
Intercept	97.9	100.0	97.9
Correlation	10.6	23.4	14.9



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# Evaluation results with respect to mass DQO & Class III equivalency requirements from 47 collocated continuous/FRM sites

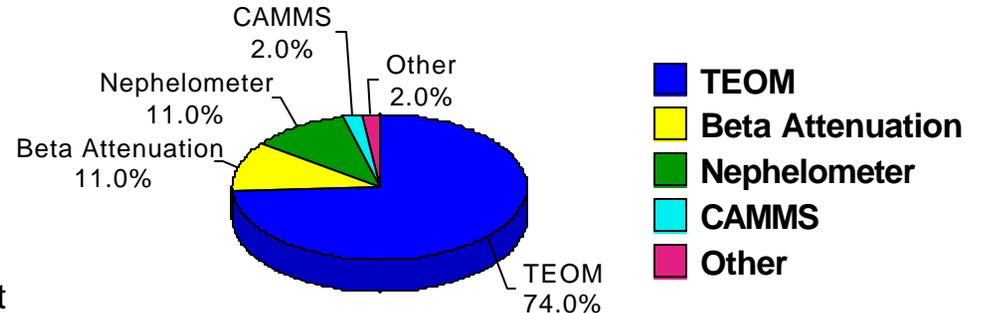
(almost exclusively TEOM data with correction factors)

Requirement	All Data	Eliminated Obs. With RE > 50%	Eliminated Obs. In Highest and Lowest 2% of RE's
DQO (5,5)	0.0	0.0	0.0
DQO (10,10)	12.8	31.9	17.0
<b>DQO (10,20)</b>	<b>48.9</b>	<b>72.3</b>	<b>55.3</b>
DQO (14,20)	57.4	87.2	61.7
Class III (~5,5)	0.0	0.0	0.0
Class III (~10,10)	6.4	19.1	10.6
Class III (~10,20)	10.6	23.4	14.9
Class III (~14,20)	10.6	23.4	14.9

# PM2.5 Continuous Methods Summary

- 50 C TEOMs
  - ▶ lots of data available
  - ▶ working well where the aerosol is relatively stable year round
  - ▶ winter episodes in areas with volatiles can cause underestimation relative to FRM
- 30 C TEOMs with Naphion dryer
  - ▶ limited data available
  - ▶ appears to be an improvement in capturing some of the volatiles
- Beta Attenuation
  - ▶ limited data available
  - ▶ generally encouraging so far
  - ▶ Multiple vendors - Although most using Met One
- CAMMs
  - ▶ limited data available
  - ▶ Issues with mechanical failures
- Nephelometers
  - ▶ limited data available
  - ▶ correlation's to FRMs are encouraging in areas used
  - ▶ Many potential vendors - Radiance Research used in WA State

PM2.5 Continuous Monitors  
Estimated percent of the National Network





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# Linkage to National Monitoring Strategy and Review

- One of key pieces in National Monitoring Strategy identified as targeted area of investment
  - ▶ continuous PM monitoring
  - ▶ information transfer and delivery
  - ▶ integration across pollutant programs
  - ▶ characterization of hazardous air pollutants
- Review
  - ▶ Technology Workgroup
    - State/local/Tribal
    - EPA - Regions & OAQPS
  - ▶ SAMWG
  - ▶ STAPPA/ALAPCO
  - ▶ National Monitoring Strategy Steering Committee
    - Large diverse groups of stakeholders
  - ▶ Internal Review
  - ▶ CASAC
    - Scientific Review



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# PM2.5 Continuous Monitoring and Network Optimization Timeline

- January 2001 - Public meeting with CASAC exploring continuous monitoring
- April - October 2001 - Communication and consensus building with STAPPA/ALAPCO, SAMWG, Regions, Workgroup
- October 2001 - Implementation plan (Work-in-progress) for CASAC
- October 23 - 25, 2001 - Monitoring Strategy Workshop
- October 2001- NMSC recommendations on the national network.
- November - December 2001 - Draft Recommendations for Regulatory Changes
- December 1, 2001 - Draft rule-making language prepared for work group review.
- January 2002- External scientific review of monitoring strategy
- June 2002 - Proposal in the Federal Register
- July -September 2002 - Public comment period
- October - December 2002 - Review public comments, prepare responses
- January 2003 - Final regulatory package published in Federal Register