



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2018 – 1st Quarter

Clarity Node + Clarity Cloud



Introduction and Sensor Profile

This analysis report is focused on assessing the performance of the Clarity Node sensor as a part of the District's Technical Evaluation of Sensor Technology (TEST) Program. The Clarity sensor uses optical laser-based particle counting methodology to estimate the concentration of PM_{2.5}. The Clarity sensor also measures CO₂, NO₂, Total VOCs, temperature, and relative humidity within a solar powered box. A unique feature of the Clarity Node sensor is its ability to self-correct its PM_{2.5} estimates based on real-time regulatory monitor readings in the area. This self-calibration process is aimed to result in more accurate PM_{2.5} measurements from the Clarity Node sensors, making them a more viable option for various monitoring projects.

Background and Approach of Evaluation Test

In late 2017, the Clarity Movement Company approached the District regarding the testing of their Clarity Node sensors in the conditions of the San Joaquin Valley. After coordination on where the sensors could be placed in the District's network for testing, on February 28, 2018, 5 Clarity sensors were installed and started collecting data to compare the performance of Clarity sensors to regulatory PM_{2.5} analyzers. Clarity Node sensors were installed at the District air monitoring stations of Clovis-Villa, Manteca, Merced-Coffee, Tracy-Airport, and Tranquillity. The data sets from each station compare Clarity sensor PM_{2.5} data to that of the regulatory PM_{2.5} data that is collocated at each of the District sites. 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

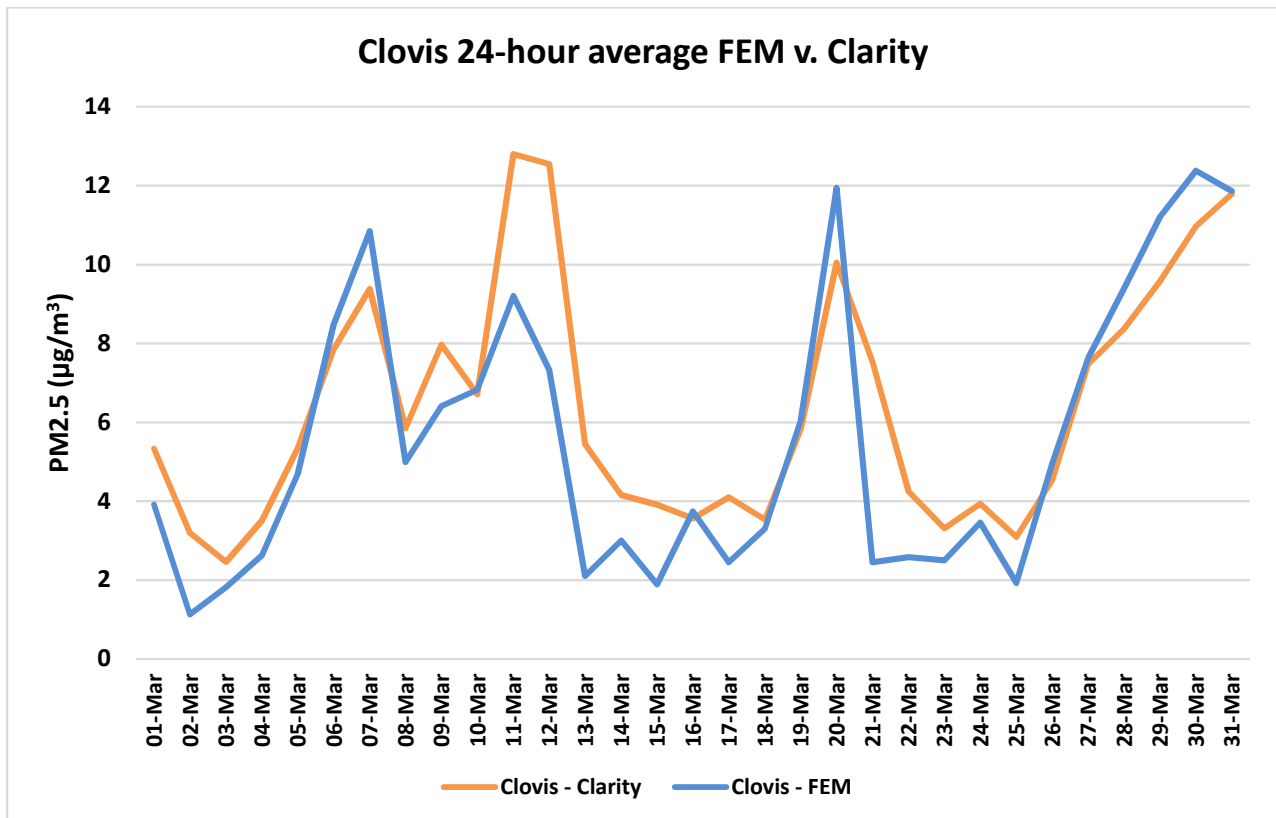
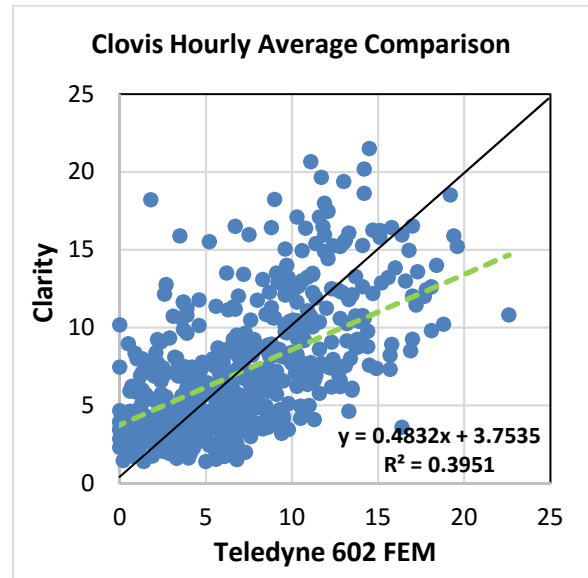
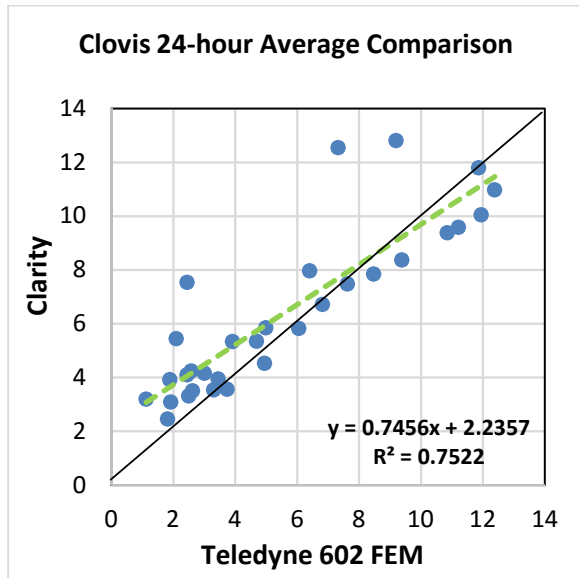
The analysis for this report covers the time period of March 1, 2018, through March 31, 2018 (2018 – 1st quarter). The month of March 2018 had fairly good dispersion conditions with low to moderate PM readings throughout the Valley. Several low pressure systems moved through the Valley, which helped keep dispersion conditions positive for air quality through this time period.

Recorded PM_{2.5} concentrations for both the Clarity Node sensor and regulatory monitors were low through the month of March. This assessment compares the Clarity Node performance against two different regulatory PM_{2.5} monitors operating in the District's network – the MetOne BAM and the Teledyne 602. Overall, most of the Clarity Node sensors operating during this period showed a slight high bias over the regulatory monitors, except for the Tranquillity sensor, which shows a low bias. No significant events related to air pollution occurred during March 2018.

Site Specific Analysis of Clarity-Node Sensor Performance

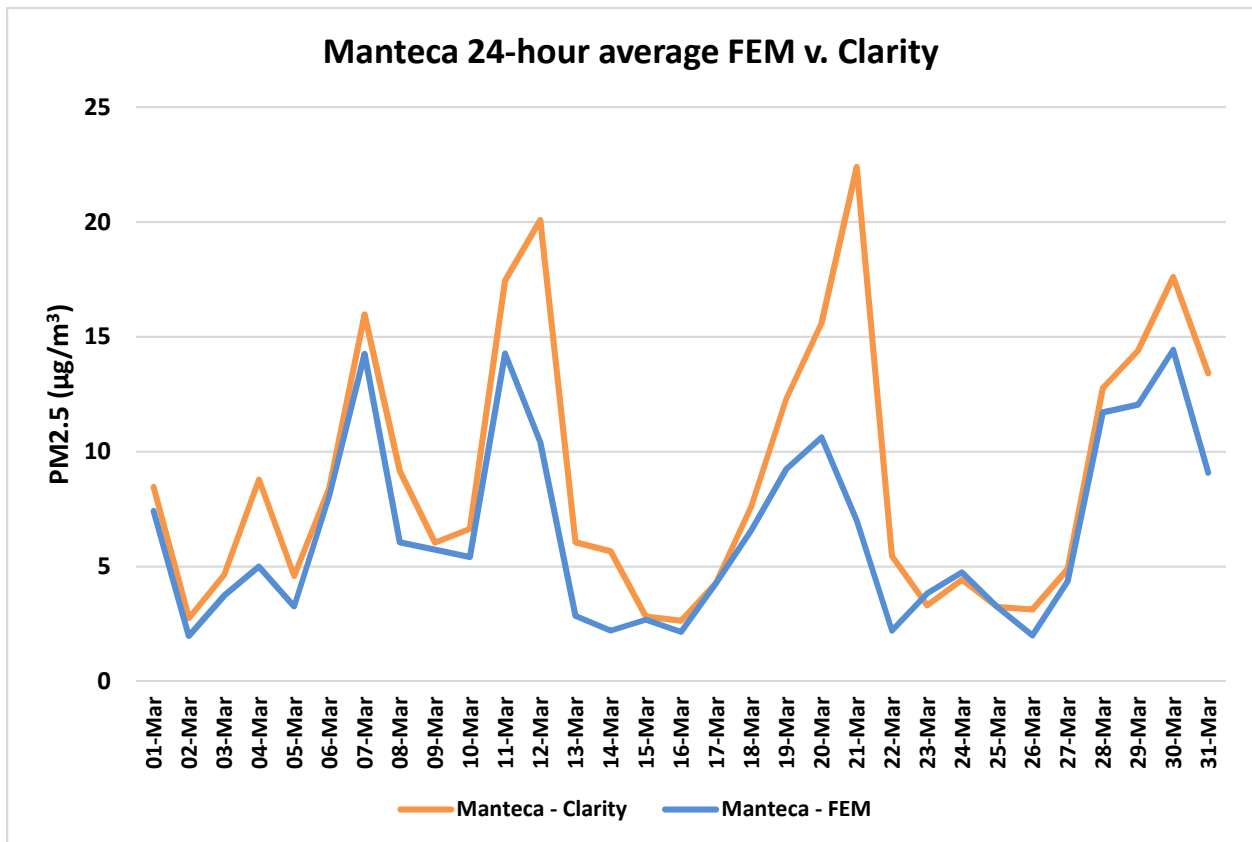
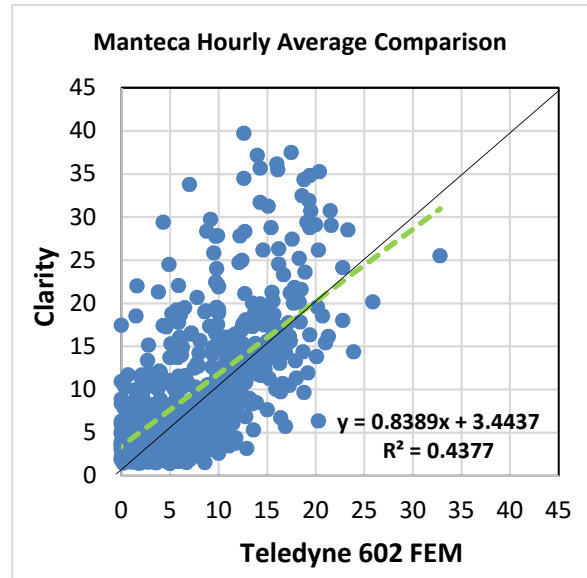
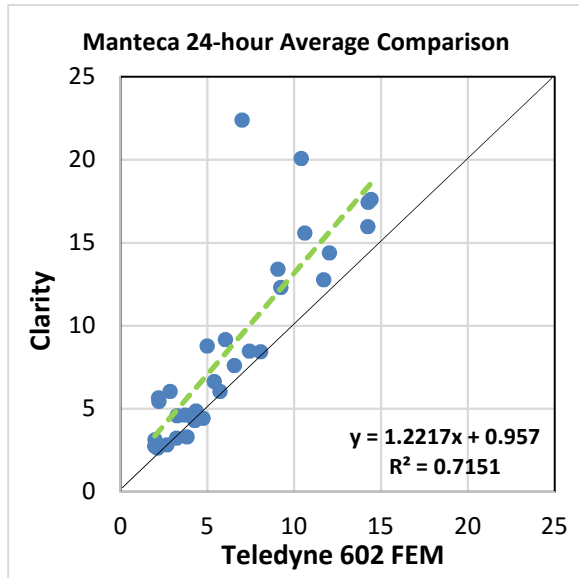
Clovis-Villa

For the 24-hour average, Clarity data had a 0.9 µg/m³ high bias during the month of March 2018. For the hourly average, Clarity data had a 0.8 µg/m³ high bias over the same period.



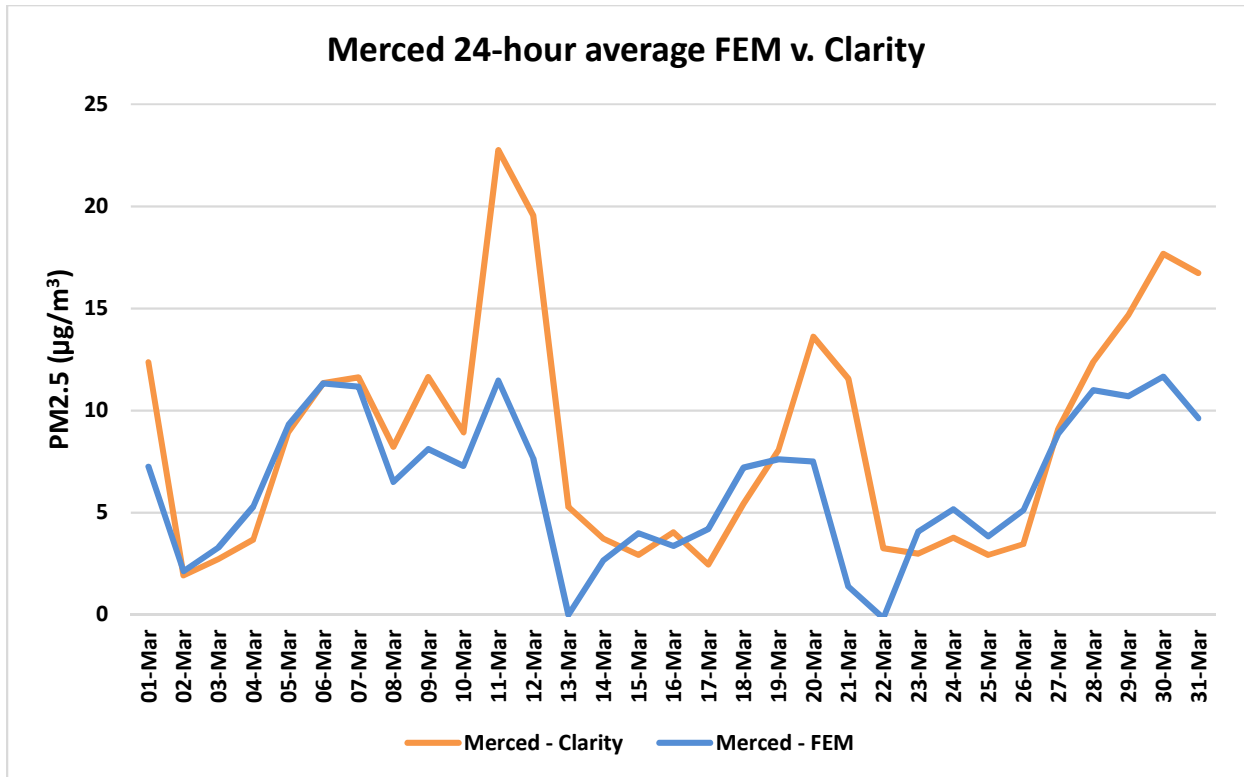
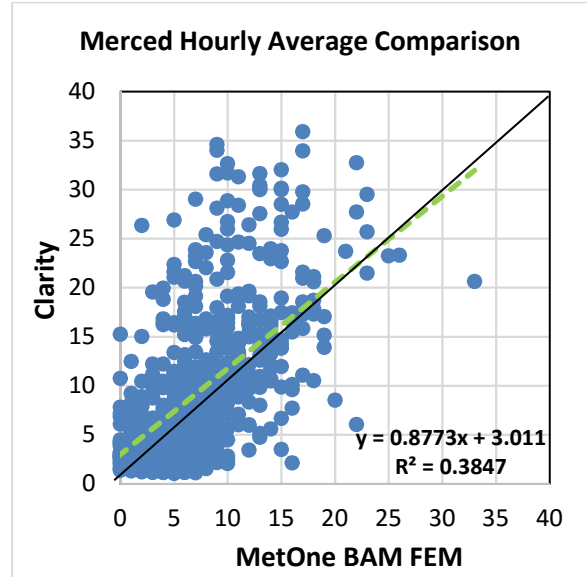
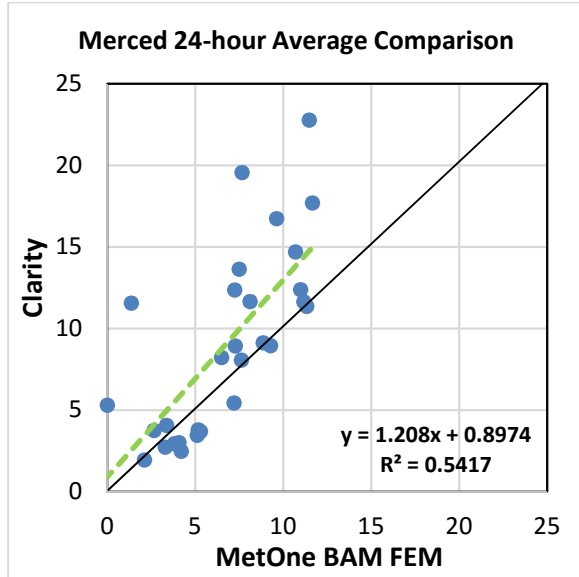
Manteca

For the 24-hour average, Clarity data had a 2.4 $\mu\text{g}/\text{m}^3$ high bias during the month of March 2018. For the hourly average, Clarity data had a 2.4 $\mu\text{g}/\text{m}^3$ high bias over the same period.



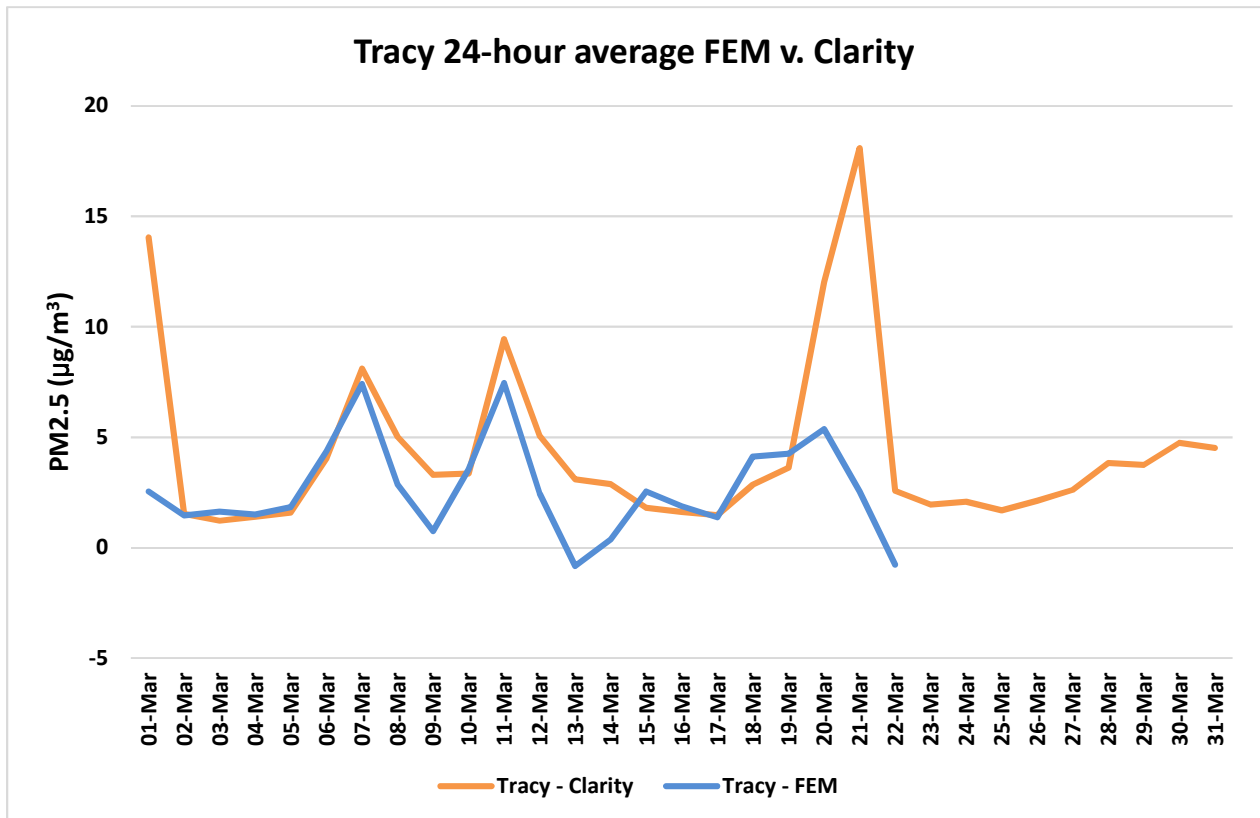
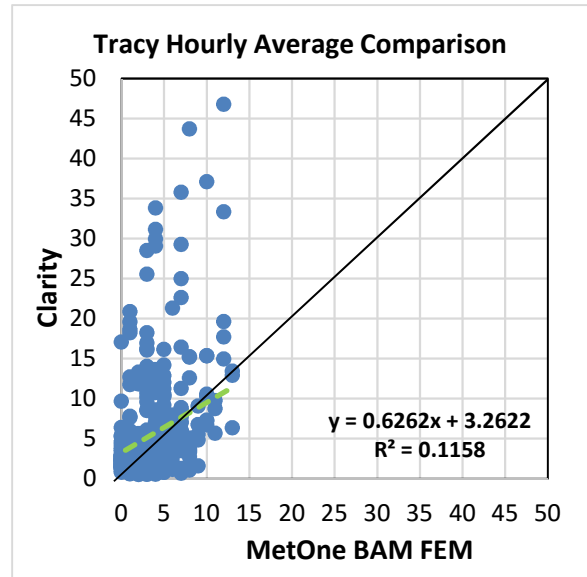
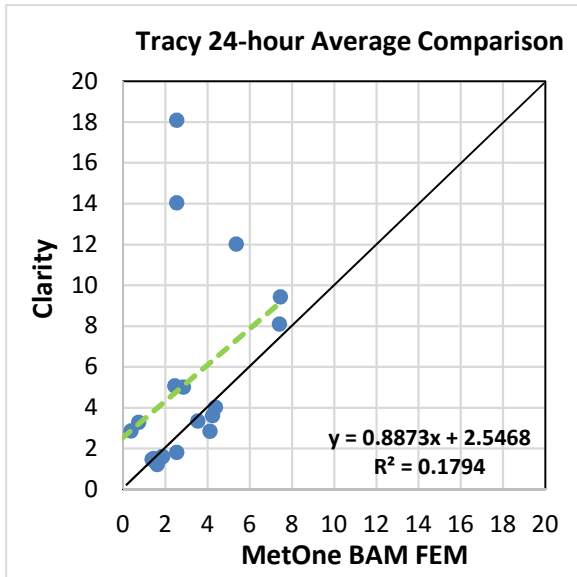
Merced-Coffee

For the 24-hour average, Clarity data had a 2.2 $\mu\text{g}/\text{m}^3$ high bias during the month of March 2018. For the hourly average, Clarity data had a 2.2 $\mu\text{g}/\text{m}^3$ high bias over the same period.



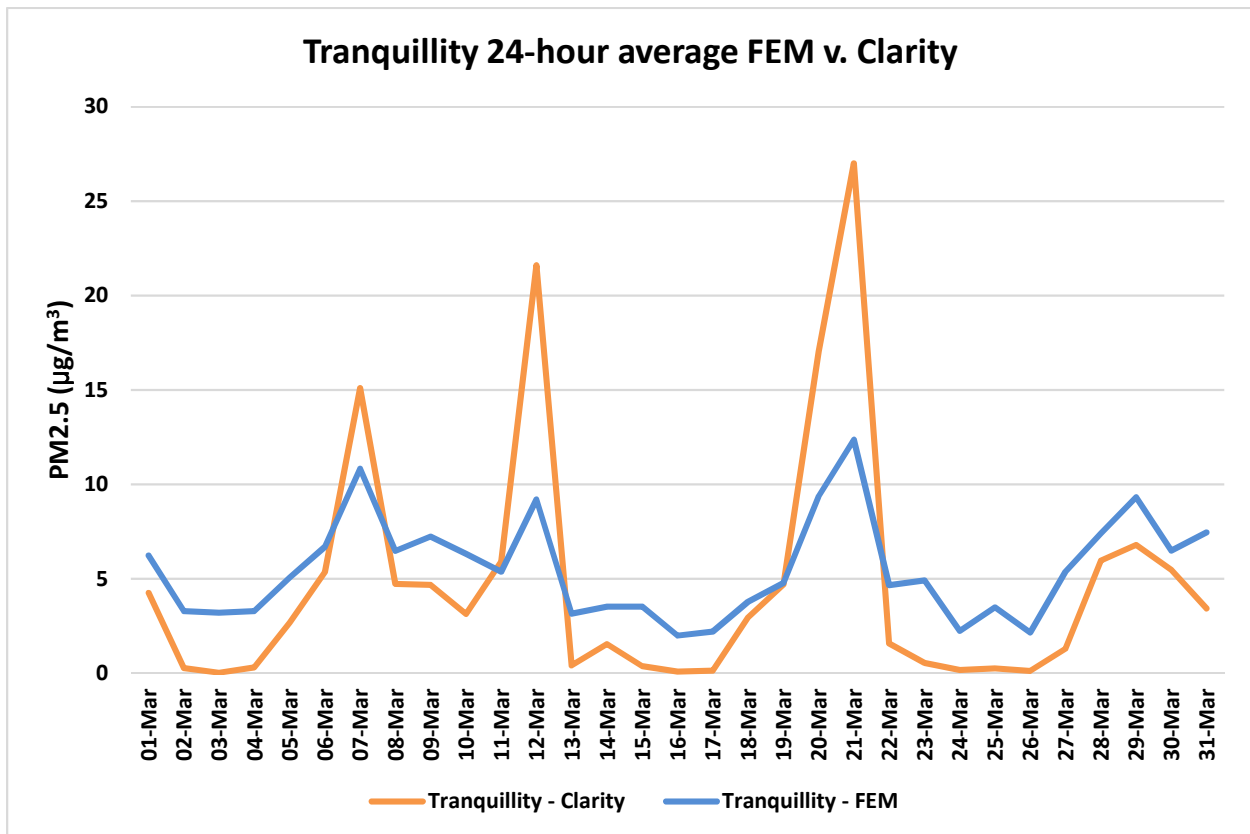
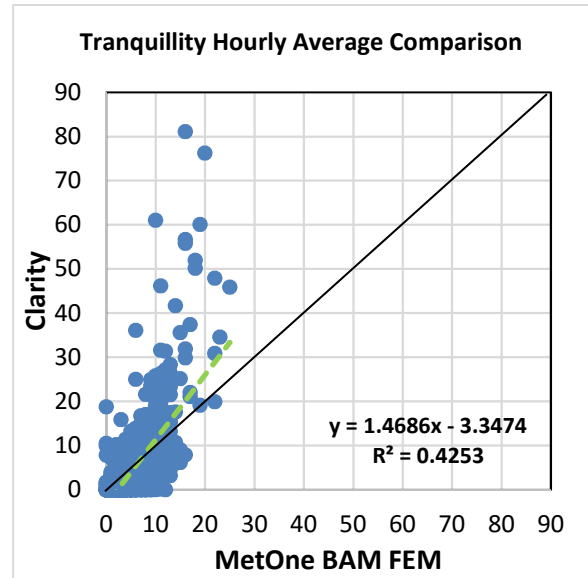
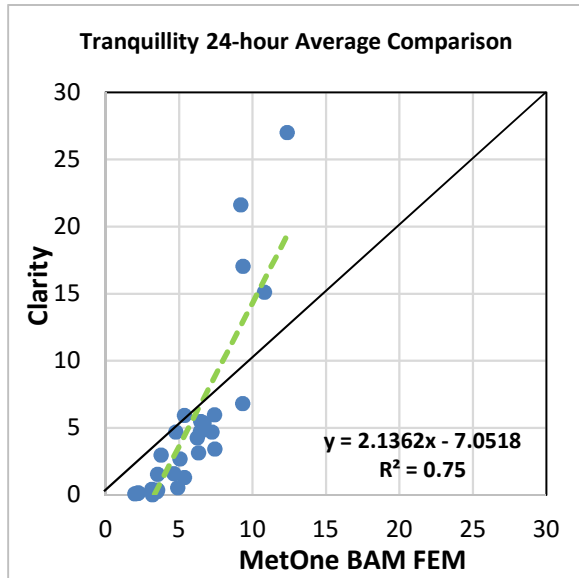
Tracy-Airport

For the 24-hour average, Clarity data had a 2.2 µg/m³ high bias from March 1 to 22, 2018. For the hourly average, Clarity data had a 2.2 µg/m³ high bias over the same period. Data from the Tracy MetOne BAM monitor was not available from March 23 through the end of the month due to the analyzer undergoing calibration.



Tranquillity

For the 24-hour average, Clarity data had a 0.8 $\mu\text{g}/\text{m}^3$ low bias during the month of March 2018. For the hourly average, Clarity data had a 0.8 $\mu\text{g}/\text{m}^3$ low bias over the same period.



Statistical Summary

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

Statistic	Clovis	Manteca	Merced	Tracy	Tranquillity
FEM Avg	5.6	6.5	6.4	2.7	5.5
Clarity Avg	6.4	8.9	8.6	4.4	4.8
FEM 1-hr Max	22.6	32.8	33.0	13.0	25.0
Clarity 1-hr Max	21.5	39.7	35.9	46.8	81.1
FEM 24-hr Max	12.4	14.4	11.7	7.5	12.4
Clarity 24-hr Max	12.8	22.4	22.8	18.1	27.0
1-hr R ²	0.3951	0.4377	0.3847	0.1158	0.4253
1-hr Slope	0.4832	0.8389	0.8773	0.6262	1.4686
1-hr Intercept	3.7535	3.4437	3.0110	3.2622	-3.3474
24-hr R ²	0.7522	0.7151	0.5417	0.1794	0.7500
24-hr Slope	0.7456	1.2217	1.2080	0.8873	2.1362
24-hr Intercept	2.2357	0.9570	0.8974	2.5468	-7.0518