Department of the Environment

BAMM FEM vs FRM Comparison

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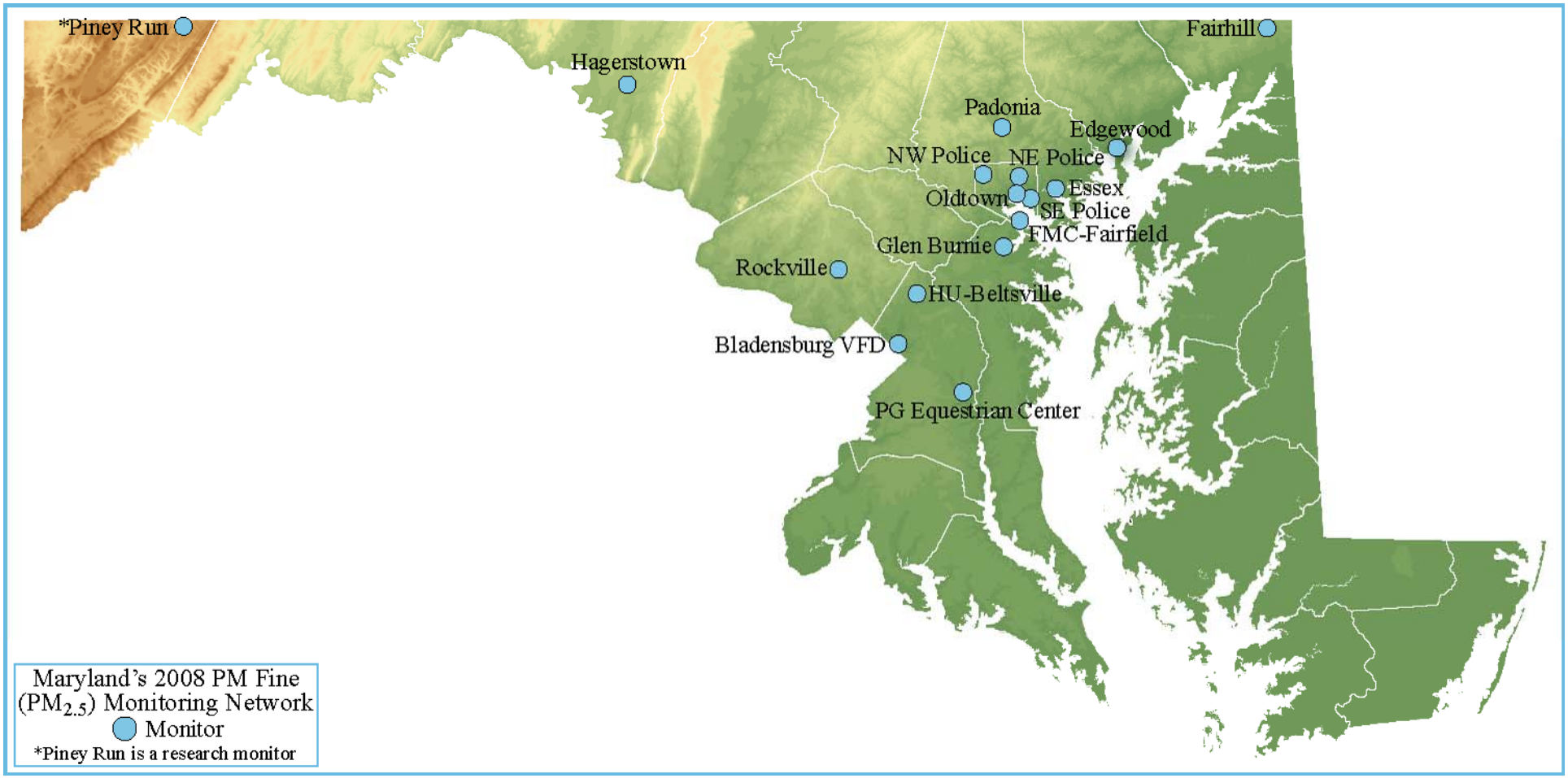
Overview

- MDE has been running 4 BAM's in FEM configuration colocated with FRM's. Fair Hill, Howard Univ, and Old Town since 7/3/08 and Rockville since 8/22/08
- Results indicate FEM bias with respect to FRM's, with the exception of Rockville
- MetOne is optimistic about removing this additive bias via proper setup and operation

Maryland $PM_{2.5}$ Monitoring Network



What is the $PM_{2.5}$ FEM Configuration?

- The classic BAM-1020 had appropriate accuracy and sensitivity for measuring PM10 levels, and was also often used for PM2.5 monitoring with the addition of a standard SCC cyclone or WINS impactor, even without equivalency.
- Field results from these early PM2.5 systems showed that the BAM needed slight detection limit and Y-intercept (offset) improvements for accurate measurements below about 15 micrograms. The slopes were typically quite adequate.
- PM2.5 levels by nature are much more difficult to measure due to low concentrations and greater volatile content. Small measurement errors may cause large proportional errors.

What is the $PM_{2.5}$ FEM Configuration?

- The transport assembly was redesigned for filter tape positioning accuracy of about 1/1000 of an inch.
- The beta source gap geometry was reduced 25%, resulting in higher signal-to-noise levels and reduced air density effects.
- The beta count time was increased from 4 to 8 minutes, improving the statistical noise stability by about 40%. Known as the “2X” effect.
- The firmware was extensively revised to provide flow statistics, new settings, and improved field calibrations.
- The field zero background test was implemented to fine-tune the slope offset characteristics in the field.
- The BX-596 Temp/Baro combination sensor was designed.

What is the $PM_{2.5}$ FEM Configuration?

- The combined effect of these improvements resulted in the typical detection limit (2σ) of the unit improving from about 6ug to about 3ug for hourly measurements, and below 1ug for 24 hour averages.
- All BAM-1020 units built after March 2007 are FEM compatible when equipped with the appropriate settings and accessories.
- The new BAM-1020 configuration maintains it's longstanding FEM status for PM10 monitoring.
- The unit must use the EPA-mandated VSCC-A™ cyclone from BGI Inc., and the standard EPA PM10 inlet.
- The unit must be equipped with revision 3.2.4 or later firmware, and must be operated per the revision F or later manual.

What is the $PM_{2.5}$ FEM Configuration?

- The unit must use the BX-596 AT/BP sensor.
- The unit must be operated with 8 minute counts and 42 minute samples on standard glass fiber filter tape.
- The unit must use the inlet Smart Heater, with an RH control set-point of 35%.
- The unit must be set for Actual volumetric flow control.
- The BKGD value must be audited in the field with the BX-302 zero filter kit upon deployment.

Measurement Challenges: Humidity

- The filter tape is semi-hydrophobic, but particulate on the tape is not.
- Moisture accumulation on the sample spot may be measured as mass noise.
- BAM-1020 uses smart heater technology to lower the RH of incoming air to about 35%.
- Mild heat and hourly spot changes limit the effects on VOCs.
- Humid conditions can increase nozzle fouling.

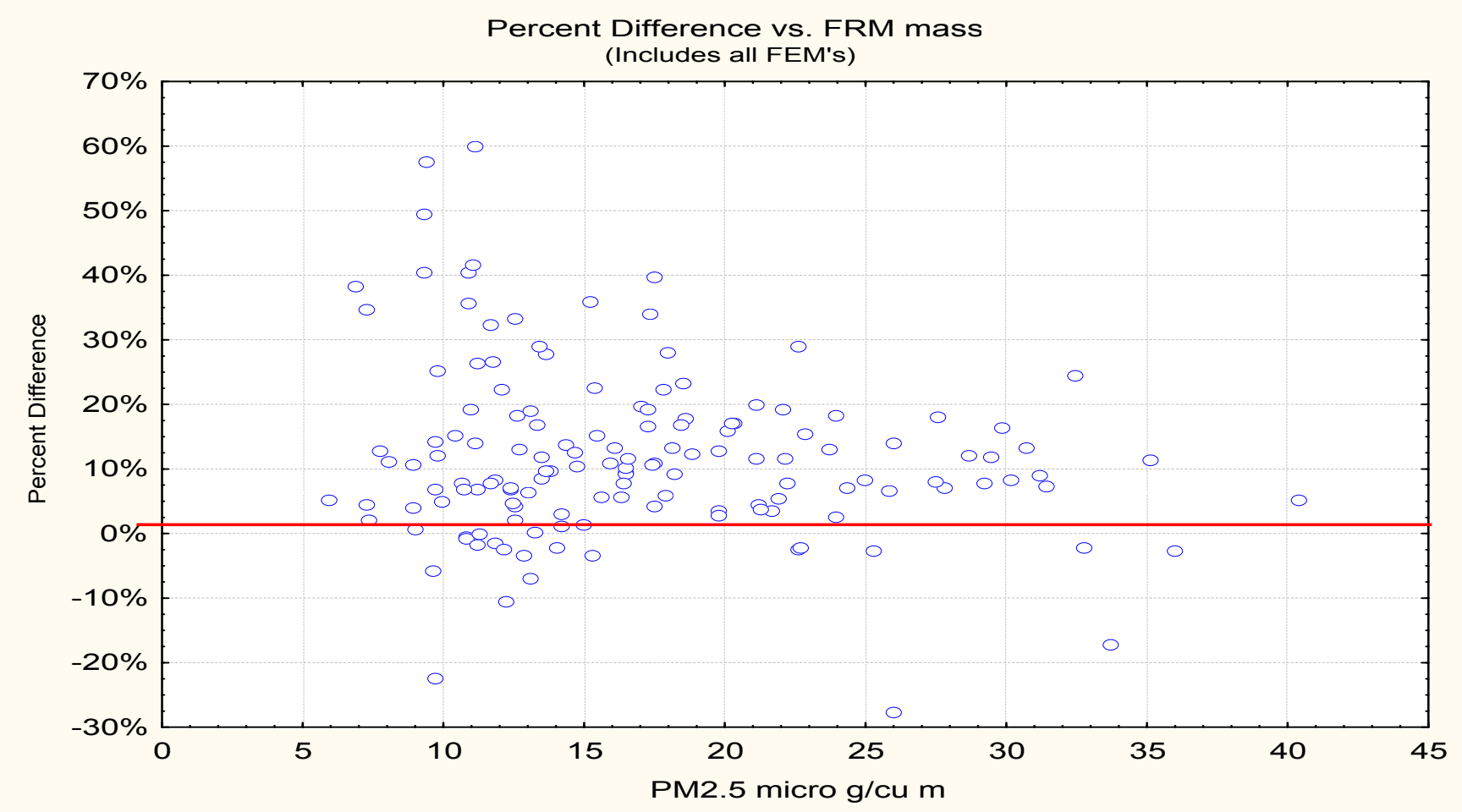
Measurement Challenges: Enclosure Temperature Stability

- The BAM-1020 should be in a stable temperature environment, to the extent possible.
- The exact temperature is not critical as long as it is fairly stable during the hour.
- Changes in air density between the source and detector may be measured as mass noise.

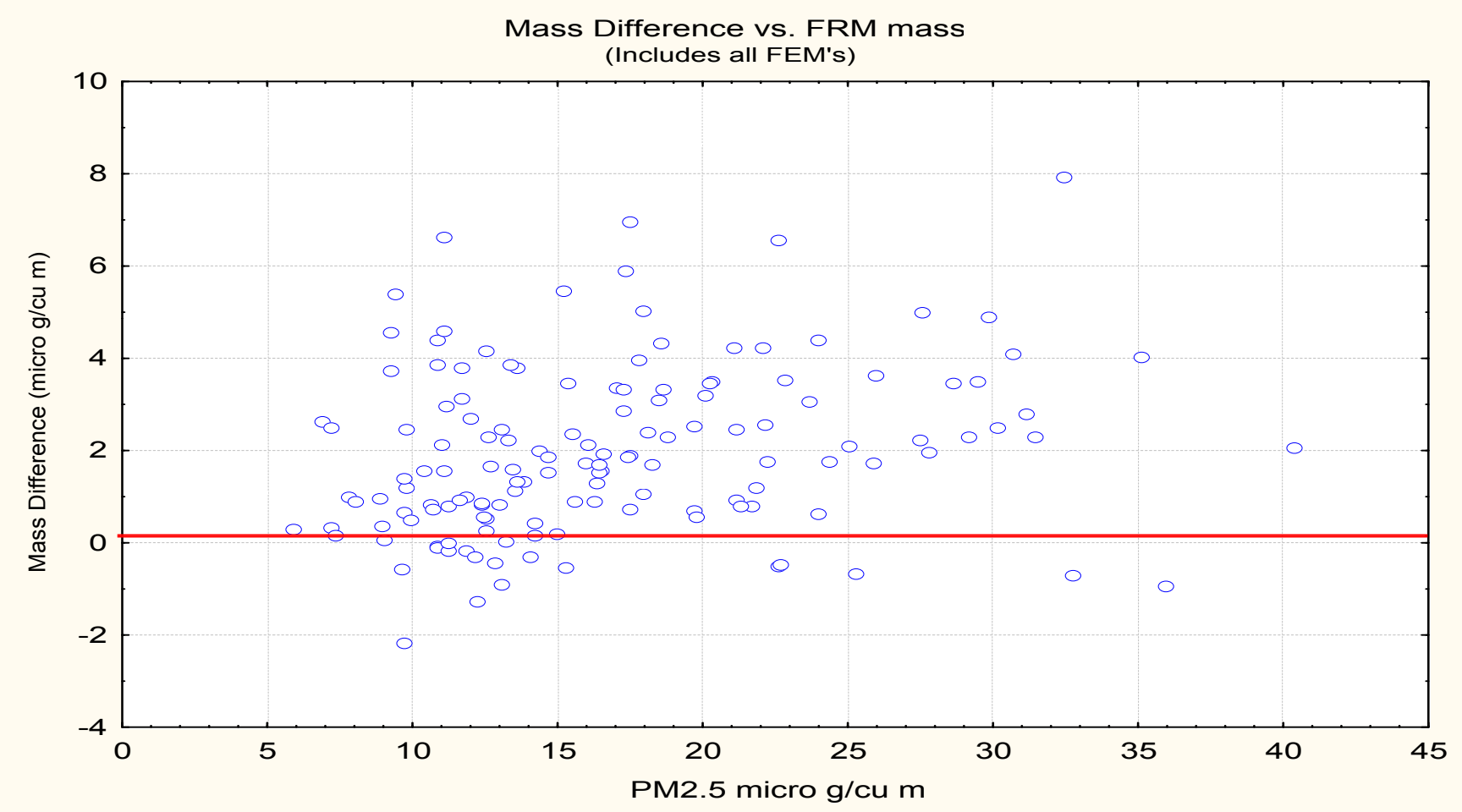
Electromagnetic Interference

- Sources of high RF energy may cause noise in the BAM-1020 if in close proximity. Examples: Radio towers or cell antennas in very close proximity.
- Sources of high EMI fields may cause noise in the system. Examples: Large AC motors, Medical imaging equipment.
- Static electricity (ESD) may cause measurement errors.
- Lightning strike on the inlet will damage the unit.
- Solutions: Proper site selection and grounding.

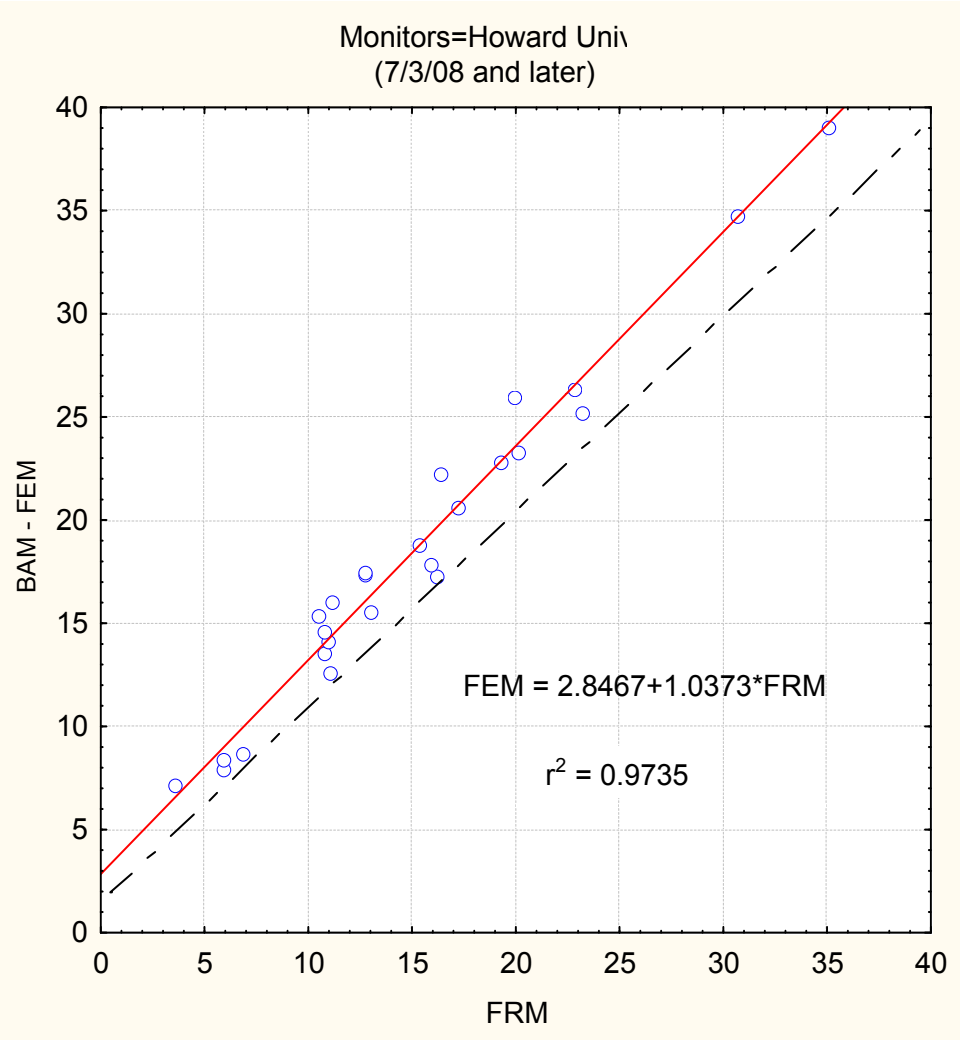
Percent Difference (All FEM's)



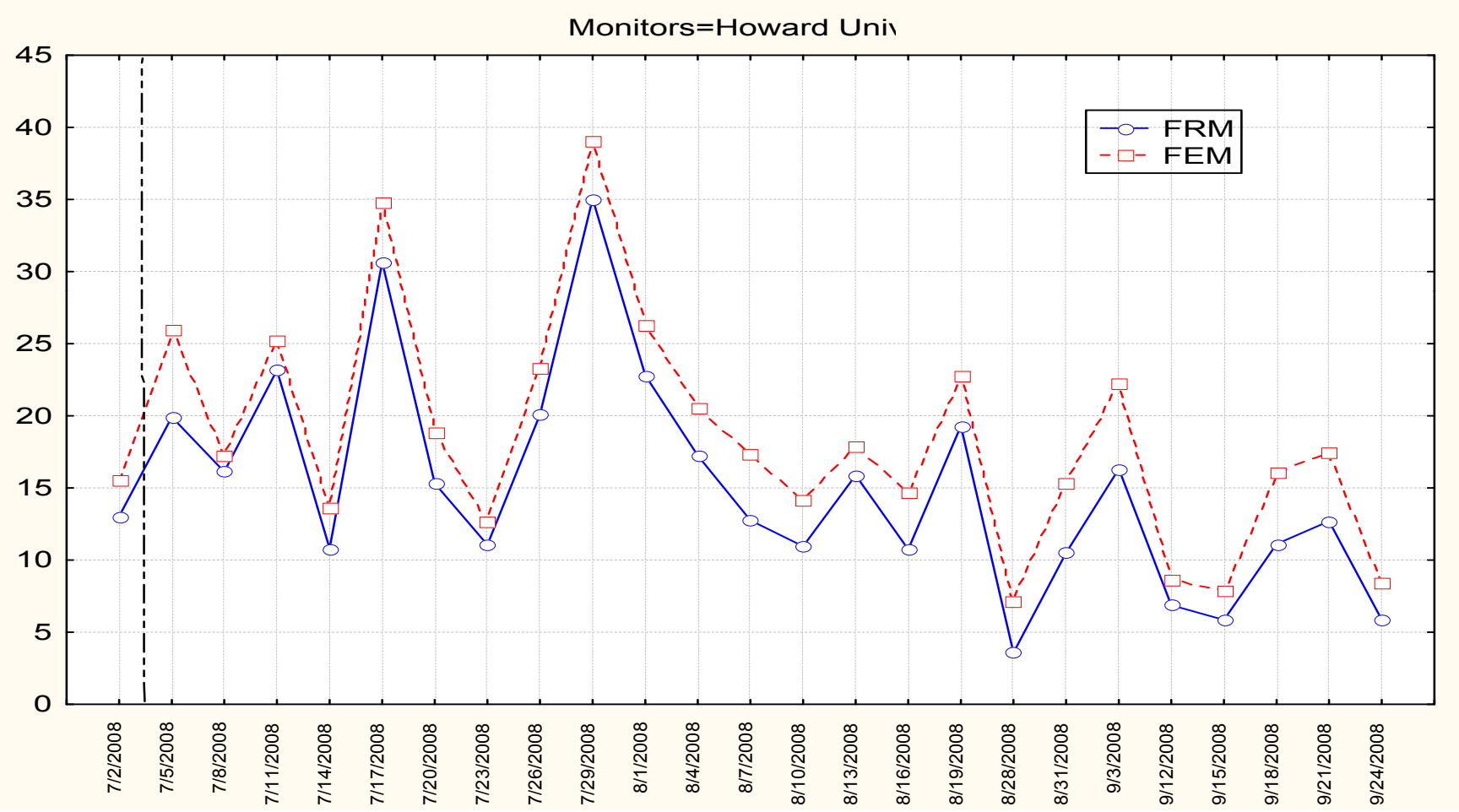
Mass Difference (All FEM's)



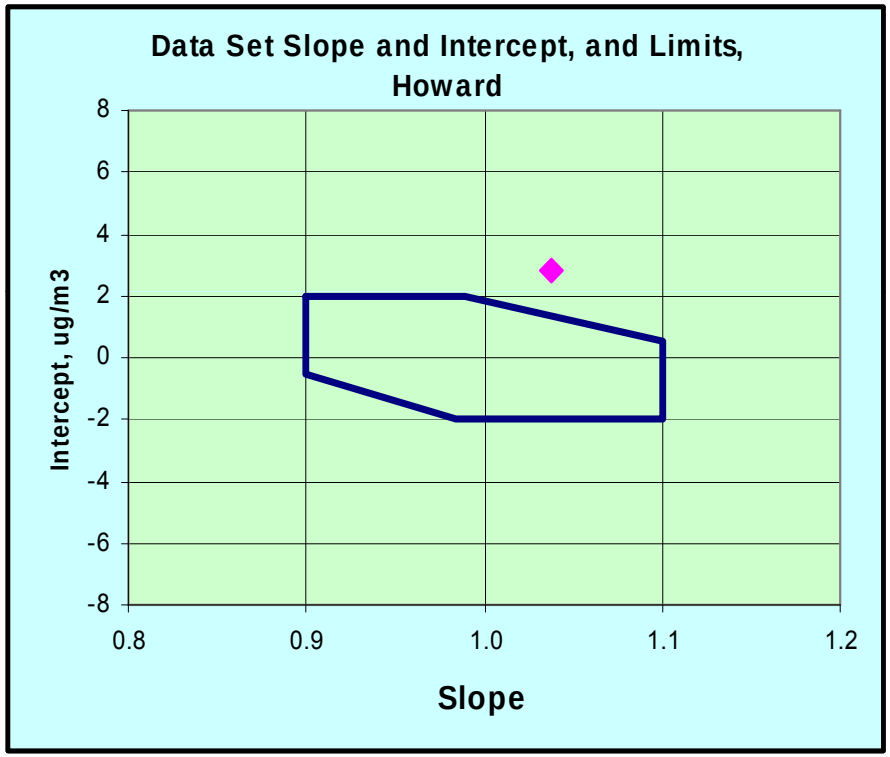
Scatter Plot: HU-Beltsville



Time-Series: HU-Beltsville

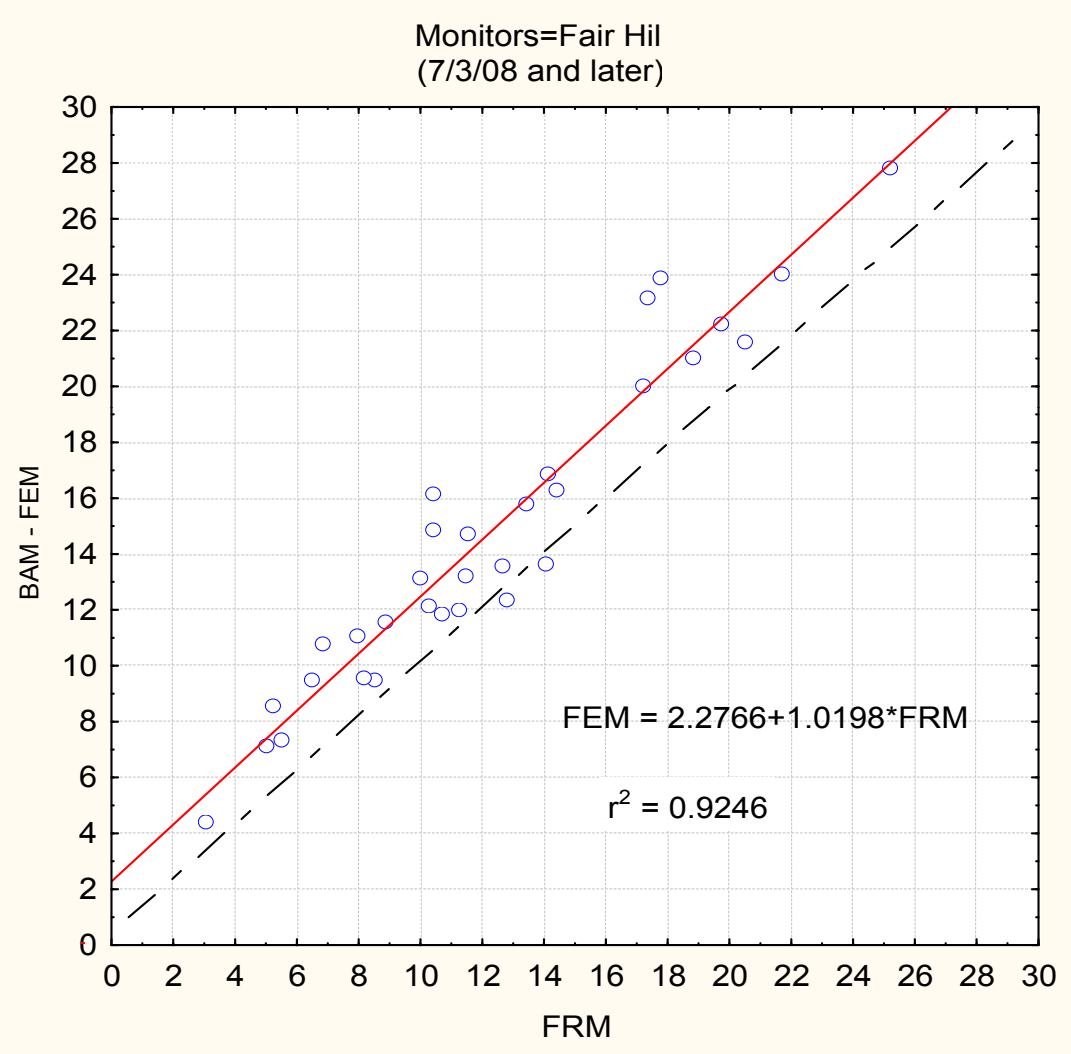


“Class III Equiv.” Test: HU-Beltsville

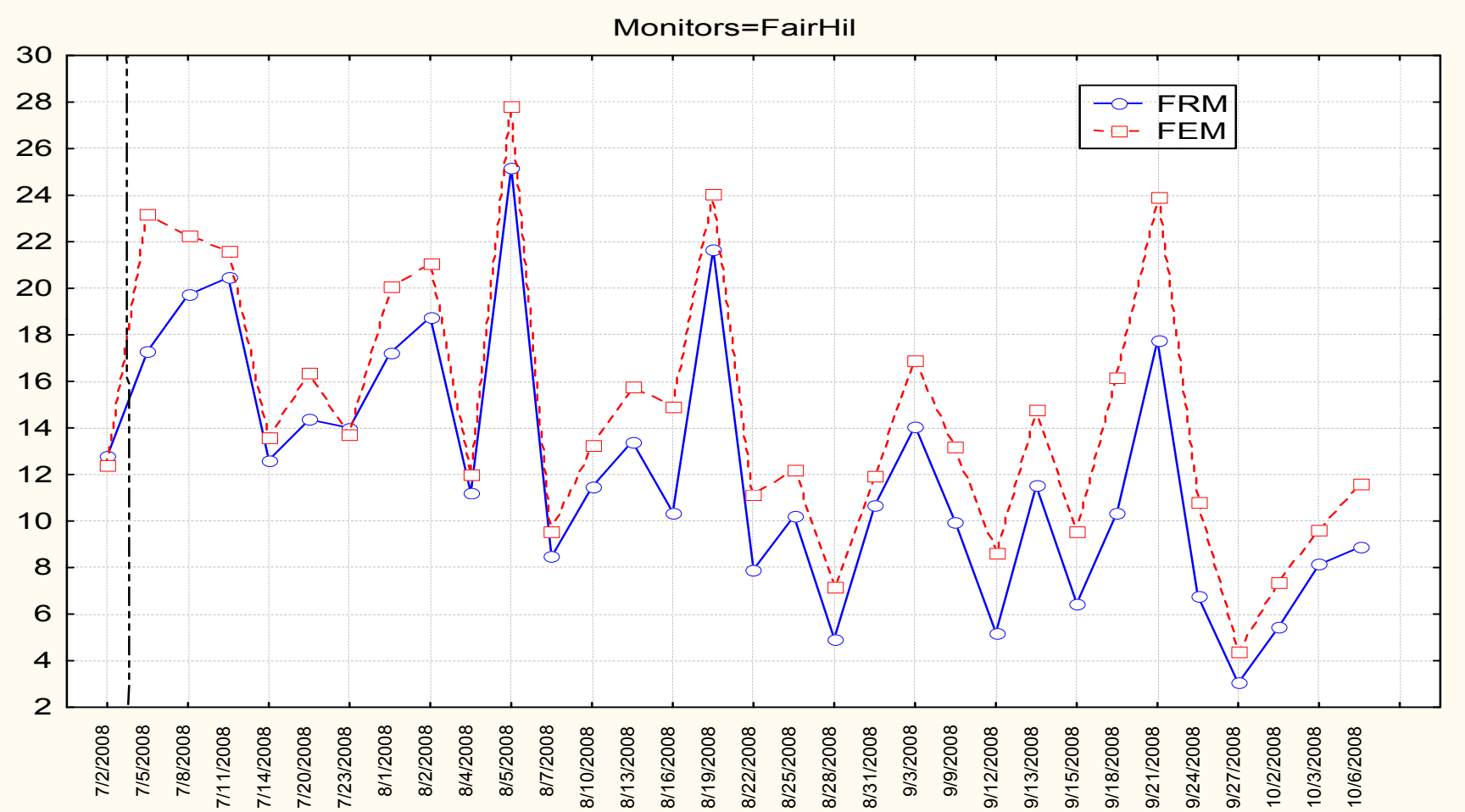


Regression statistics		Slope	Intercept	Correlation (r)
Test Statistics		1.037	2.847	0.97350
Limits for PM2.5 Class III	Upper:	1.100	1.358	
	Lower:	0.900	-2.000	0.94170
Test Results (Pass/Fail):		PASS	FAIL	PASS

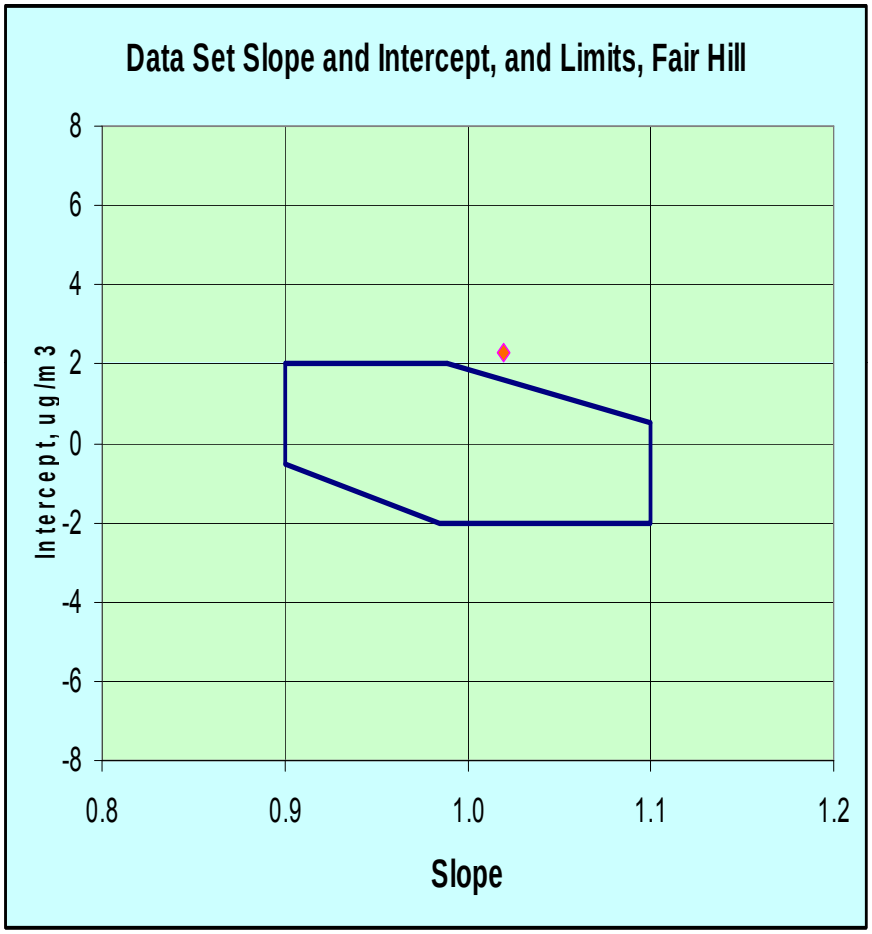
Scatter Plot: Fairhill



Time-Series: Fairhill

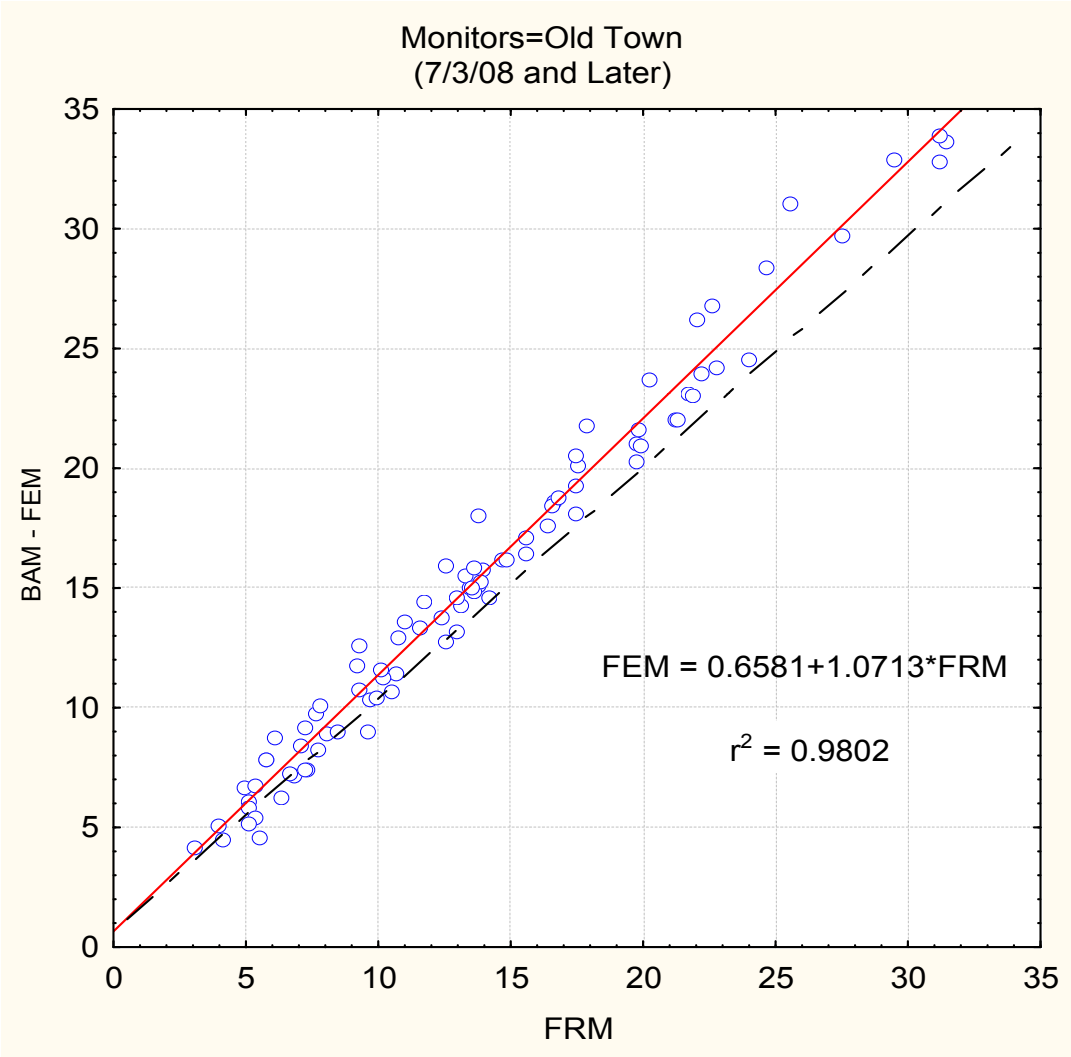


“Class III Equiv.” Test: Fairhill



Regression statistics		Slope	Intercept	Correlation (r)
Test Statistics		1.020	2.277	0.92460
Limits for PM2.5 Class III	Upper:	1.100	1.589	
	Lower:	0.900	-2.000	0.94170
Test Results (Pass/Fail):		PASS	FAIL	FAIL

Scatter Plot: Oldtown



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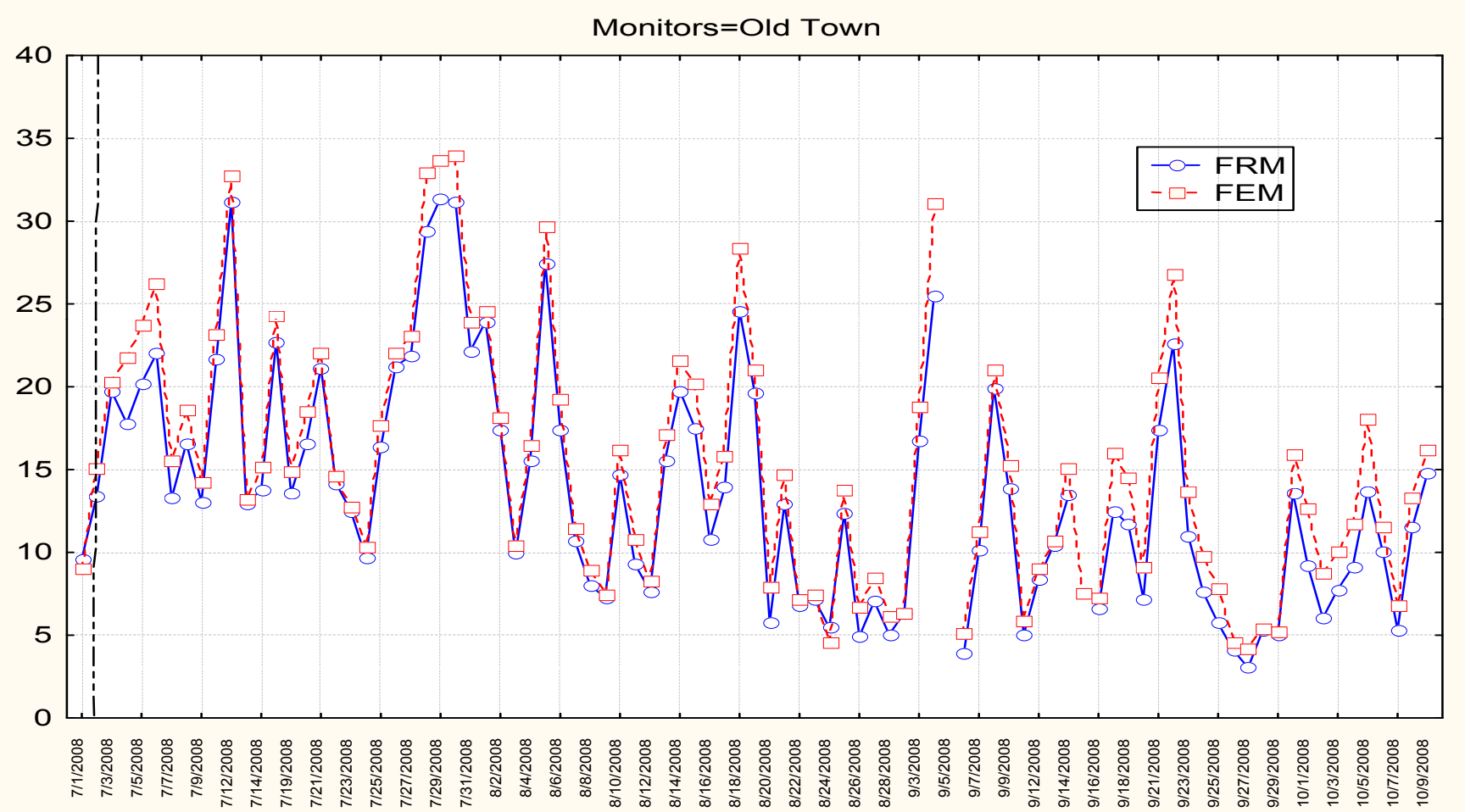

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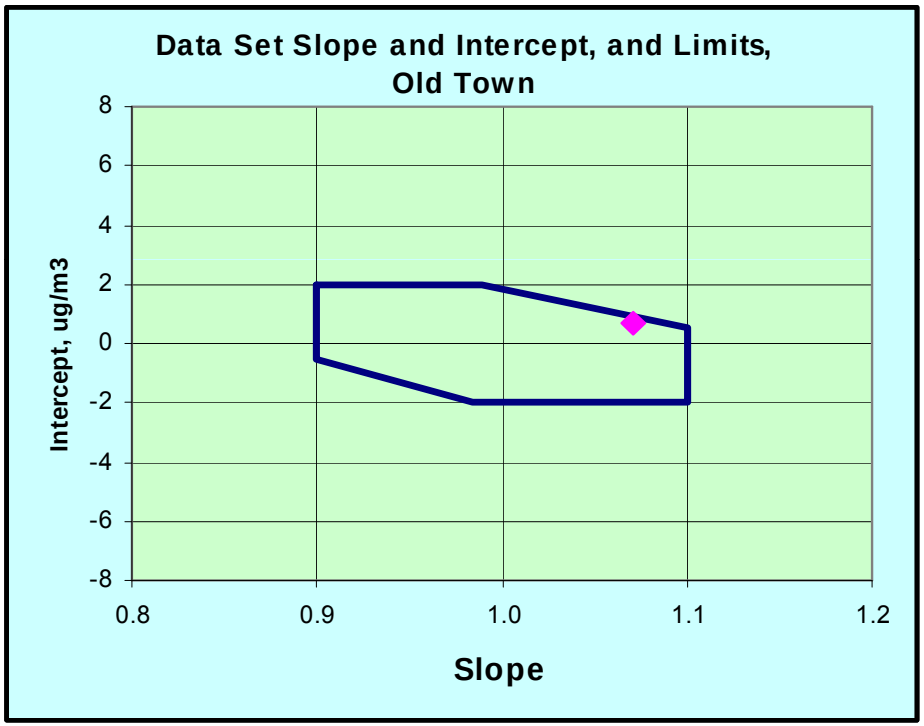
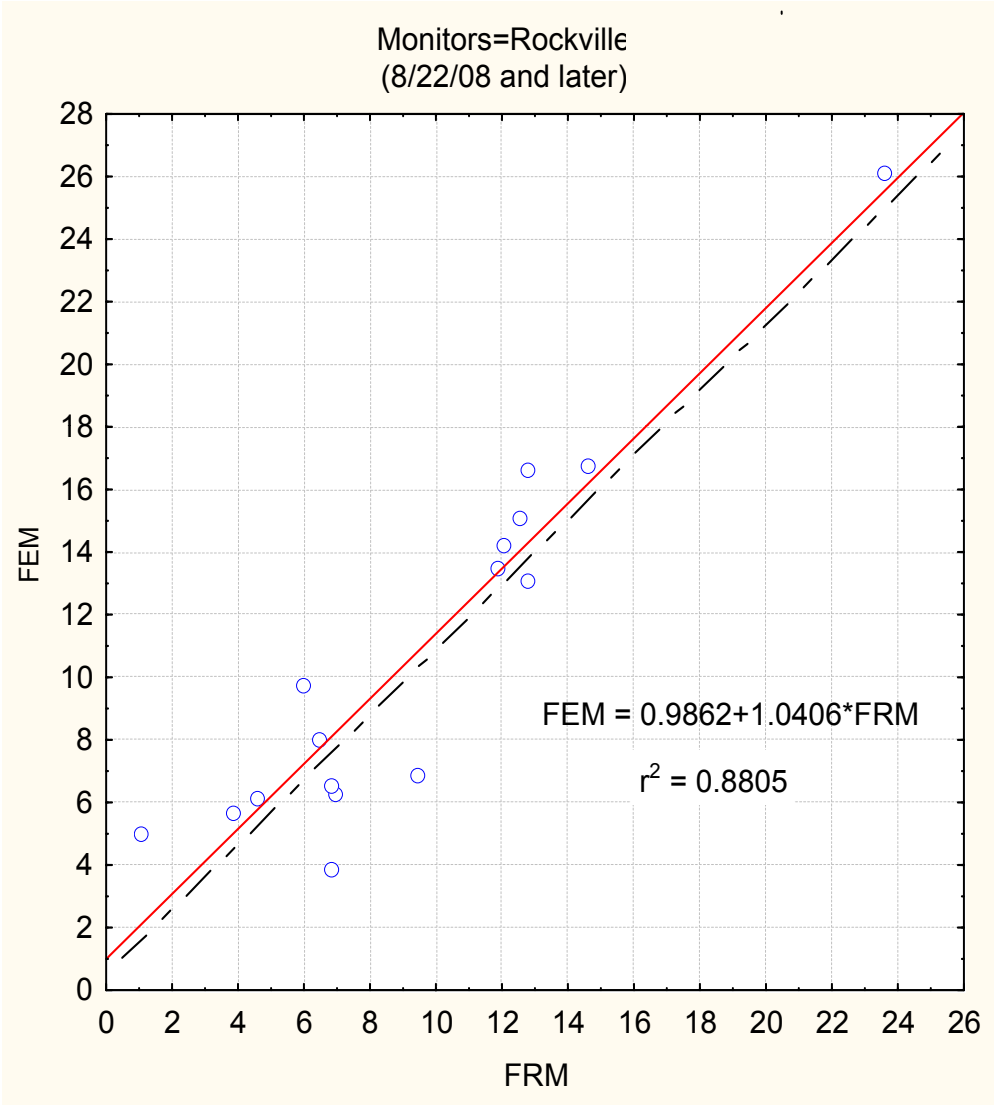


Regression statistics		Slope	Intercept	Correlation (r)
Test Statistics		1.071	0.658	0.98020
Limits for PM2.5 Class III	Upper:	1.100	0.913	
	Lower:	0.900	-2.000	0.94170
Test Results (Pass/Fail):		PASS	PASS	PASS

Scattered Plot: Rockville



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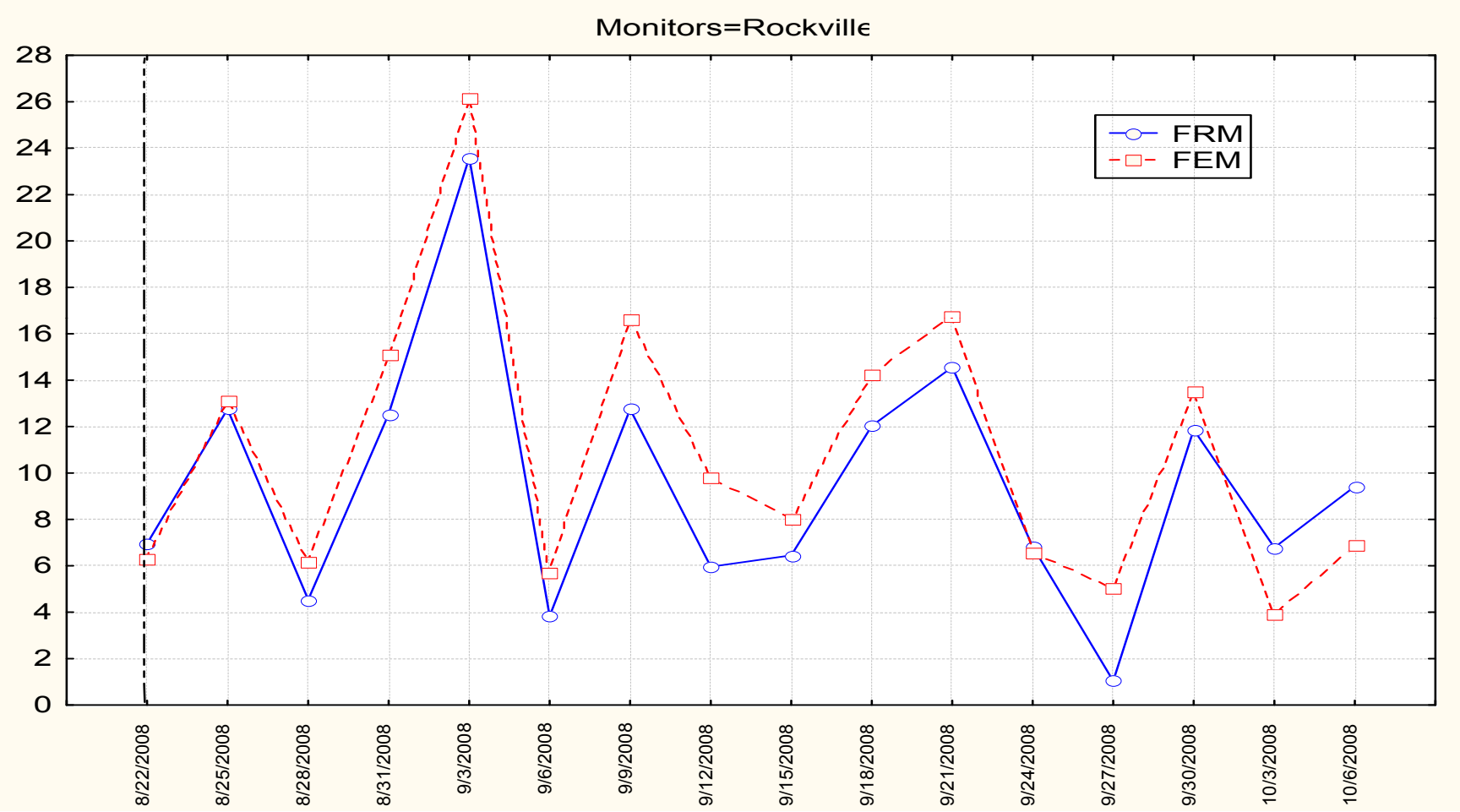
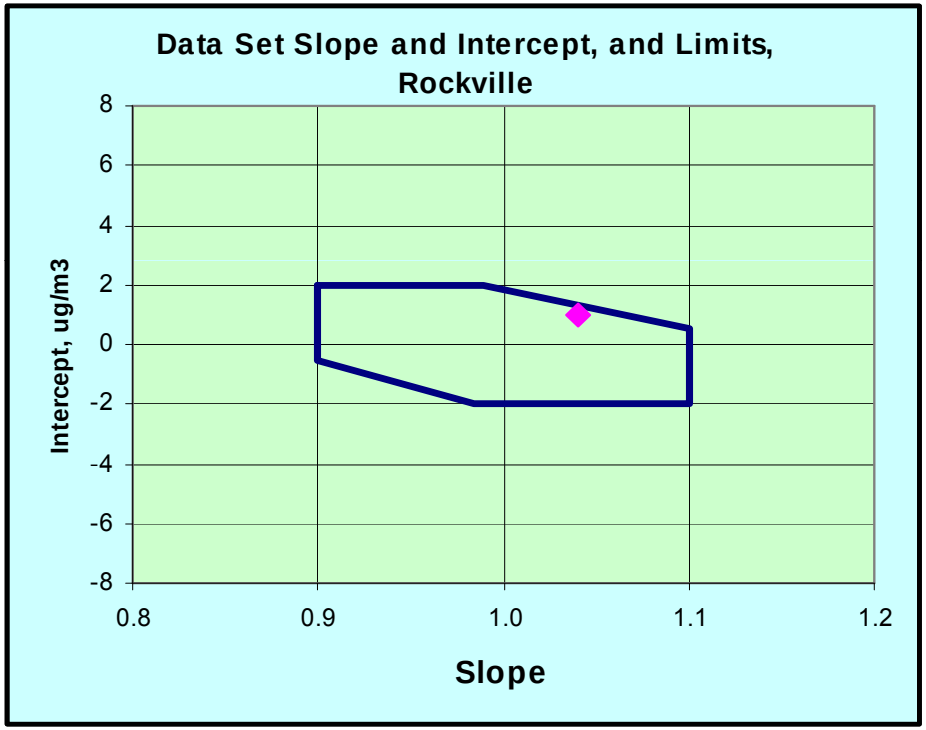


“Class III Equiv.” Test: Rockville



Regression statistics		Slope	Intercept	Correlation (r)
Test Statistics		1.040	0.986	0.88050
Limits for PM2.5 Class III	Upper:	1.100	1.322	
	Lower:	0.900	-2.000	0.94170
Test Results (Pass/Fail):		PASS	PASS	FAIL

Follow-up/Next Steps

- Dave Gobeli and Dennis Hart from MetOne visited MDE on 10/31/08 to evaluate our results and field procedures
- Field zero/background tests need to be repeated and new 2σ detection limit/zero offsets will be applied
- Re-evaluate field performance with new offsets vs. FRM's

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