



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

*Clarity Node Sensor
2018 – 2nd Quarter*



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

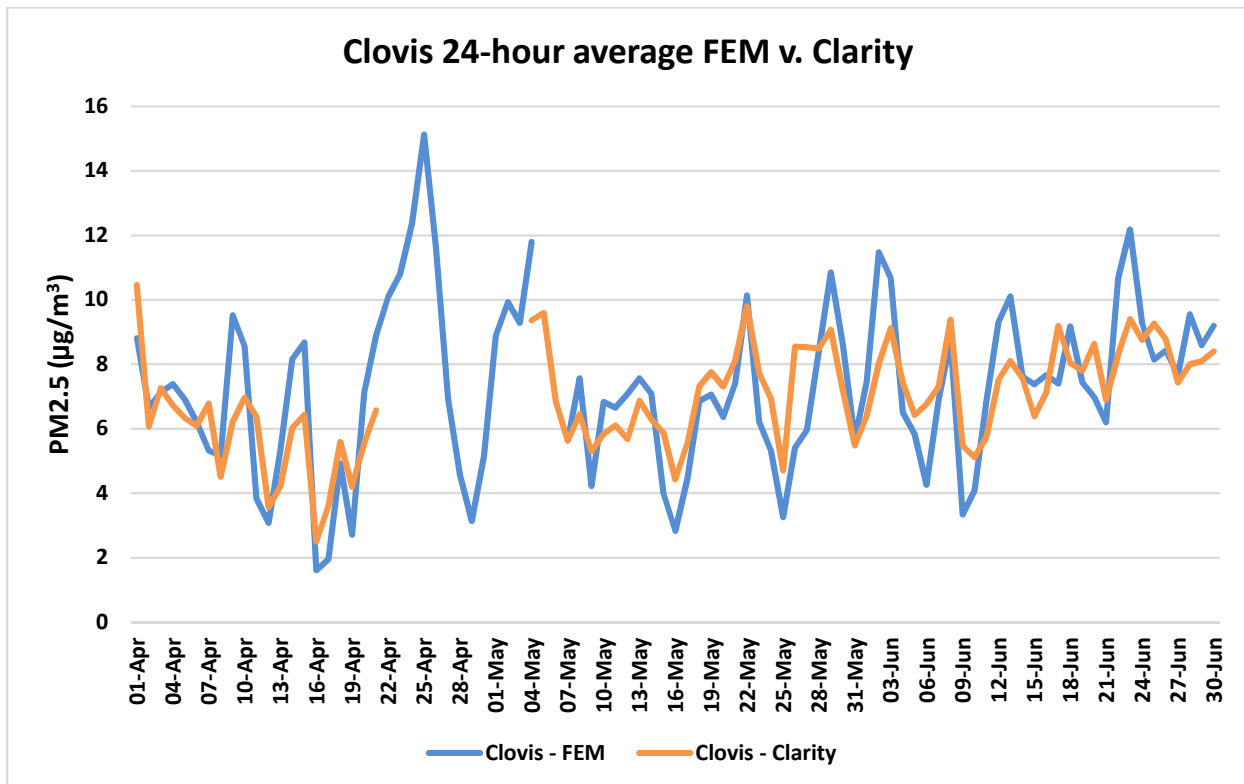
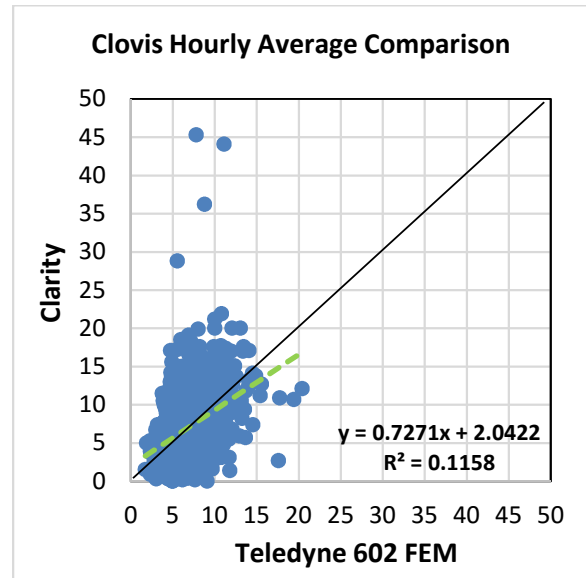
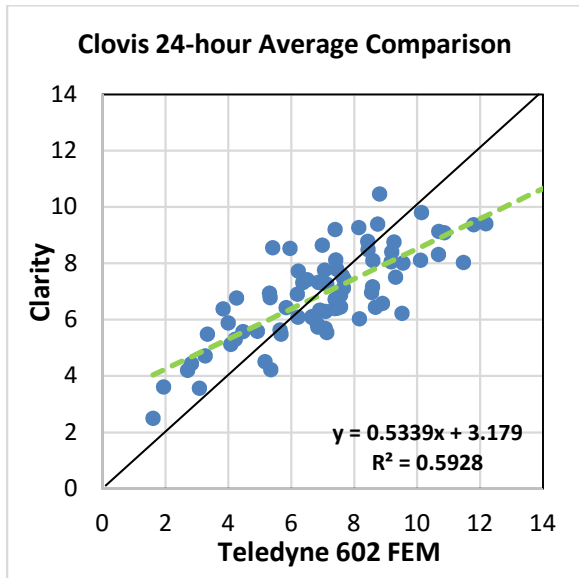
The analysis for this report covers the time period of April 2018 through June 2018 (2018 – 2nd quarter). The 2nd quarter of 2018 had fairly good dispersion conditions with low to moderate PM readings throughout the Valley. Several low pressure systems moved through the Valley, which helped keep dispersion 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 period of April to June 2018. 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 negligible bias (both high and low) compared to the regulatory monitors, except for the Tranquillity sensor, which showed a more pronounced low bias. During this period, two wildfires located just northwest of Coalinga occurred during the second week of June and transported smoke into the Valley. This smoke event impacted the Tranquillity air monitoring site, where the Tranquillity regulatory monitor recorded an hourly reading of 134 µg/m³, while the Clarity sensor had a reading of 1.6 µg/m³.

Site Specific Analysis of Clarity-Node Sensor Performance

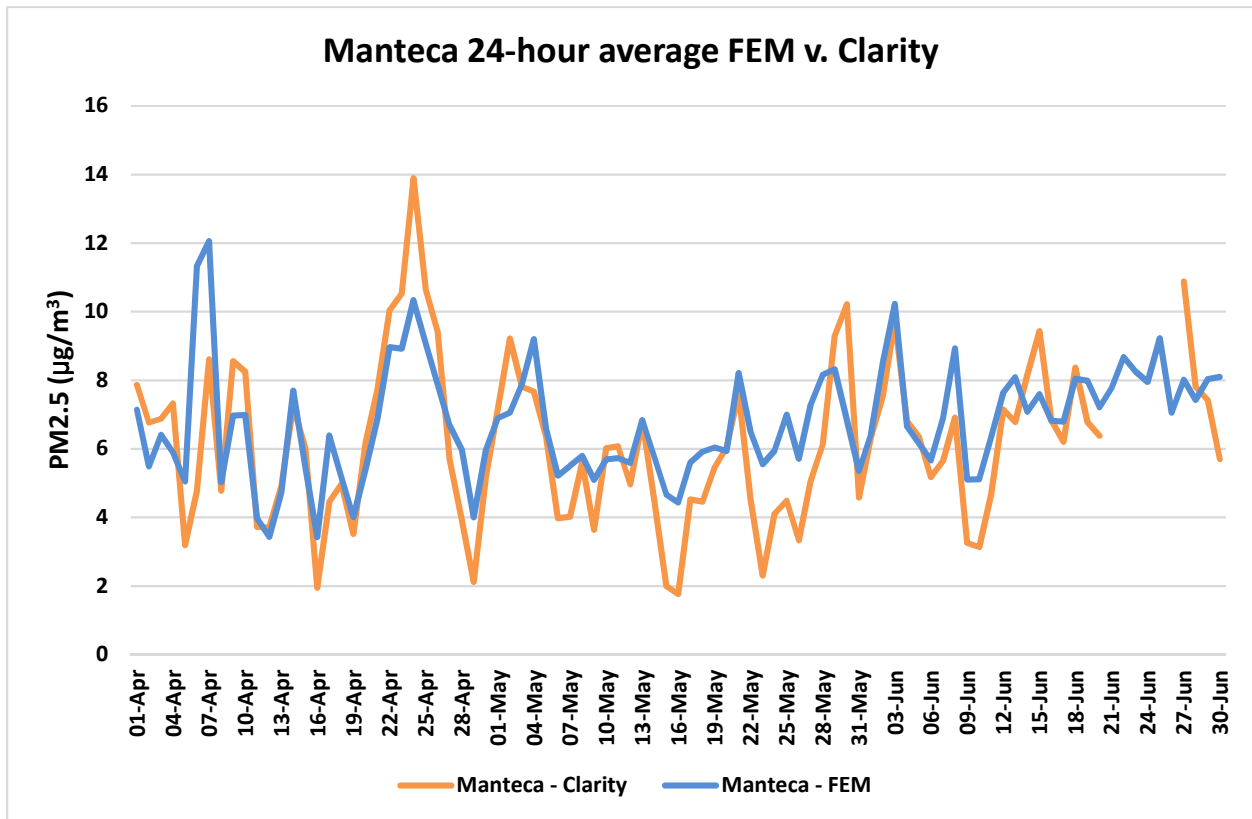
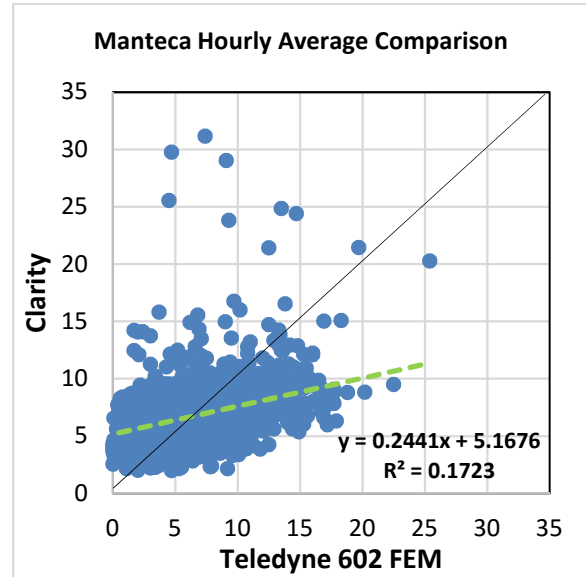
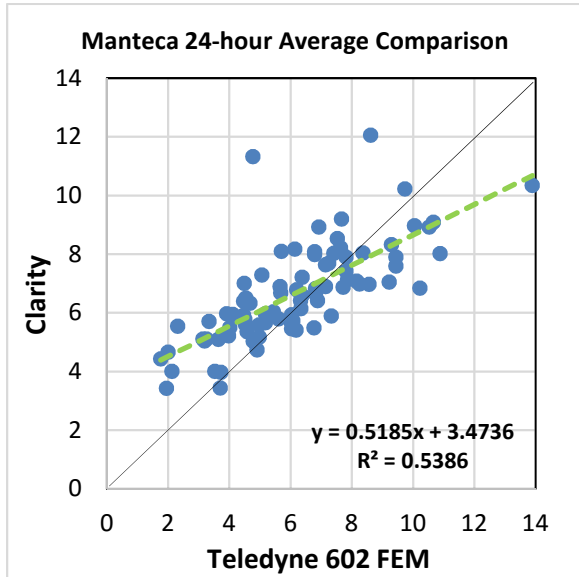
Clovis-Villa

For the 24-hour average, Clarity data had a 0.1 µg/m³ low bias during the second quarter of 2018. For the hourly average, Clarity data had a 0.1 µg/m³ low bias over the same period.



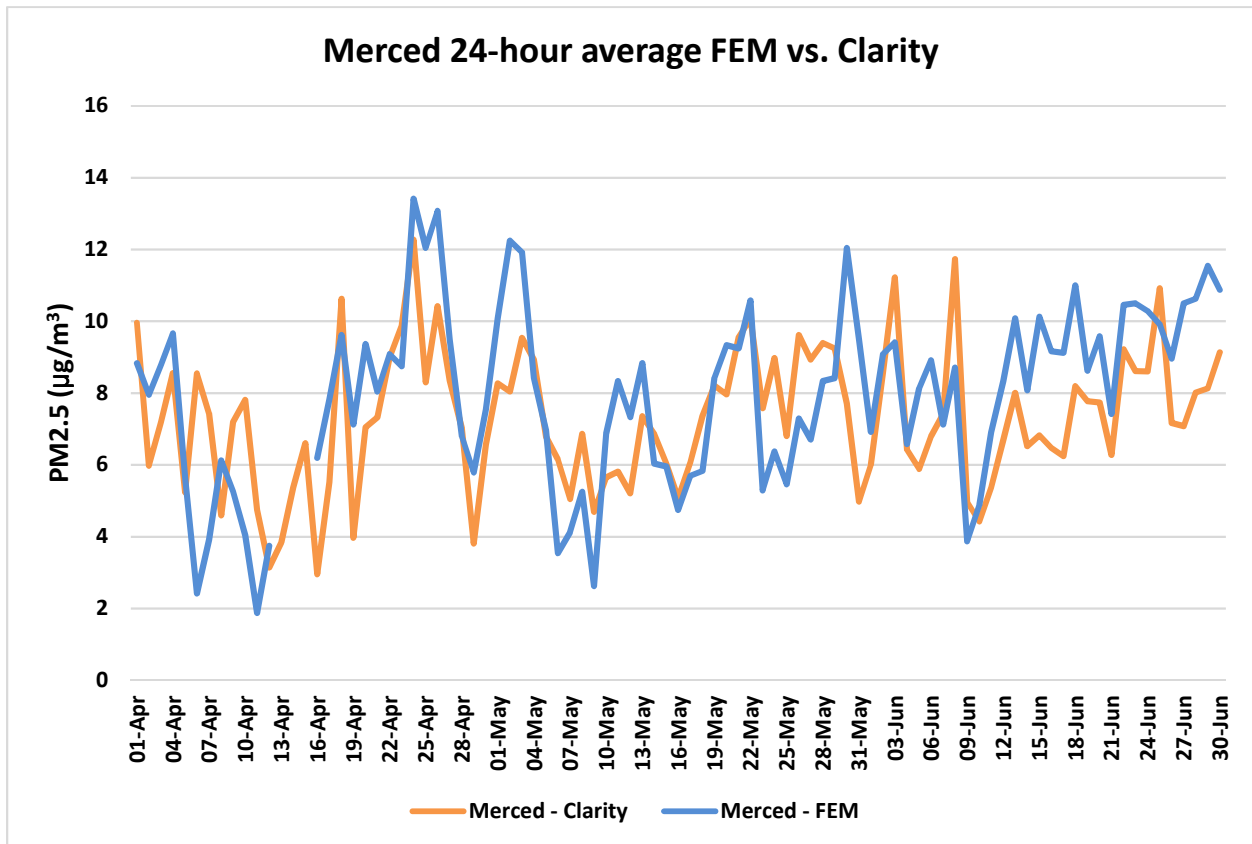
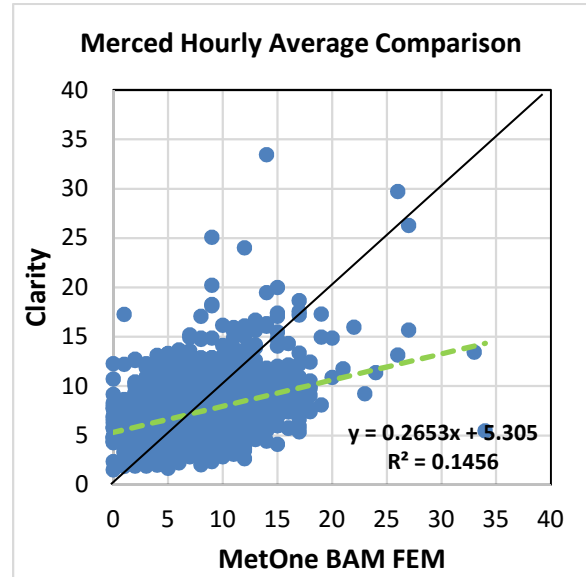
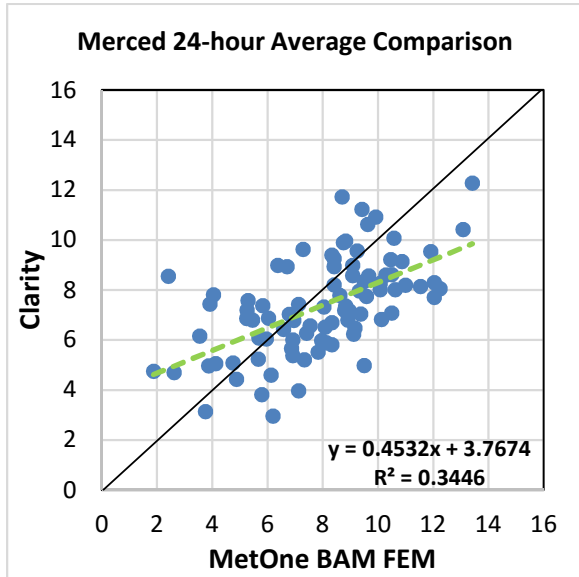
Manteca

For the 24-hour average, Clarity data had a 0.5 µg/m³ high bias during the April 2018 through June 2018 period. For the hourly average, Clarity data had a 0.5 µg/m³ high bias over the same period.



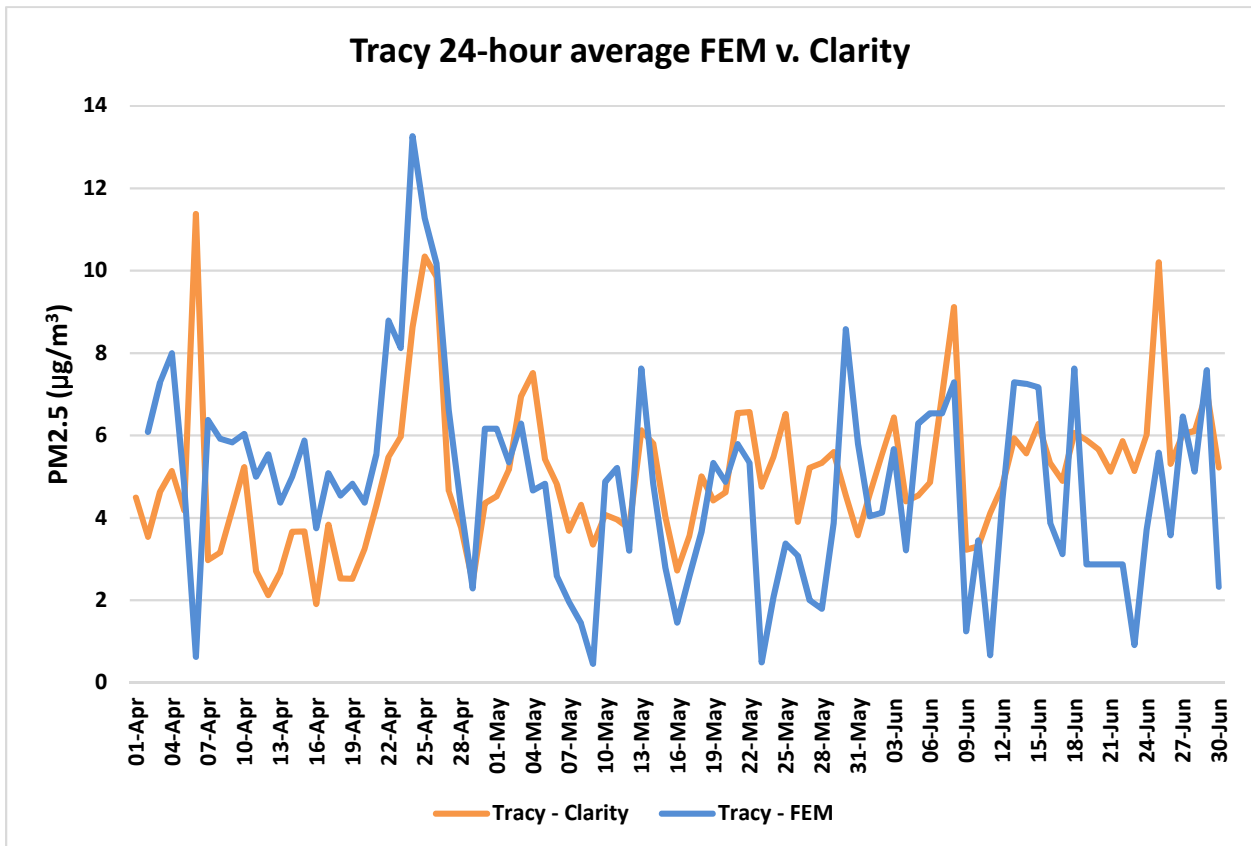
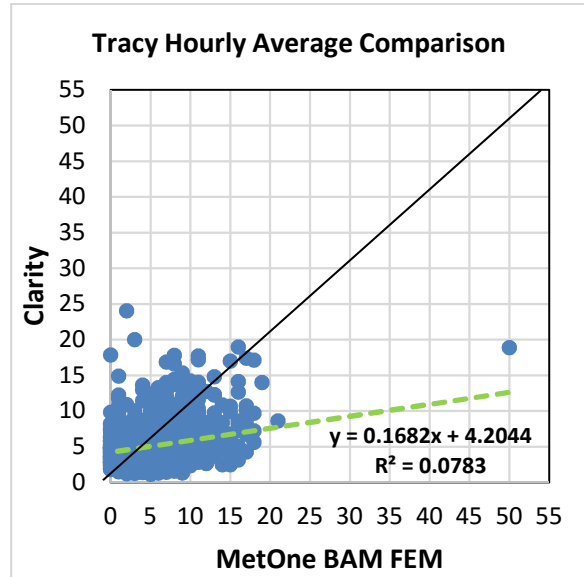
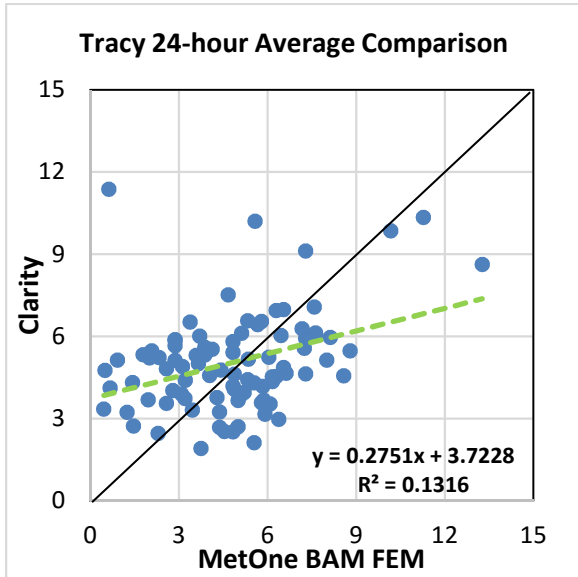
Merced-Coffee

For the 24-hour average, Clarity data had a 0.6 µg/m³ low bias during the April through June 2018 period. For the hourly average, Clarity data had a 0.6 µg/m³ low bias over the same period.



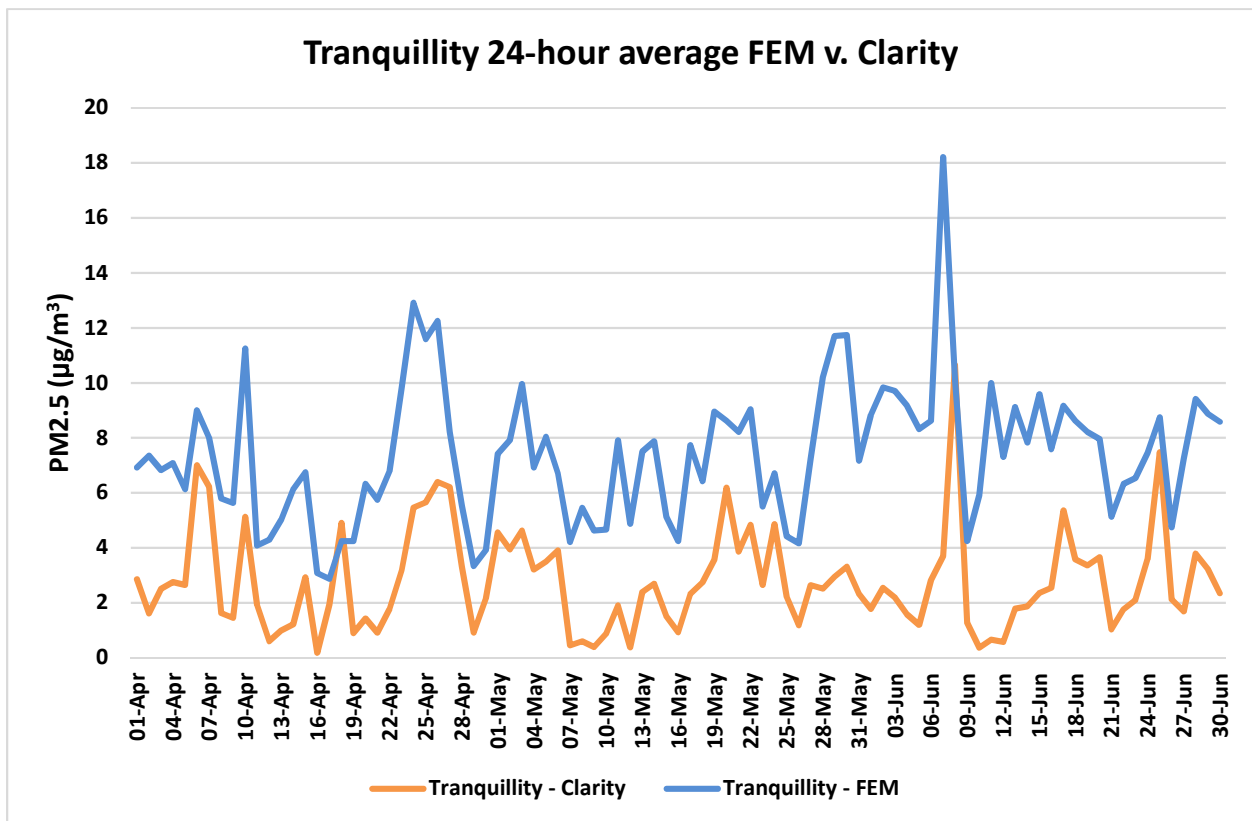
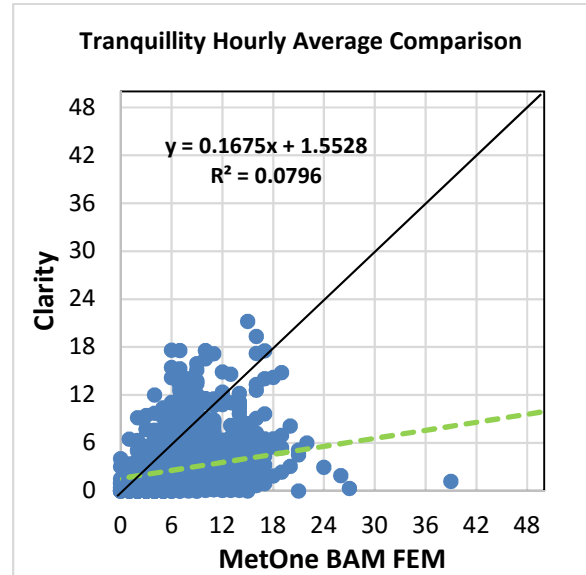
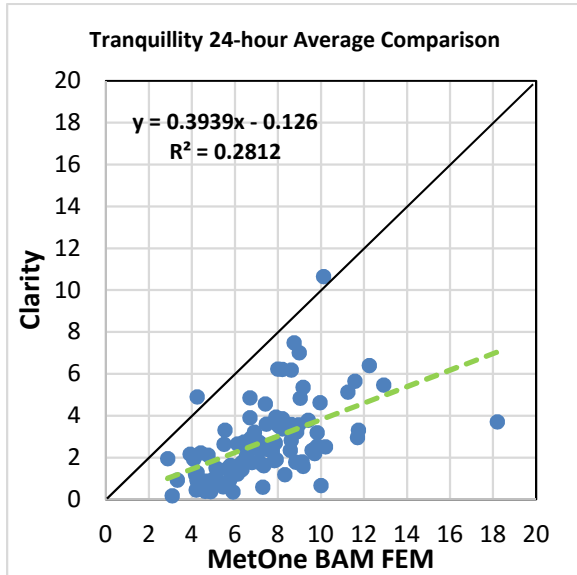
Tracy-Airport

For the 24-hour average, Clarity data had a 0.2 µg/m³ high bias during the April through June 2018 period. For the hourly average, Clarity data had a 0.2 µg/m³ high bias over the same period.



Tranquillity

For the 24-hour average, Clarity data had a 4.6 $\mu\text{g}/\text{m}^3$ low bias during the April through June 2018 period. For the hourly average, Clarity data had a 4.6 $\mu\text{g}/\text{m}^3$ 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	7.0	6.8	8.0	4.8	7.4
Sensor Avg	7.3	6.2	7.3	5.0	2.8
FEM 1-hr Max	20.4	25.4	34.0	50.0	134.0
Sensor 1-hr Max	45.3	31.2	33.5	24.0	21.2
FEM 24-hr Max	10.5	12.1	13.4	13.3	18.2
Sensor 24-hr Max	15.1	13.9	12.3	11.4	10.6
1-hr R ²	0.1158	0.1723	0.1456	0.0783	0.0796
1-hr Slope	0.7271	0.2441	0.2653	0.1682	0.1675
1-hr Intercept	2.0422	5.1676	5.3050	4.2044	1.5528
24-hr R ²	0.5928	0.5386	0.3446	0.1316	0.2812
24-hr Slope	0.5339	0.5185	0.4532	0.2751	0.3939
24-hr Intercept	3.1790	3.4736	3.7674	3.7228	-0.1260