



## Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor  
2019 – 3<sup>rd</sup> Quarter*



## **Introduction and Sensor Profile**

This analysis report is focused on assessing the performance of the PurpleAir PA-II sensor as a part of the District's Technical Evaluation of Sensor Technology (TEST) Program. The PurpleAir PA-II sensor uses an optical laser-based particle counting methodology to estimate the mass of varying diameters of particulate matter, including PM1, PM2.5, and PM10. The PA-II sensor also measures temperature, pressure, and relative humidity.

## **Background and Approach of Evaluation Test**

In November of 2017, NASA began an air quality study to compare the performance of PurpleAir sensors to regulatory PM2.5 monitors. The study is focused on the conditions in the San Joaquin Valley and is based at California Air Resources Board (CARB) air monitoring sites of Fresno-Garland, Visalia-Church, Modesto-14<sup>th</sup> St, and Bakersfield-California. In 2019, the District began operating PurpleAir sensors at the District's Clovis-Villa air monitoring site and in the Shafter and South Central Fresno AB 617 communities.

The data sets analyzed for this report compare PM2.5 data collected from PurpleAir sensors and Federal Equivalent Method (FEM) monitors that are collocated at the CARB and District air monitoring sites listed above. The scatter plots and time series graphs below show how the datasets compare for both hourly values and the 24-hour average.

## **Overview of Analysis Findings from Current Period**

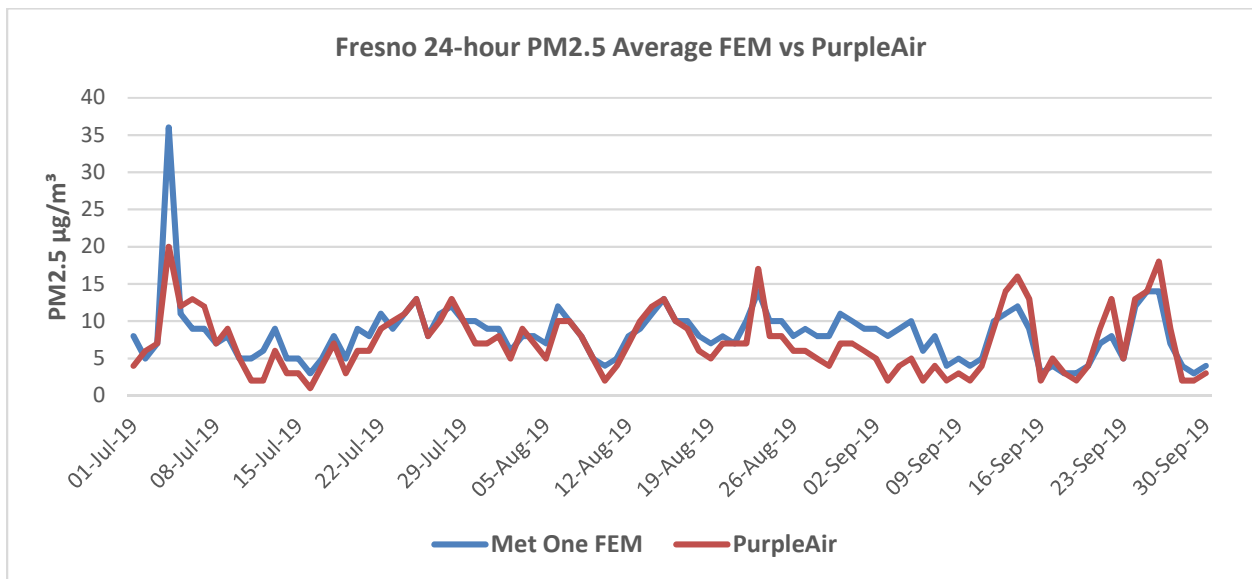
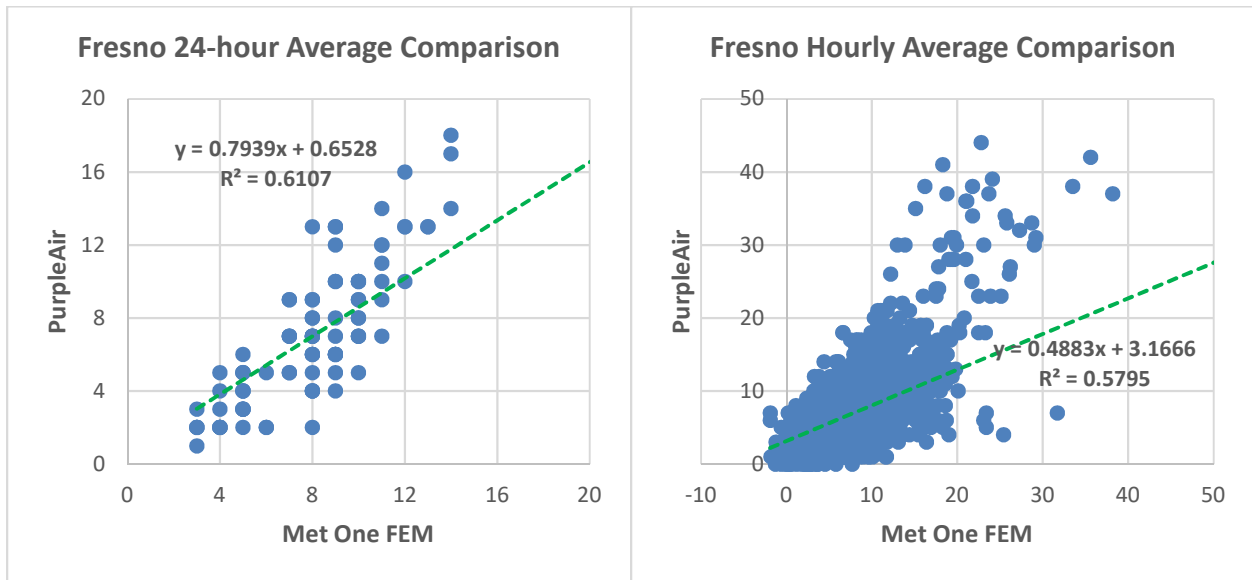
This assessment compares the Purple Air PA-II sensor performance against the Met One 1020 (Fresno-Garland, Visalia-Church, Modesto-14<sup>th</sup>, Bakersfield-California, and Clovis-Villa) and the Met One 1022 (Shafter and South Central Fresno) near-continuous particulate monitors. The analysis for this report covers the time period of July 2019 through September 2019 (2019 – 3<sup>rd</sup> quarter). During this this period, hourly data was removed from the calculation of bias and average concentrations when either the Purple Air sensor or regulatory monitor did not have a valid sample. For the 24-hour average line graphs, all available data is shown for each collocated analyzer and sensor. Additionally, the Purple Air #3 at Clovis has many hours of data where the analyzer was clearly malfunctioning. This data was also removed.

Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Concentrations during the 3<sup>rd</sup> quarter of 2019 were influenced by periods of high pressure over the region which caused an increase in temperatures and stability. Several low pressure systems moved through the region with gusty winds, especially on the west side and mountain passes in the California Coastal Range. The low pressure systems brought an increase of onshore air flows that helped decrease temperatures and increase dispersion.

### Site Specific Analysis of PurpleAir PA-II Sensor Performance

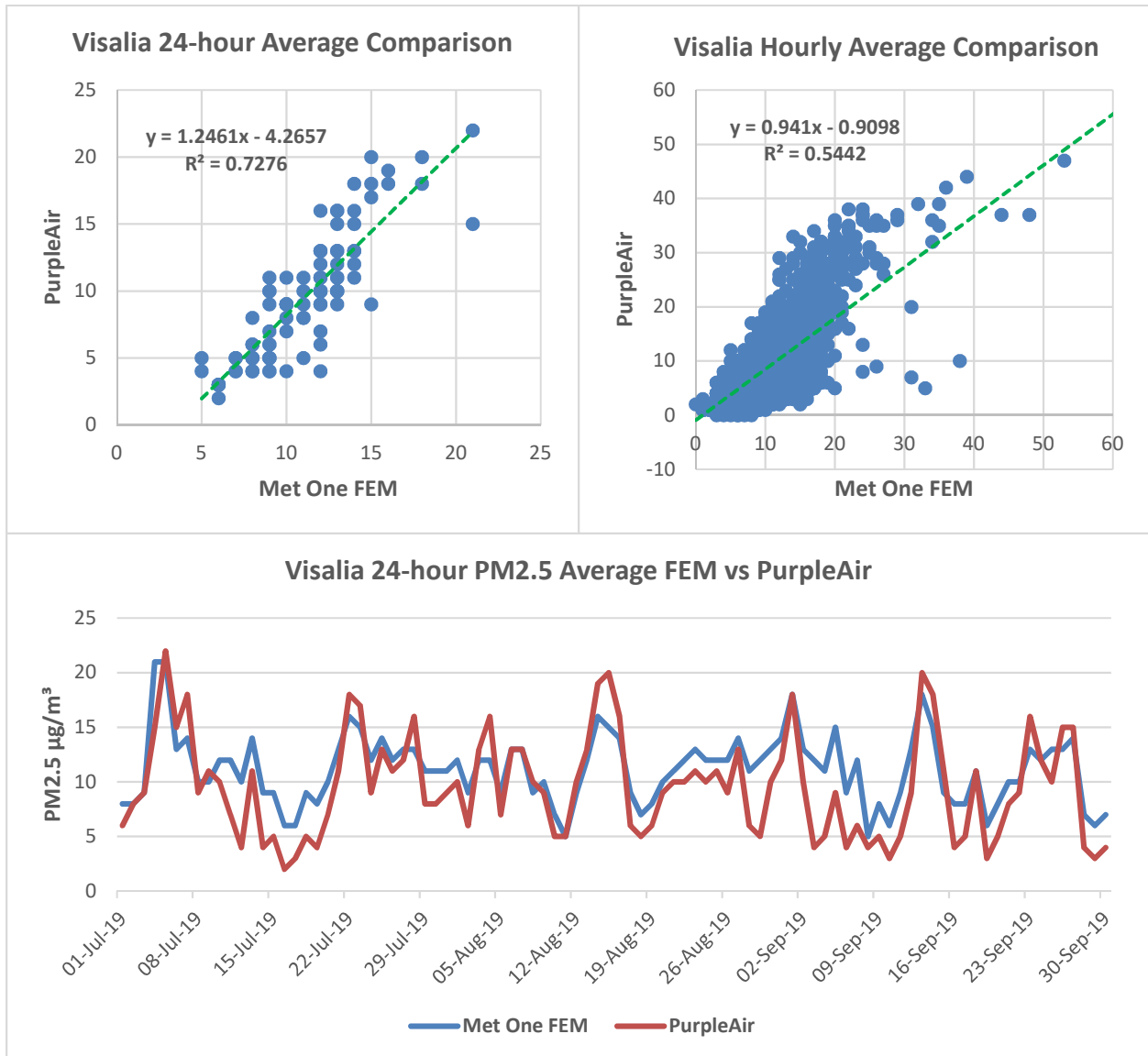
#### Fresno-Garland

For the 24-hour average, PurpleAir data had a 1.1  $\mu\text{g}/\text{m}^3$  high bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 1.1  $\mu\text{g}/\text{m}^3$  over the same period.



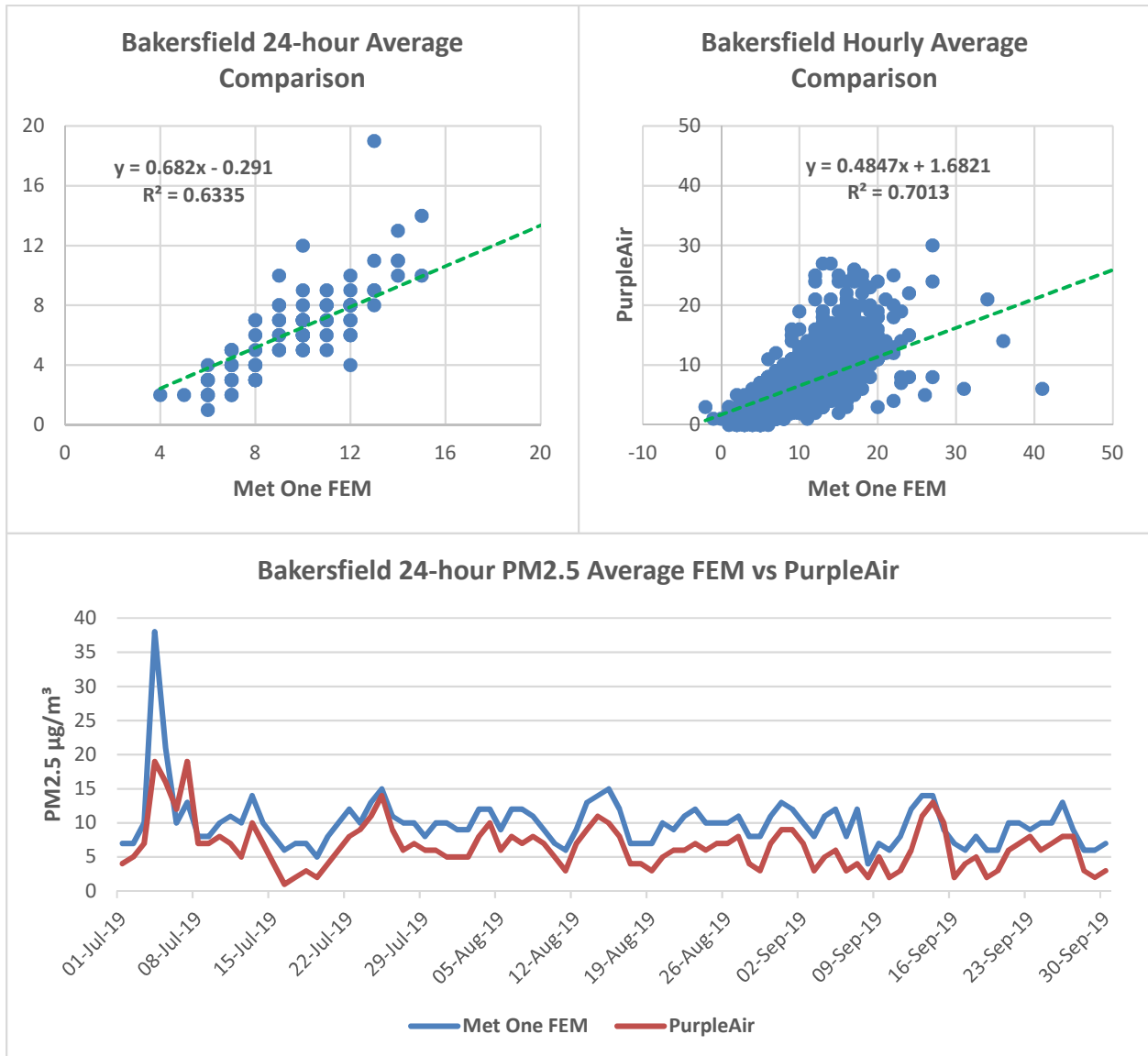
### Visalia-Church

For the 24-hour average, PurpleAir data had a 1.5  $\mu\text{g}/\text{m}^3$  low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 1.6  $\mu\text{g}/\text{m}^3$  over the same period.



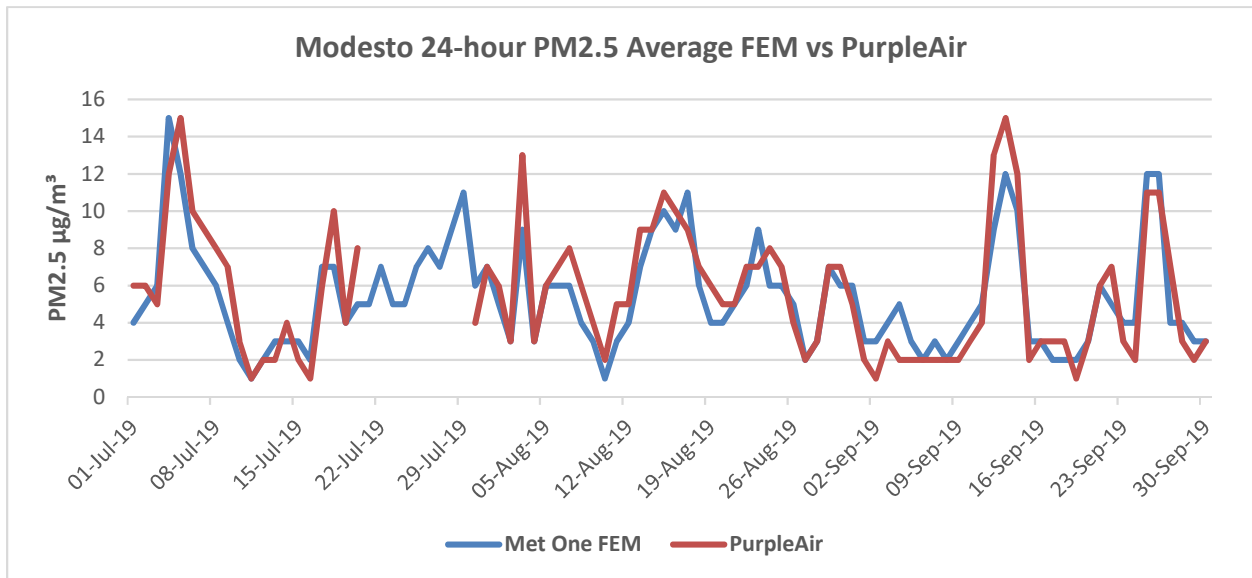
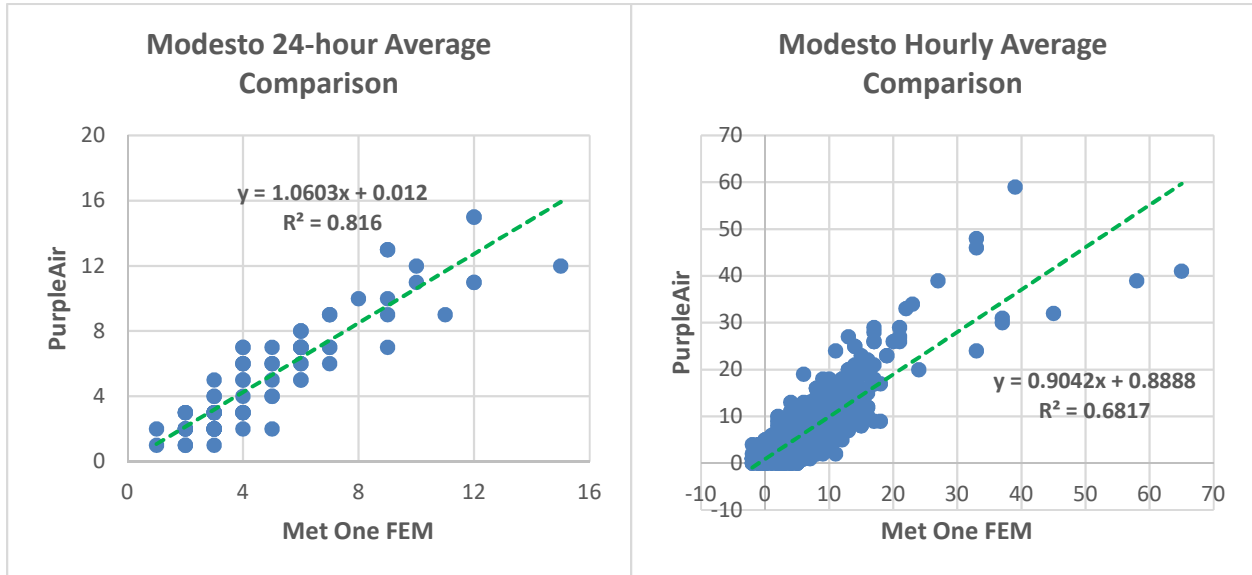
### Bakersfield-California

For the 24-hour average, PurpleAir data had a 3.5  $\mu\text{g}/\text{m}^3$  low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 3.5  $\mu\text{g}/\text{m}^3$  over the same period.



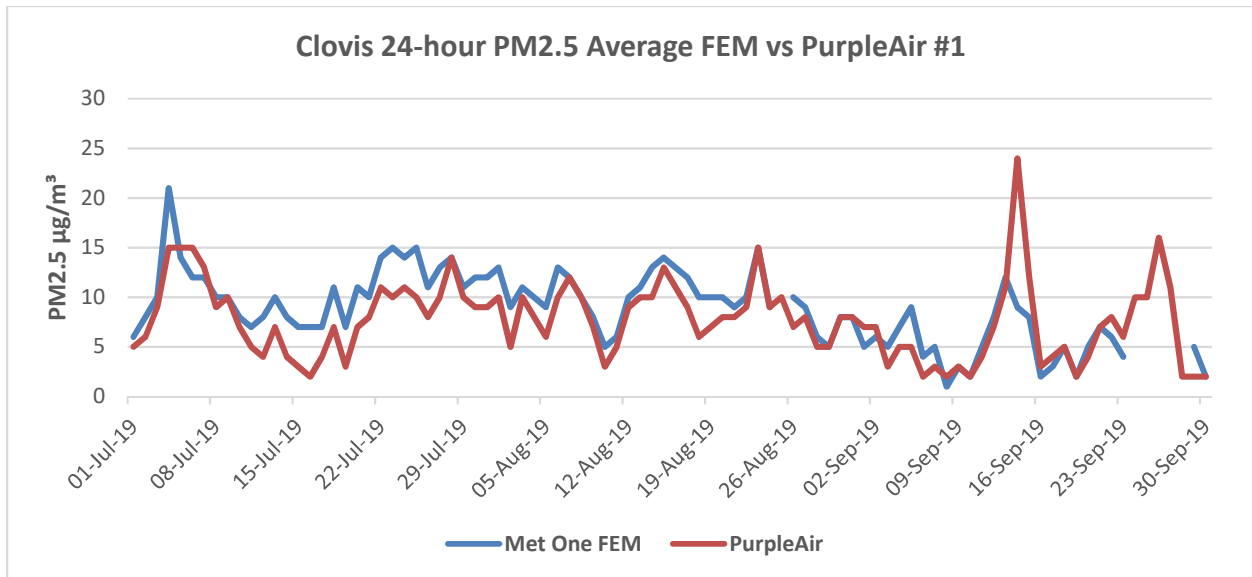
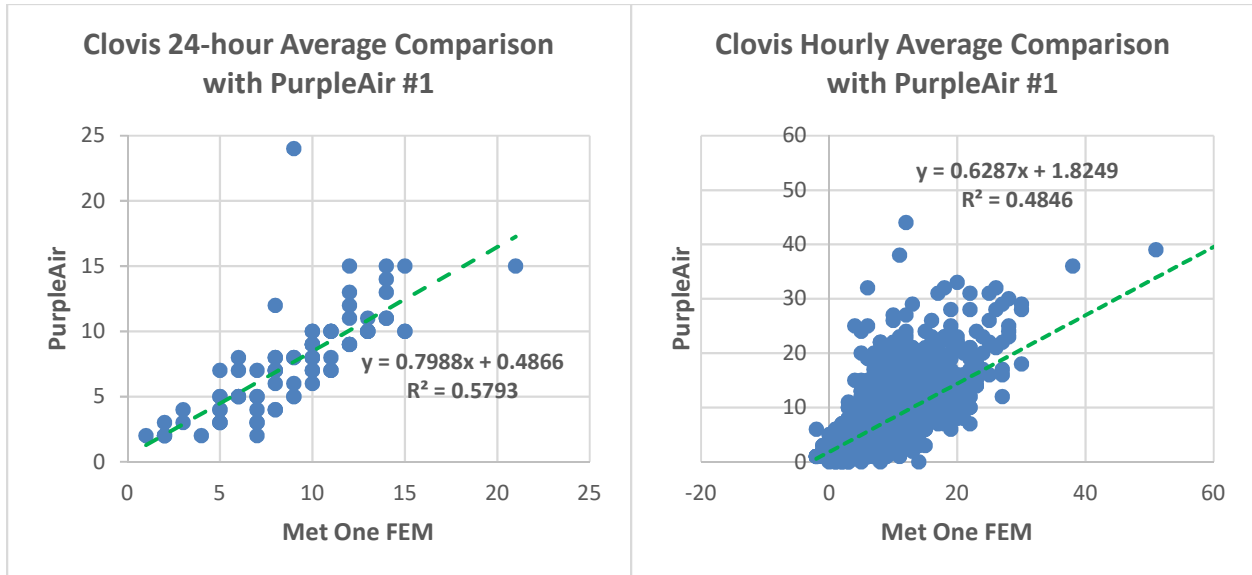
**Modesto-14<sup>th</sup> St.**

For the 24-hour average, PurpleAir data had a 0.3 µg/m<sup>3</sup> high bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a high bias of 0.4 µg/m<sup>3</sup> over the same period.



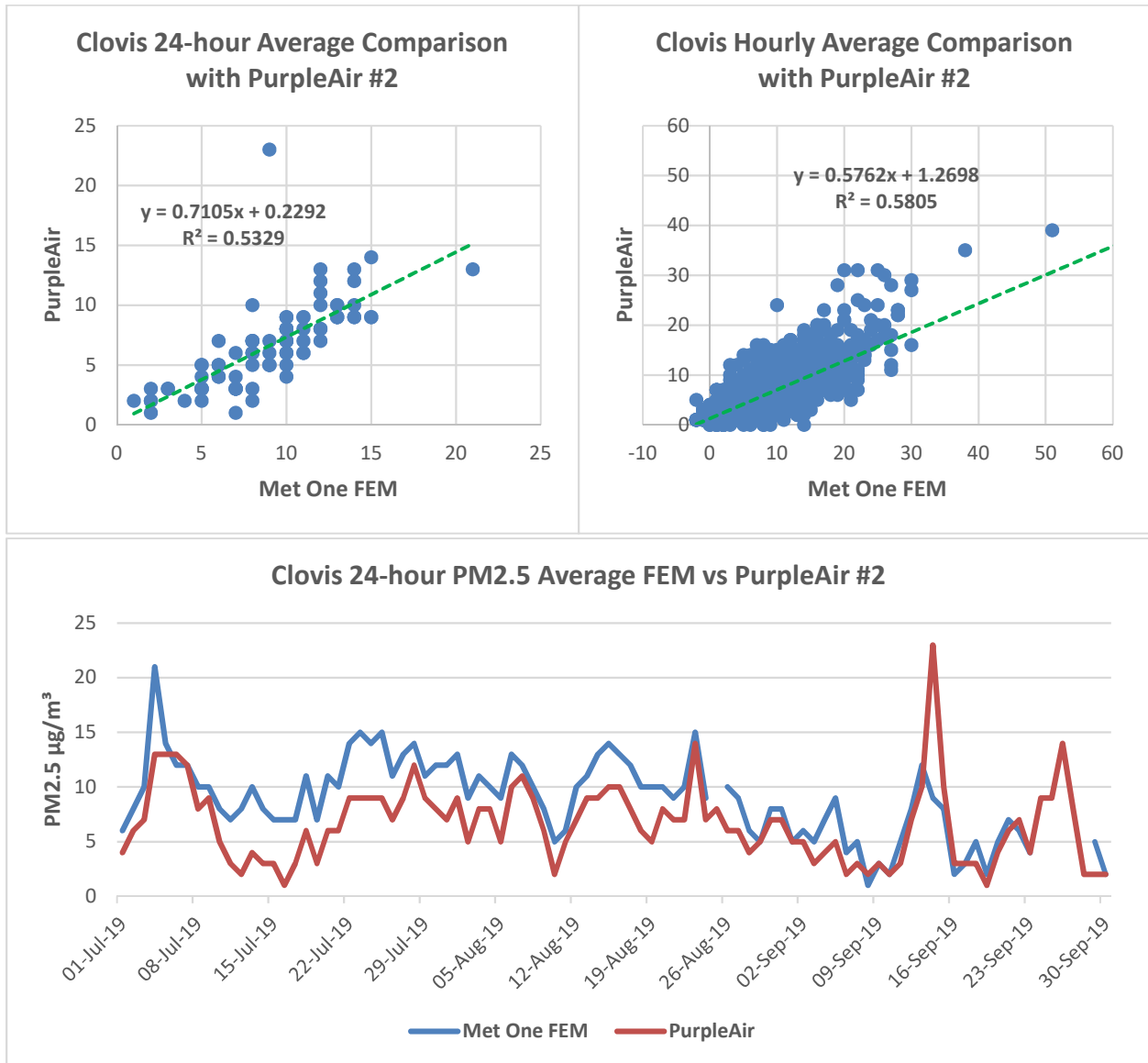
### Clovis-Villa #1

For the 24-hour average, PurpleAir data had a  $1.3 \mu\text{g}/\text{m}^3$  low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of  $1.4 \mu\text{g}/\text{m}^3$  over the same period.



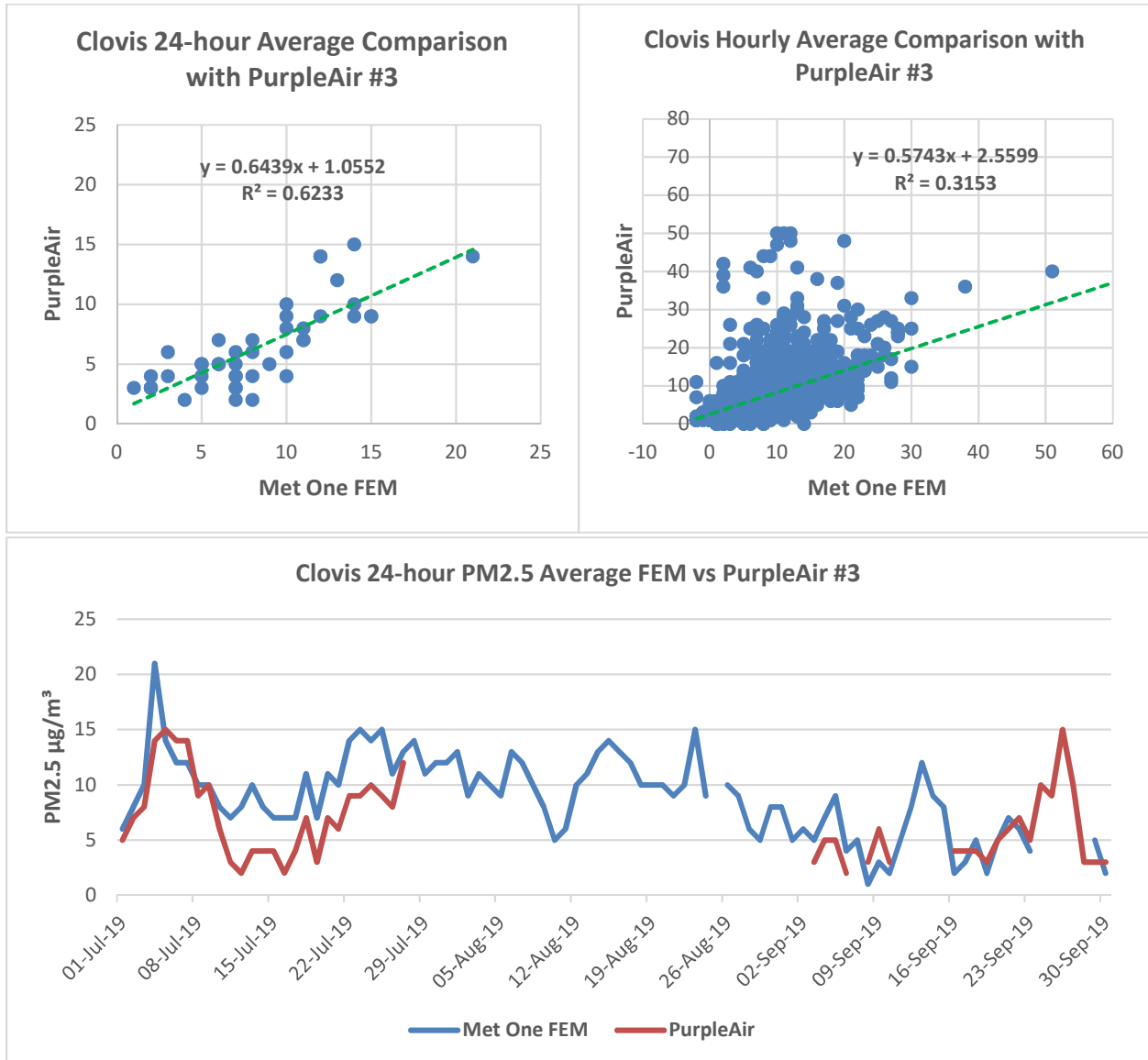
### Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 2.5  $\mu\text{g}/\text{m}^3$  low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 2.4  $\mu\text{g}/\text{m}^3$  over the same period.



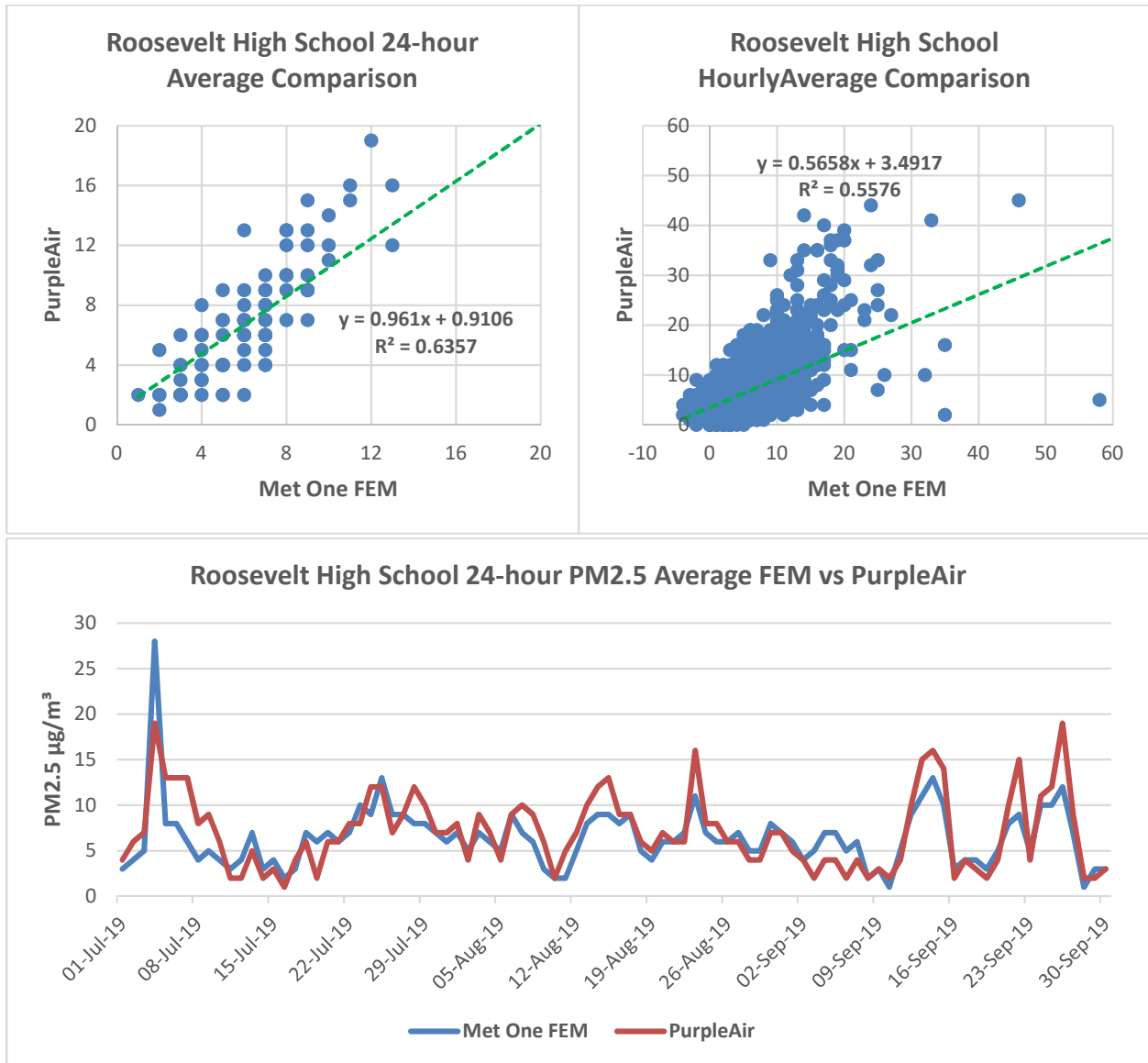
**Clovis-Villa #3**

For the 24-hour average, PurpleAir data had a 1.9 µg/m<sup>3</sup> low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 1.2 µg/m<sup>3</sup> over the same period. The PurpleAir analyzer appears to have malfunctioned between July 28<sup>th</sup> and September 15<sup>th</sup> and data from this range were removed from this analysis. Readings before and after these dates are assumed valid.



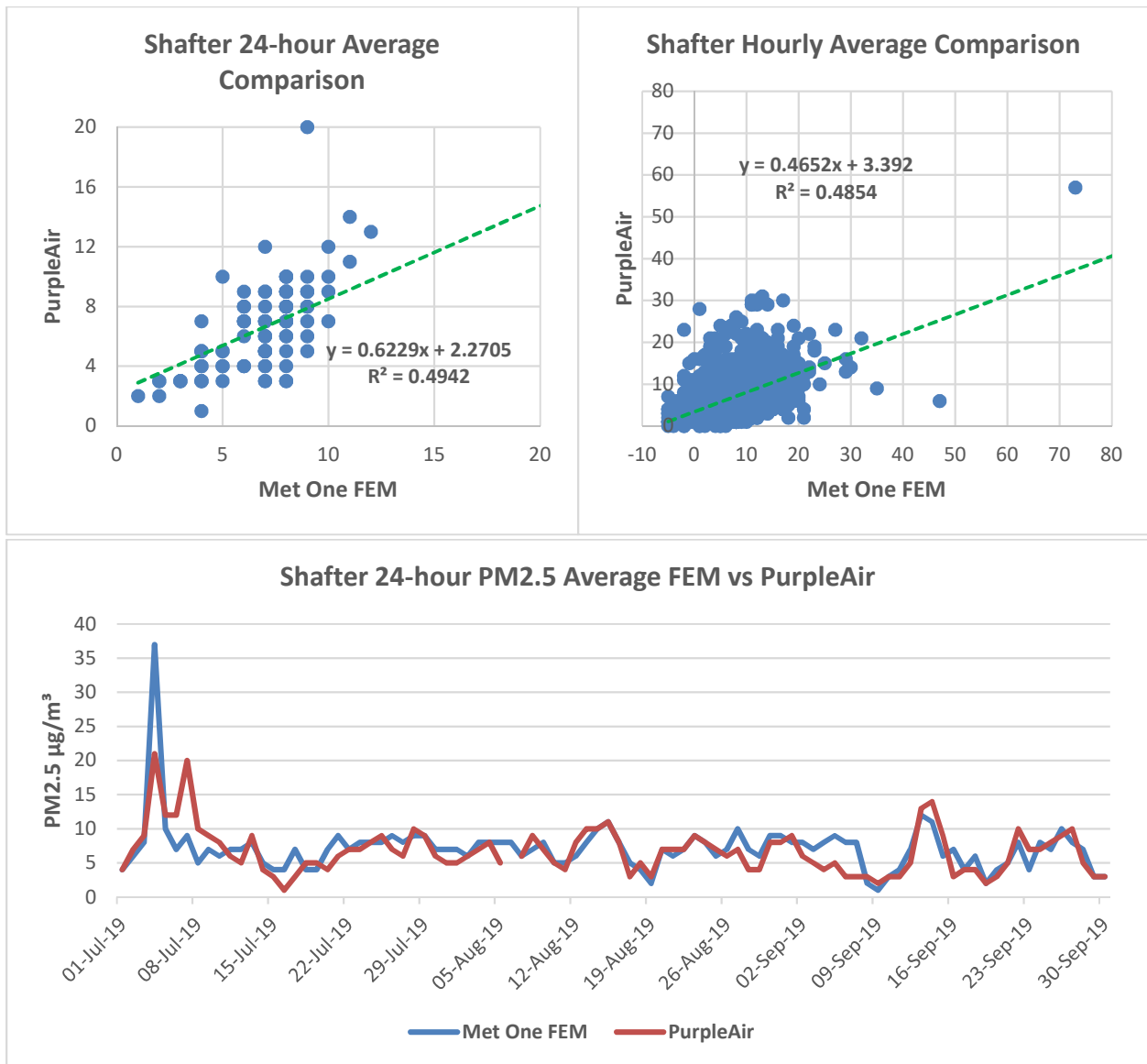
### South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 0.7  $\mu\text{g}/\text{m}^3$  high bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a high bias of 0.7  $\mu\text{g}/\text{m}^3$  over the same period.



**Shafter**

For the 24-hour average, PurpleAir data had a 0.3  $\mu\text{g}/\text{m}^3$  low bias during the July 1, 2019 through September 30, 2019 period. For the hourly average, PurpleAir data had a low bias of 0.4  $\mu\text{g}/\text{m}^3$  over the same period.



### **Statistical Summary**

The following tables provides a statistical summary of the data collected during the analysis period of this report.

**Table A – Fresno-Garland, Visalia-Church, Bakersfield-California, and Modesto-14<sup>th</sup> Sites**

<b>Statistic</b>	<b>Fresno-Garland</b>	<b>Visalia-Church</b>	<b>Bakersfield-Cal</b>	<b>Modesto</b>
FEM Avg 24-hr	8	11	10	5
Sensor Avg 24-hr	7	10	7	6
FEM Max 1-hr	343	112	341	65
Sensor Max 1-hr	137	54	140	59
FEM Max 24-hr	36	21	38	15
Sensor Max 24-hr	20	22	19	15
1-hr R <sup>2</sup>	0.58	0.54	0.70	0.68
1-hr Slope	0.48	0.94	0.48	0.90
1-hr Intercept	3.17	-0.91	1.68	0.89
24-hr R <sup>2</sup>	0.61	0.73	0.63	0.82
24-hr Slope	0.79	1.25	0.68	1.06
24-hr Intercept	0.65	-4.27	-0.29	0.01

**Table B – Clovis-Villa Site**

<b>Statistic</b>	<b>Clovis-Villa PurpleAir #1</b>	<b>Clovis-Villa PurpleAir #2</b>	<b>Clovis-Villa PurpleAir #3</b>
FEM Avg 24-hr	9	9	8.3
Sensor Avg 24-hr	8	7	6.4
FEM Max 1-hr	122	122	122
Sensor Max 1-hr	55	54	56
FEM Max 24-hr	21	21	21
Sensor Max 24-hr	24	23	15
1-hr R <sup>2</sup>	0.48	0.58	0.32
1-hr Slope	0.63	0.58	0.57
1-hr Intercept	1.82	1.27	2.56
24-hr R <sup>2</sup>	0.80	0.53	0.62
24-hr Slope	0.71	0.71	0.64
24-hr Intercept	0.49	0.22	1.06

**Table C – South Central Fresno and Shafter Sites**

<b>Statistic</b>	<b>South Central Fresno – Roosevelt HS</b>	<b>Shafter</b>
FEM Avg 24-hr	7	7
Sensor Avg 24-hr	7	7
FEM Max 1-hr	266	257
Sensor Max 1-hr	126	131
FEM Max 24-hr	28	37
Sensor Max 24-hr	19	21
1-hr R <sup>2</sup>	0.56	0.49
1-hr Slope	0.57	0.47
1-hr Intercept	3.49	3.39
24-hr R <sup>2</sup>	0.64	0.49
24-hr Slope	0.96	0.62
24-hr Intercept	0.91	2.27