



State of Oregon  
Department of  
Environmental  
Quality

# SALEM, OREGON PM<sub>2.5</sub> PARTICULATE SITE VALIDATION STUDY

**1999 - 2000**

Conducted By

The Oregon Department Of Environmental Quality

Laboratories And Applied Research Division

Air Quality Monitoring Section

Report By: Mark Hansen, Shanique Young, and Jeff Smith

November 11, 2000

**Review by:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Review by:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Review by:** \_\_\_\_\_

**Date:** \_\_\_\_\_

# WORK PLAN

## 1. PURPOSE:

This study is being conducted in conjunction with the establishment of a new Federal Reference Method (FRM) PM<sub>2.5</sub> particulate sampling site in Salem on the property of Salem General Hospital on Medical Center Dr. NE, off of D St. Data from this fine particulate study will help determine if the FRM PM<sub>2.5</sub> sampler is optimally placed to characterize neighborhood scale PM<sub>2.5</sub> levels in Salem. If the study validates the selection of the Salem General Hospital site PM<sub>2.5</sub> measurements from there will be used to determine if the Salem area air shed meets the new National Ambient Air Quality Standard (NAAQS) for PM<sub>2.5</sub> particulates.

## 2. HOW ACCOMPLISHED:

The study will begin in February, 1999 and continue for one year. The survey samplers have been successfully tested and their sampling precision and accuracy documented. Two types of PM<sub>2.5</sub> survey samplers are available for use in this study. Both samplers are low volume devices using an inertial greased impactor as the particulate size separation method. Both use the same 47 mm diameter Teflon filter. One is a battery powered sampler, the "Mini-Vol", operating at 5 lpm (liters per minute). The filter attaches to the top of the sampler by means of a special fitting. The other samplers uses a 110 VAC pump to pull 15 lpm of ambient air through the filter. The filter is "Quik" connected to a 2 meter piece of PVC pipe which is attached to the pump with tygon tubing. Both types of samplers have been used in many studies in the past and both have been recently re-tested at selected sites for their precision and accuracy. Test results are on file at the ODEQ laboratory. The battery powered 5 lpm "Mini-Vol" samplers will be used in the Salem survey, primarily due to noise concerns and limited access to power.

The samplers will run on the national EPA every 6<sup>th</sup> day schedule, the same as other particulate samplers located statewide. Sites will be serviced by the Portland DEQ Lab air monitoring staff as required. The filters will be returned to the Oregon DEQ laboratory for analysis and determination of their PM<sub>2.5</sub> mass loadings.

## 3. SITE SELECTION:

Survey sites have been located to the north, south, east and west of the FRM PM<sub>2.5</sub> benchmark sampler at the Salem Hospital site with surroundings approximately similar to the FRM site and to each other. Effort was made to select sites with no known major fine particulate point source nearby. The survey sites are all within 1-2 kilometers of the benchmark FRM site.

See the site photos and network map below for more information about the sites.

## Salem PM2.5 Survey Site Photos

**BENCHMARK SITE**  
Salem General Hospital  
755 Medical Center Dr. NE  
Lat./Long. 44° 56' 35.63" / 123° 0' 21.6"  
Site ID# 24-38-040  
Survey Site ID# 99-24-015



**NORTH**  
Salstrom Residence  
1990 24<sup>th</sup> St. NE  
Lat./Long. 44° 57' 14.23" / 123° 1' 39.26"  
Site ID# 99-24-009



**EAST**  
Holden Residence  
4485 Center St. NE  
Lat./Long. 44° 56' 24.4" / 122° 58' 27.05"  
Site ID# 99-24-010



**SOUTH**  
Endresen Residence  
2290 Electric St. NE  
Lat./Long. 44° 55' 11.36" / 123° 0' 53"  
Site ID# 99-24-011



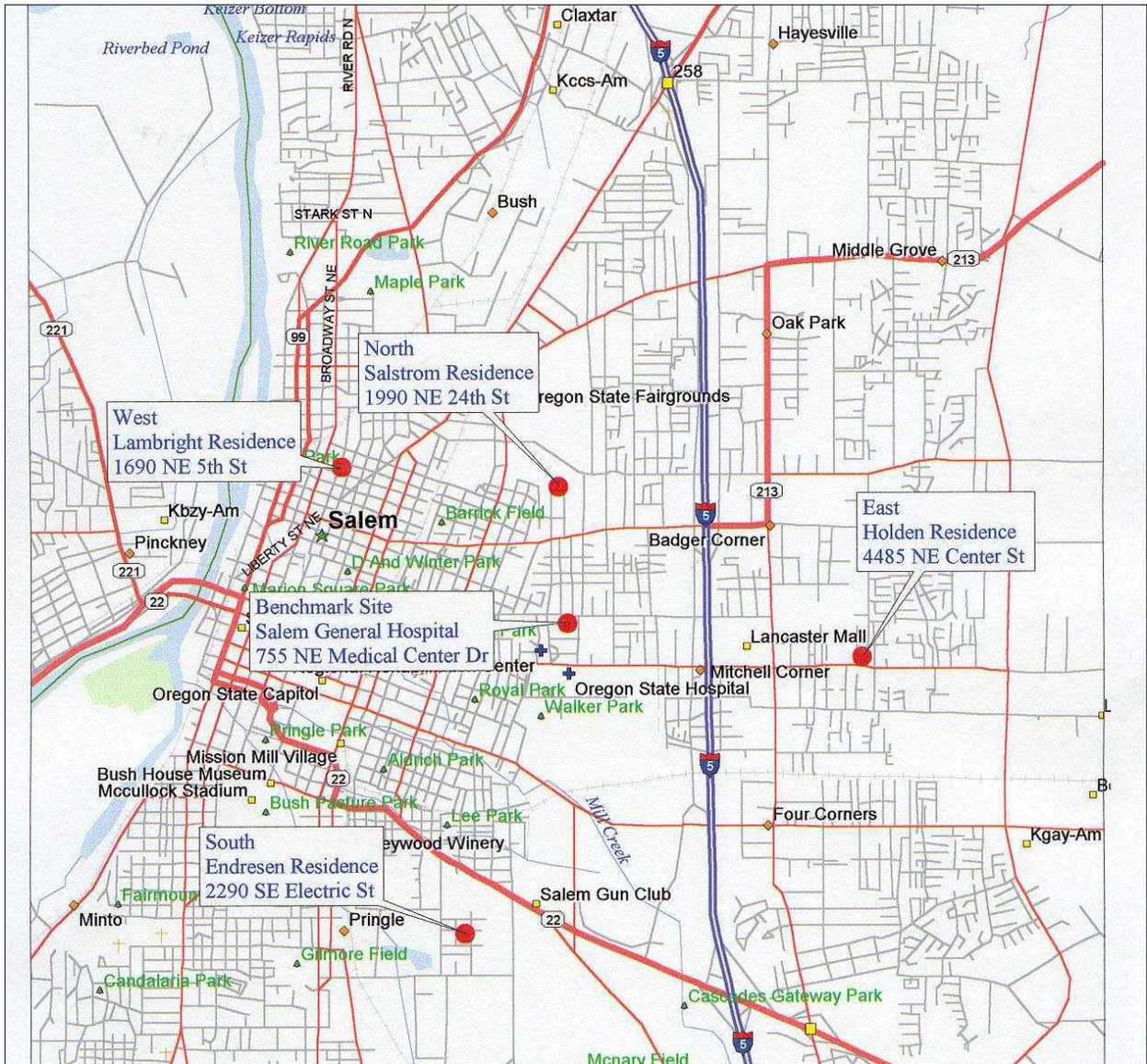
**WEST**  
Lambright Residence  
1690 5<sup>th</sup> St. NE  
Lat./Long. 44° 57' 16.86" / 123° 1' 39.28"  
Site ID# 99-24-012



# SALEM PM 2.5 SURVEY SITES MAP

Figure 1

↑ North



## 4. NETWORK QA/QC:

The Rupprecht & Patashnick (R&P) model 2025 sequential FRM PM<sub>2.5</sub> sampler is an EPA certified reference method sampler for the measurement of PM<sub>2.5</sub>. It is a proven and reliable method of measuring fine particulate and will be the benchmark device for this study. It is located at the Salem General Hospital benchmark site. Two PM<sub>2.5</sub> survey samplers will be co-located at the benchmark site where they will provide data to determine the precision and accuracy of the study results.

All of the survey samplers will be subjected to periodic independent flow audits performed by DEQ Lab staff during regularly scheduled (monthly) network reviews. The performance of the staff operators will also be reviewed during these visits.

The operators will maintain a journal of the project, noting significant events (equipment problems, unusual weather, etc.), and document the required cleaning and regreasing of the PM<sub>2.5</sub> impactor inlets.

Additional standard Quality Control activities will occur at the laboratory during the review of the samples, field data sheets, and analytical mass determination.

## **5. FUND CODE:**

This study is part of the calendar year 1999 work plan for the state wide PM<sub>2.5</sub> network. It is funded under an EPA 103 grant. The internal DEQ Lab fund code is 9811.

## **6. SUMMARY AND REPORT:**

A report detailing the results of this study will be generated at the end of the one year project. The report will include all of the sampling data from all 5 sites. The data from the co-located survey samplers (primary and duplicate) at the benchmark site will be analyzed to determine the precision of the survey samplers. The accuracy of the survey method will be determined by comparing the results of the co-located survey and FRM samplers. The results of the 4 survey sites will be compared to that of the benchmark site. A conclusion will be made as to the suitability of the current PM<sub>2.5</sub> siting in Salem.

## **7. PROJECT SCHEDULE:**

<b>Activity</b>	<b>Date</b>
Develop work plan.	October –November, 1998
Site search and procurement.	November-December,1998
Equipment preparation and testing.	December,1998-January, 1999
Begin sampling.	February, 1999
End sampling.	March, 2000
Final report.	August, 2000

# Project Implementation

## 1. NETWORK QA/QC:

All sampler and flow orifices used in the survey were calibrated at the ODEQ Lab using a National Institute of Standards and Technology (NIST) traceable roots meter.

Prior to startup of the actual survey, the 5 lpm inlets were tested as a group at a site in Portland. Three 24 hour samples were collected. This was to test each sampler's operation as well as to compare the performance of the PM<sub>2.5</sub> inlets used in the survey. Results of the group testing showed that the inlets compared favorably to one another although they tended to over-collect PM<sub>2.5</sub> as compared to the reference method sampler. The results of this test are on file at the ODEQ laboratory.

Network Quality Control (QC) audits were performed at network setup on 10-19-00, and again on 11-18-00. A final audit was performed at the conclusion of the survey on 2-23-00. A review of audit records indicated that all of the samplers operated within 10% of the ideal design flow (assuring a proper particulate size cut by the inlets) and that the operator's flow orifice used for the survey was well within 10% of the audit orifice values. Delays in the audit schedule were due to the need to develop and test an audit orifice for the "Mini-Vol" samplers. According to the operator's records all of the PM<sub>2.5</sub> impactor inlets were cleaned at their regularly scheduled (monthly) intervals throughout the duration of the survey.

The benchmark PM<sub>2.5</sub> FRM sampler was subject to regular monthly QC audits. All sensor and flow audits performed during the duration of the survey were within EPA established limits. Additional quarterly Quality Assurance (QA) audits of the PM<sub>2.5</sub> FRM sampler performed by the DEQ Laboratory QA section were all within EPA limits, confirming these results.

As a result of all of these efforts, we believe that the data quality objectives for this project were met and are confident in the quality of the data generated by this survey.

## 2. RESULTS:

Results of the Salem PM<sub>2.5</sub> survey are shown in the following tables and graphs. Table 1 contains all of the sampling data from the study. Table 2 is a summary of the data. Table 3 provides a list and explanation for all of the samples missed during the study.

The precision and accuracy (P&A) of the R&P PM<sub>2.5</sub> FRM sampler was not tested as part of this study. P&A data for this sampler is routinely developed at a number of regular PM<sub>2.5</sub> sampling sites across the state. This information is available from the DEQ Lab and from EPA.

Data on the precision of the survey samplers was generated by co-locating (primary and duplicate) samplers at the benchmark site. This data is displayed in Table 4 and its accompanying graph. The statistical correlation between the two is 0.9447. The corresponding R squared value is 0.8924. The average difference between the primary and duplicate samplers was 0.453 ug/m<sup>3</sup> with a maximum difference of 6.4 ug/m<sup>3</sup>. The standard deviation (sigma value) between the two is 1.907.

Survey sampler accuracy is represented by the average of the co-located survey samplers vs. the benchmark PM<sub>2.5</sub> FRM sampler. This data is displayed in Table 5 and its accompanying graph. The survey samplers tended to over collect particulate as compared to the benchmark FRM PM<sub>2.5</sub> sampler by a factor of about 10%. The correlation between these two is 0.8964 with a corresponding R squared value of 0.8036. The average difference between the FRM and the survey sampler average was 2.05 ug/m<sup>3</sup>, with a maximum difference of 7.6 ug/m<sup>3</sup>. The standard deviation (sigma value) between the two was 2.509 ug/m<sup>3</sup>.

All of the survey sites generated similar results. The data is displayed as graphs in Figures 2 - 4. Survey averages from the five sites ranged from 10.5 to 12.2 ug/m<sup>3</sup>, all below the annual PM<sub>2.5</sub> NAAQS of 15 ug/m<sup>3</sup>. Only 1.7 ug/m<sup>3</sup> separates the highest and lowest survey averages, which indicates a relatively homogenous mixture in the area surveyed. This difference is small, less than one sigma of the precision of the method. The East site generated the highest individual concentration (44.3 ug/m<sup>3</sup> on 11-2-99) as well as the highest survey average. This is approximately 2/3 of the NAAQS 24 hour standard of 65 ug/m<sup>3</sup>. The benchmark site at the Salem Hospital had the lowest average value and the lowest maximum value.

### **3. CONCLUSIONS:**

Results of the survey show that the PM<sub>2.5</sub> monitoring station at the Salem General Hospital site produced the lowest average and the lowest high value from the five sites in this survey. This location may not be ideally located to characterize neighborhood scale PM<sub>2.5</sub> levels in Salem. While the differences between the 5 sites is small the fact that the benchmark site had the lowest average value is significant. This may be due to the sampler placement on the hospital grounds. Although the hospital is surrounded by residential areas, the complex itself is quite large and our sampling site is located well back (at least 350 feet) from immediate residential impacts.

The “Mini-Vol” 5 lpm survey samplers appear to perform reasonably well for surveys of this nature. Although they compare adequately to one another, more variability was present in the accuracy and precision data as compared to results from the recent Beaverton survey which utilized ODEQ 15 lpm samplers. The conclusion here is that the increased variability in the data is attributable to the lower flow (and thus lower mass collected) used by the battery powered “Mini-Vol” samplers.

Weather conditions during the winter of this study tended to be warmer and wetter than average, and cooler and wetter than normal during the summer season. We would not characterize these weather conditions as average, and certainly not worse case. While never prudent to extrapolate one year of results over the 3 year PM<sub>2.5</sub> standard, from the data gathered during this study it appears unlikely that this portion of the Salem will exceed the PM<sub>2.5</sub> NAAQS.

### **4. RECOMMENDATIONS:**

It is recommended that further study is needed to verify whether or not the Salem General Hospital Site is ideally located to characterize neighborhood scale PM<sub>2.5</sub> levels. This could be accomplished by additional survey sampling to verify results under more normal weather conditions, perhaps utilizing the ODEQ 15 LPM samplers in place of the “Mini-Vol” samplers or the operation of a second PM<sub>2.5</sub> FRM site on the east side of town.

**Table 1. Salem PM2.5 Survey Results (all values in ug/m3)**

	NORTH (Salstrom)	EAST (Holden)	SOUTH (Endresen)	WEST (Lambright)	SGH (prim)	SGH (dupe)	Avg of P&D	SGH FRM
17-Feb-99	6.9	7.7	4.6	9.1				5.1
23-Feb		3.1	3.3	0.4	2.7		2.7	1.8
1-Mar	7.2	1.9	1.7	4.5	4.7		4.7	4.5
7-Mar	12.7	15.6		8.6	9.9		9.9	8.9
13-Mar	7.6	10.5	7.7	9.8	8.2	7.1	7.7	5.5
19-Mar	21.9	21.8	21.8	16.8	18.2	20.7	19.5	13.8
25-Mar	2.8	11.7	5.3	2.6	2.7	5.8	4.3	3
31-Mar	6.3	5.8	10.6	5.7	7.3	5.3	6.3	4.3
6-Apr	4.8	14	3.8	9.1	8.4	10.3	9.4	6.9
12-Apr	9.9	9.8	5.8	3	6.4	7.4	6.9	4.5
18-Apr	7.1	7.9	9.1	5.9	8.1	10.2	9.2	6.2
24-Apr	12.5	13.2	16.3	12.8	18.2	14.2	16.2	8.6
30-Apr	21.4	16	12.3	13	13.8	12.6	13.2	8.3
6-May	9.4	15.3	7.6	8.5	8.1	8.5	8.3	
12-May	4	5.7				10.7	10.7	2.7
18-May	3.6	9.7	4.9	9.1	4.7	2.6	3.7	3
24-May	10.8	11.2	14.7	10.2	10.1	12.3	11.2	6.5
30-May	15.4	10.7	11.1	11.7	9.1	9.8	9.5	6.4
5-Jun	9.5	7.3	11.4	7.8	9.9	9.5	9.7	2.7
11-Jun	12.9	10.9	11.1	11	11	9.8	10.2	6.5
17-Jun		7.9	9.2	7.3	8.2	6.6	7.4	5.2
23-Jun	5.6	9	4.3	6.3	5.3	5.0	5.2	4
29-Jun	6.9	8.6	8.4	9.1	7.7	5.9	6.8	4.3
5-Jul	16	12.2	16.2	13	13.5	15.2	14.4	7.9
14-Jul		6.6	7.8	6.5	6.7		6.7	3.5
17-Jul	8.2	10.5	9.3	10	8.2	8.9	8.6	4.9
23-Jul	5	5	4.8	3.2	4.8	5.6	5.2	3.1
29-Jul	6.7	6.6	12.1	6.1	5.4	3.2	4.3	5.4
4-Aug	7	8.8	1	7.3	6.6	3.2	4.9	4.1
10-Aug		12.3	14.7	14.5		10.3	10.3	7.3
16-Aug		6.4	16.7	10.3	9.7	3.3	6.5	
22-Aug	17.6	13.3		11.4	14.3	12.8	13.6	7.4
28-Aug	11.7	9.7	11.1	8.8		10.6	10.6	9
3-Sep	28.8	16.8	15.3	12.5	12.0	12.8	12.4	
9-Sep		12.5	15	13.1	10.2	8.9	9.6	6.2
15-Sep	22	21.3	23.8	16.5	21.0	22.2	21.6	14
21-Sep	16.6	17.9		15.8	19.1	18.7	18.9	13
27-Sep	10.4	9.9	13	37.1	11.7	12.0	11.9	7.2
3-Oct	15.7	3.3	18	18.7		24.4	24.4	
9-Oct	8.2	8.4	11.3	6.6	6.9	8.5	7.7	8.1
15-Oct	14.4	18.7	16.9	12.3	15.6	13.1	14.4	10
21-Oct	24.7	27.8	29.3	21.9	23.6	24.7	24.2	19.6
27-Oct	15	14.8	14	15	15.1	14.0	14.6	14.7
2-Nov	29.7	44.3	30.9	25.8	20.6	23.5	22.1	21.4
8-Nov	27	22.2	18.7	12.5		15.5	15.5	15.2
14-Nov	11.7	12.5	39.7	10.2	11.4	10.8	11.1	12
20-Nov	4.9	5.1	1.5	5.1	8.6	4.7	6.7	3.1
26-Nov	8.8	6.1	5.6	1.6	5.4	6.2	5.8	5
2-Dec	3.1	2.6	3.2	2.9	2.0	2.4	2.2	2.2
8-Dec	7.3	6.7	7.6	5.8	6.7	4.5	5.6	6.1
14-Dec	5.6	6.1	4.7	3.4	3.8	4.5	4.2	2.3
20-Dec	20	23.6		25.3	20.4	18.9	19.7	21.9
26-Dec	8.1	14.3	8.4	10.6	9.6	8.2	8.9	9.2
1-Jan	6.6	10.5	5.5	6	7.3	6.8	7.1	4.1
7-Jan	4.2	6	6.5	6.6	3.6		3.6	3.3
13-Jan	6	8	6.6	5.9	5.4	5.1	5.3	5.2
19-Jan	22.8	34	24	22	24.2	20.8	22.5	22.8
25-Jan	20	15.3	10.5	9.4	9.5	9.1	9.3	9.2
31-Jan	8.1	12.9		12.6	11.6	10.4	11.0	13.2
6-Feb	13.6	15.5	14.6	15.7	15.9	16.1	16.0	18.3
12-Feb	10.5	14.1		9.7	7.8	6.7	7.3	7.3
18-Feb	18.3	20.3	23.8	23.6	18.8	19.2	19.0	20.4
Average	11.8	12.2	11.8	10.8	10.3	10.7	10.5	8.1

**Table 2. Summary of Results**

Site	# samples (62 possible)	Average ug/m3	Highest ug/m3	Days > 15 ug/m3
North	56	11.8	29.7	16
East	62	12.2	44.3	16
South	55	11.8	39.7	14
West	61	10.8	37.1	11
SGH-primary	56	10.3	24.2	12
SGH-dupe	56	10.7	24.4	12
Avg of P&D	60	10.5	24.2	11
SGHosp. FRM	58	8.1	22.8	7

**Table 3. Explanations of Missing Samples**

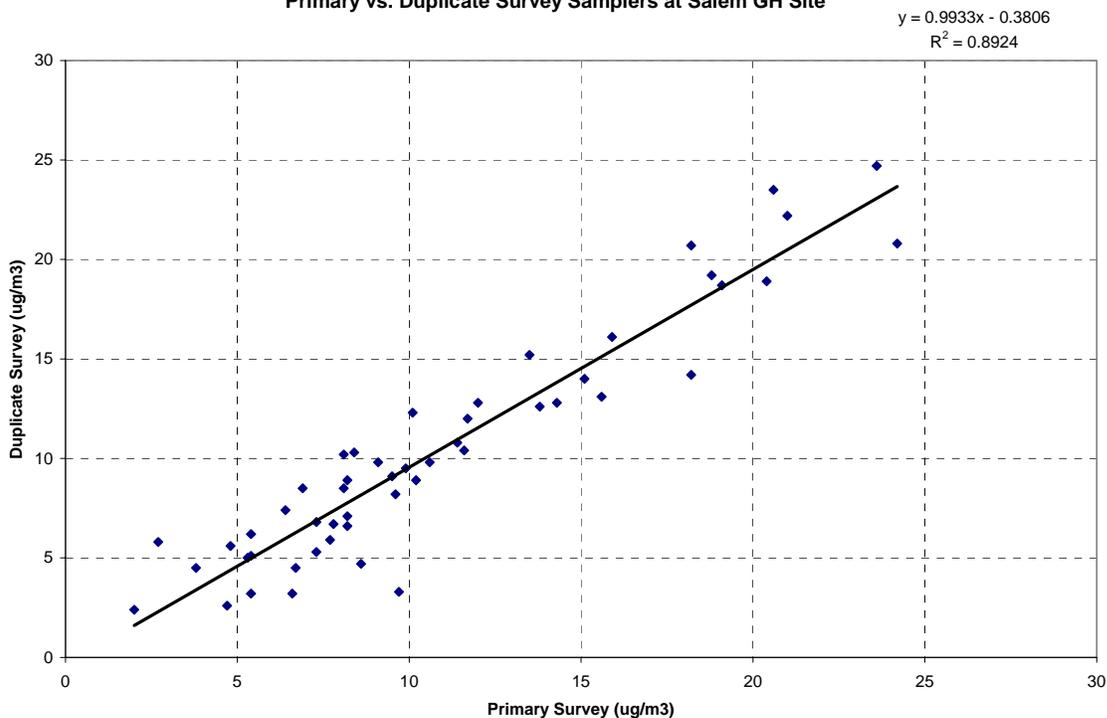
<b>North - Salstrom</b>	<b>EAST -Endresen</b>	<b>SGH FRM</b>
23-Feb Did not run	7-Mar Ran Short	6-May power failure
17-Jun Tare Weight Problem	12-May Inst. Malfunction	16-Aug Ran short
14-Jul Did not run	22-Aug Ran Short	3-Sep operator error
10-Aug Inst. Malfunction	21-Sep Ran long	3-Oct Inst. Malfunction
16-Aug Inst. Malfunction	20-Dec Did not run	
9-Sep Did not run	31-Jan Program error	<b>SGH (pri)</b>
25-Jan Ran short -battery	12-Feb Did not run	17-Feb Equip. damage
31-Jan Low battery		12-May Inst. Malfunction
		10-Aug Inst. Malfunction
		28-Aug Filter damaged
		3-Oct Equip. damage
		8-Nov Ran short
		<b>SGH (dup)</b>
		17-Feb Equip. damage
		23-Feb Equip. damage
		1-Mar Did not run
		7-Mar Did not run
		14-Jul Did not run
		7-Jan Filter damaged
<b>West - Lambright</b>		
12-May Inst. Malfunction		

**Table 4. Precision Data: Co-located survey samplers at the Benchmark Site.**

All values in ug/m3.

Date	Pri	Dup	Pri-Dup	Date	Pri	Dup	Pri-Dup
13-Mar-99	8.2	7.1	1.1	21-Sep-99	19.1	18.7	0.4
19-Mar-99	18.2	20.7	-2.5	27-Sep-99	11.7	12	-0.3
25-Mar-99	2.7	5.8	-3.1	9-Oct-99	6.9	8.5	-1.6
31-Mar-99	7.3	5.3	2	15-Oct-99	15.6	13.1	2.5
6-Apr-99	8.4	10.3	-1.9	21-Oct-99	23.6	24.7	-1.1
12-Apr-99	6.4	7.4	-1	27-Oct-99	15.1	14	1.1
18-Apr-99	8.1	10.2	-2.1	2-Nov-99	20.6	23.5	-2.9
24-Apr-99	18.2	14.2	4	14-Nov-99	11.4	10.8	0.6
30-Apr-99	13.8	12.6	1.2	20-Nov-99	8.6	4.7	3.9
6-May-99	8.1	8.5	-0.4	26-Nov-99	5.4	6.2	-0.8
18-May-99	4.7	2.6	2.1	2-Dec-99	2	2.4	-0.4
24-May-99	10.1	12.3	-2.2	8-Dec-99	6.7	4.5	2.2
30-May-99	9.1	9.8	-0.7	14-Dec-99	3.8	4.5	-0.7
5-Jun-99	9.9	9.5	0.4	20-Dec-99	20.4	18.9	1.5
11-Jun-99	10.6	9.8	0.8	26-Dec-99	9.6	8.2	1.4
17-Jun-99	8.2	6.6	1.6	1-Jan-00	7.3	6.8	0.5
23-Jun-99	5.3	5	0.3	13-Jan-00	5.4	5.1	0.3
29-Jun-99	7.7	5.9	1.8	19-Jan-00	24.2	20.8	3.4
5-Jul-99	13.5	15.2	-1.7	25-Jan-00	9.5	9.1	0.4
17-Jul-99	8.2	8.9	-0.7	31-Jan-00	11.6	10.4	1.2
23-Jul-99	4.8	5.6	-0.8	6-Feb-00	15.9	16.1	-0.2
29-Jul-99	5.4	3.2	2.2	12-Feb-00	7.8	6.7	1.1
4-Aug-99	6.6	3.2	3.4	18-Feb-00	18.8	19.2	-0.4
16-Aug-99	9.7	3.3	6.4	Survey Ave	10.8	10.4	0.453
22-Aug-99	14.3	12.8	1.5	Count			51
3-Sep-99	12	12.8	-0.8	Maximum			6.4
9-Sep-99	10.2	8.9	1.3	Sigma			1.89
15-Sep-99	21	22.2	-1.2				

**Primary vs. Duplicate Survey Samplers at Salem GH Site**



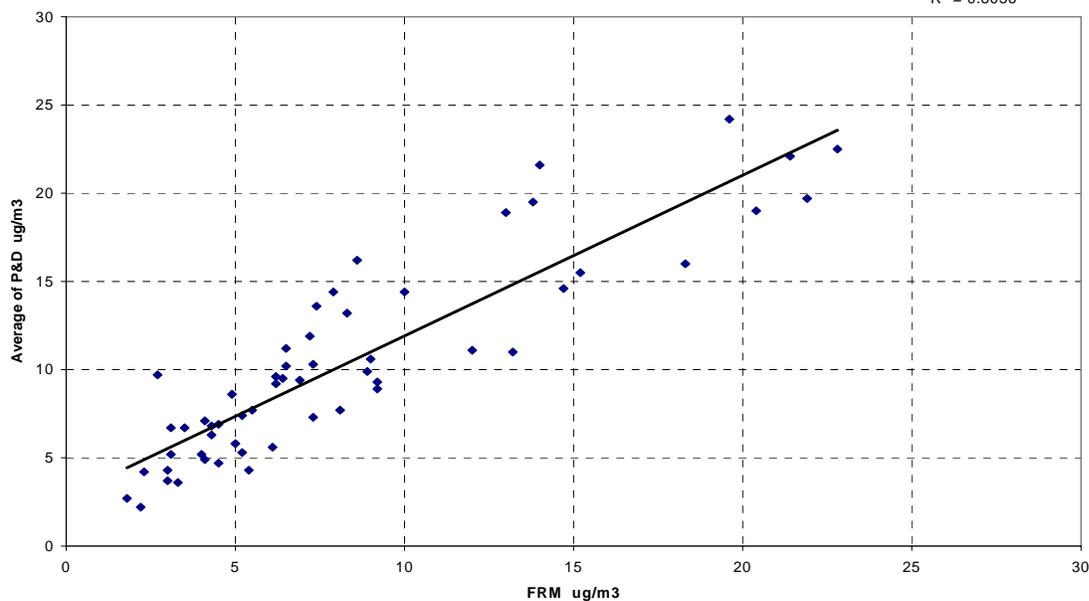
**Table 5. Accuracy Data: FRM versus Survey at Benchmark Site (SGH).**

Date	SGH FRM	Avg of P&D	FRM - P&D
23-Feb	1.8	2.7	-0.9
1-Mar	4.5	4.7	-0.2
7-Mar	8.9	9.9	-1.0
13-Mar	5.5	7.7	-2.2
19-Mar	13.8	19.5	-5.7
25-Mar	3.0	4.3	-1.3
31-Mar	4.3	6.3	-2.0
6-Apr	6.9	9.4	-2.5
12-Apr	4.5	6.9	-2.4
18-Apr	6.2	9.2	-3.0
24-Apr	8.6	16.2	-7.6
30-Apr	8.3	13.2	-4.9
18-May	3.0	3.7	-0.7
24-May	6.5	11.2	-4.7
30-May	6.4	9.5	-3.1
5-Jun	2.7	9.7	-7.0
11-Jun	6.5	10.2	-3.7
17-Jun	5.2	7.4	-2.2
23-Jun	4.0	5.2	-1.2
29-Jun	4.3	6.8	-2.5
5-Jul	7.9	14.4	-6.5
14-Jul	3.5	6.7	-3.2
17-Jul	4.9	8.6	-3.7
23-Jul	3.1	5.2	-2.1
29-Jul	5.4	4.3	1.1
4-Aug	4.1	4.9	-0.8
10-Aug	7.3	10.3	-3.0
22-Aug	7.4	13.6	-6.2
28-Aug	9.0	10.6	-1.6
9-Sep	6.2	9.6	-3.4
15-Sep	14.0	21.6	-7.6

Date	SGH FRM	Avg of P&D	FRM - P&D
21-Sep	13.0	18.9	-5.9
27-Sep	7.2	11.9	-4.7
9-Oct	8.1	7.7	0.4
15-Oct	10.0	14.4	-4.4
21-Oct	19.6	24.2	-4.6
27-Oct	14.7	14.6	0.1
2-Nov	21.4	22.1	-0.7
8-Nov	15.2	15.5	-0.3
14-Nov	12.0	11.1	0.9
20-Nov	3.1	6.7	-3.6
26-Nov	5.0	5.8	-0.8
2-Dec	2.2	2.2	0.0
8-Dec	6.1	5.6	0.5
14-Dec	2.3	4.2	-1.9
20-Dec	21.9	19.7	2.3
26-Dec	9.2	8.9	0.3
1-Jan	4.1	7.1	-3.0
7-Jan	3.3	3.6	-0.3
13-Jan	5.2	5.3	0.0
19-Jan	22.8	22.5	0.3
25-Jan	9.2	9.3	-0.1
31-Jan	13.2	11.0	2.2
6-Feb	18.3	16.0	2.3
12-Feb	7.3	7.3	0.0
18-Feb	20.4	19.0	1.4
Average	8.3	10.3	-2.04
		count	56
		sigma	2.50
		max difference	-7.6

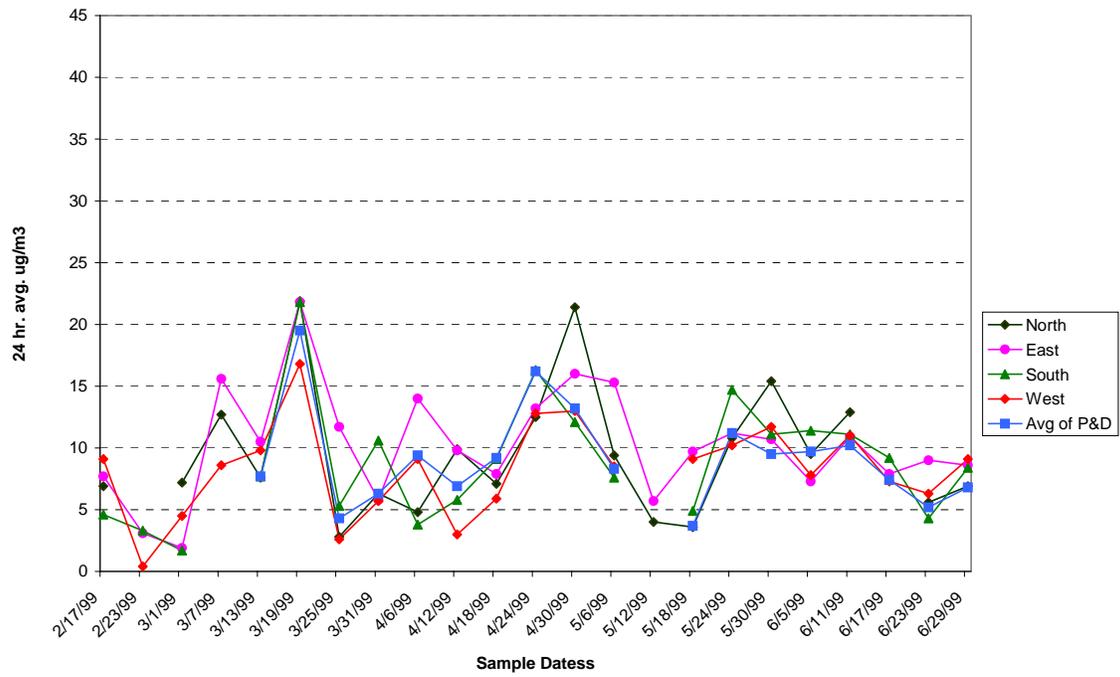
**FRM vs Average of Co-located Survey Samplers (Pri & Dupe) at SGH**

$y = 0.9109x + 2.7998$   
 $R^2 = 0.8036$

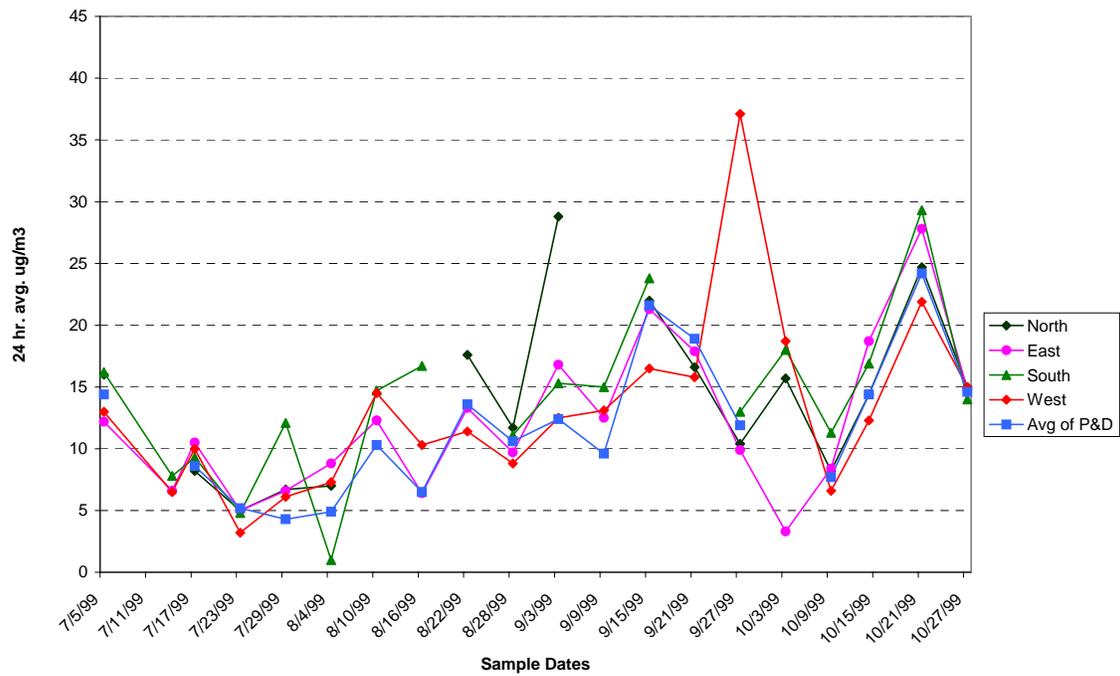


Figures 2 -4.

Salem PM2.5 Survey Comparison



Salem PM2.5 Survey Comparison



Salem PM2.5 Survey Comparison

