San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2018 – 3rd 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 PM2.5. 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 PM2.5 estimates based on real-time regulatory monitor readings in the area. This self-calibration process is aimed to result in more accurate PM2.5 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, five Clarity sensors were installed and started collecting data to compare the performance of Clarity sensors to regulatory PM2.5 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 analyzed for this report compare PM2.5 data collected from Clarity sensors and Federal Equivalent Method (FEM) monitors that are collocated at the 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

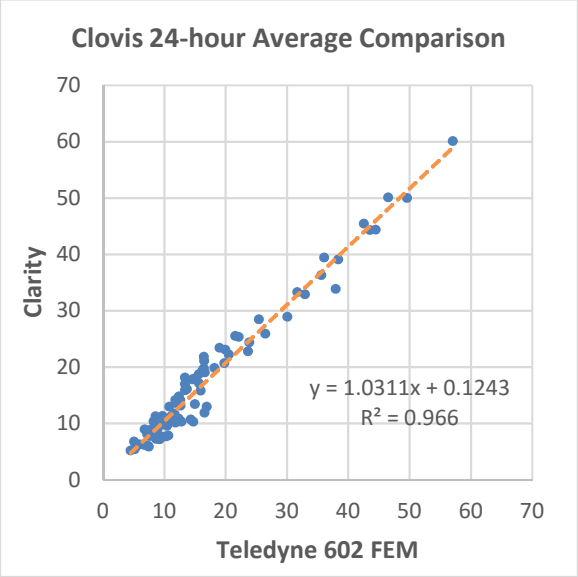
The analysis for this report covers the time period of July 2018 through September 2018 (2018 – 3rd quarter). The data from the 3rd quarter of 2018 were impacted by firework displays and several wildfires burning throughout California causing moderate to high PM readings throughout the Valley. A few troughs of low pressure passed over the region which brought smoke from the Coast Range and Northern California wildfires into the San Joaquin Valley. Eleven wildfires located on all sides of the San Joaquin Valley occurred during July and August. During the majority of this time period, high pressure resided over the Valley which not only brought smoke from the Sierras, but also kept residual wildfire smoke contained in the region.

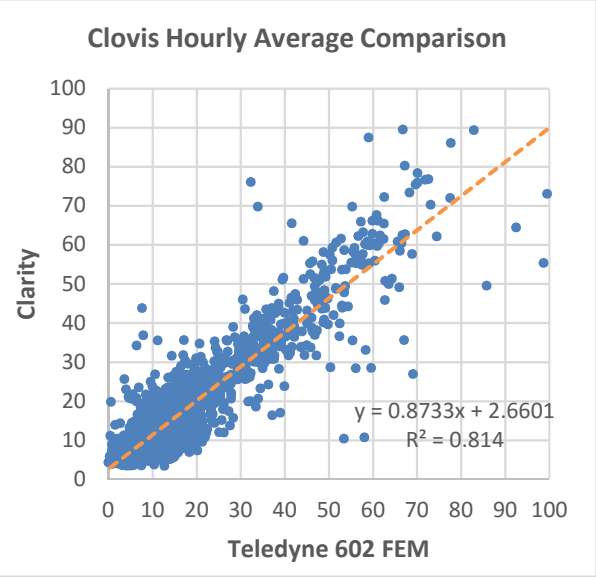
Recorded PM2.5 concentrations for both the Clarity Node sensor and regulatory monitors were relatively high through the period of July to September 2018. This assessment compares the Clarity Node performance against two different regulatory PM2.5 monitors operating in the District's network – the MetOne BAM-1020 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 high bias. Smoke impacts were detected all monitors throughout the valley as seen in the graphs below.

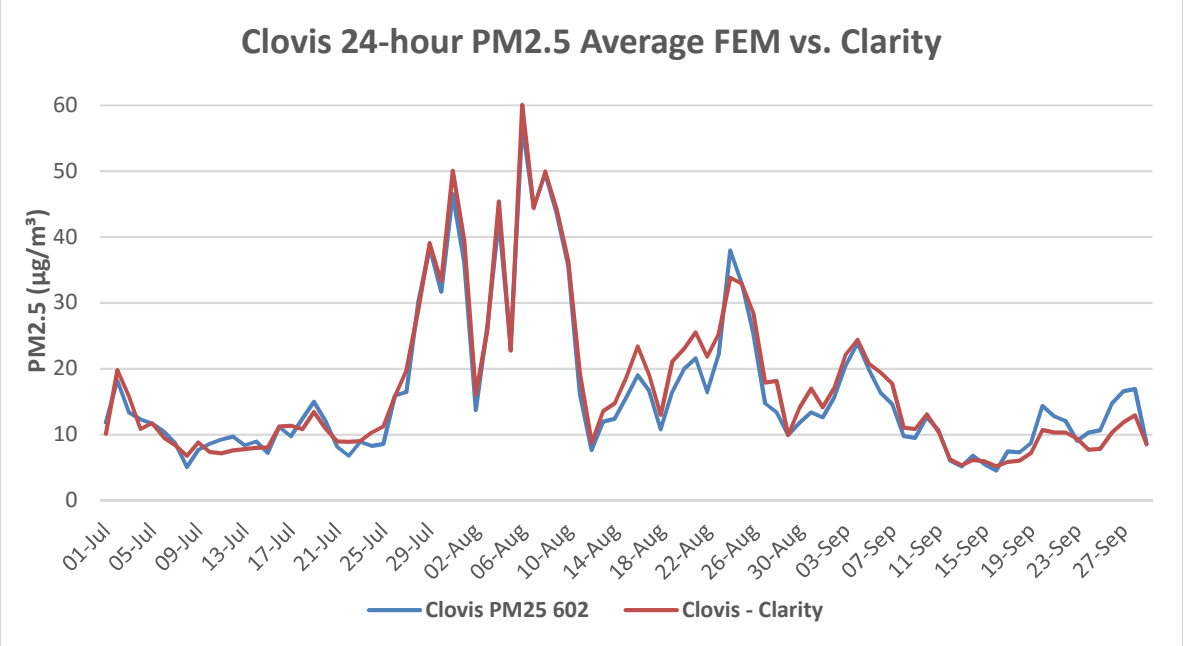
Site Specific Analysis of Clarity-Node Sensor Performance

Clovis-Villa

For the 24-hour average, Clarity data had a 0.5 µg/m^3 high bias during the July 2018 through September 2018 period. For the hourly average, Clarity data had a 0.6 µg/m^3 high bias over the same period.

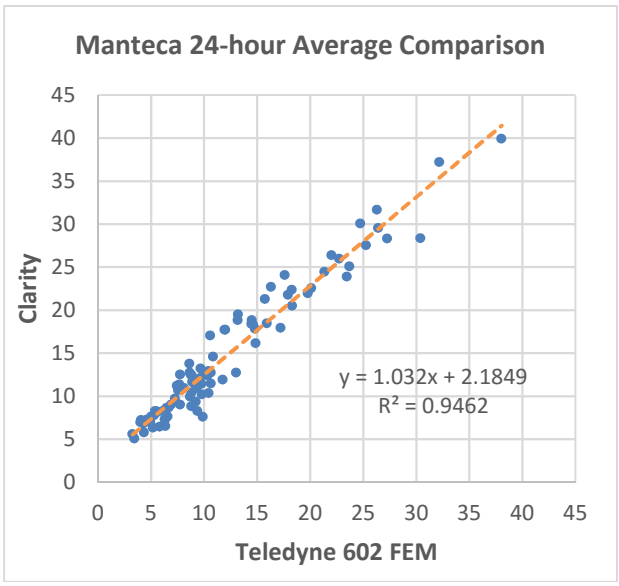


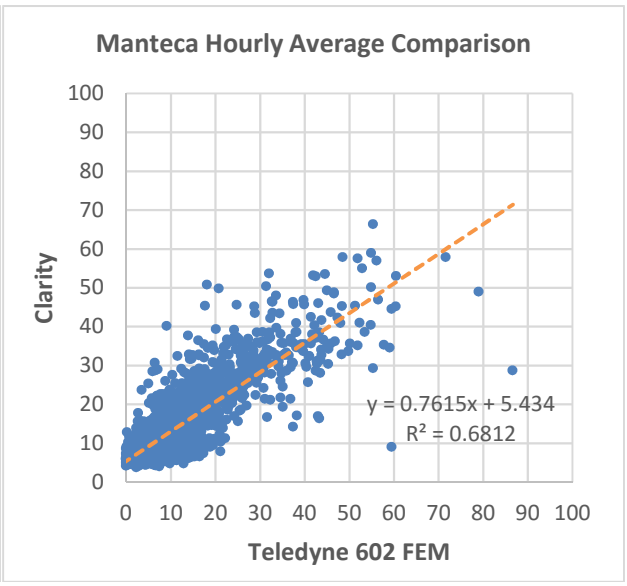


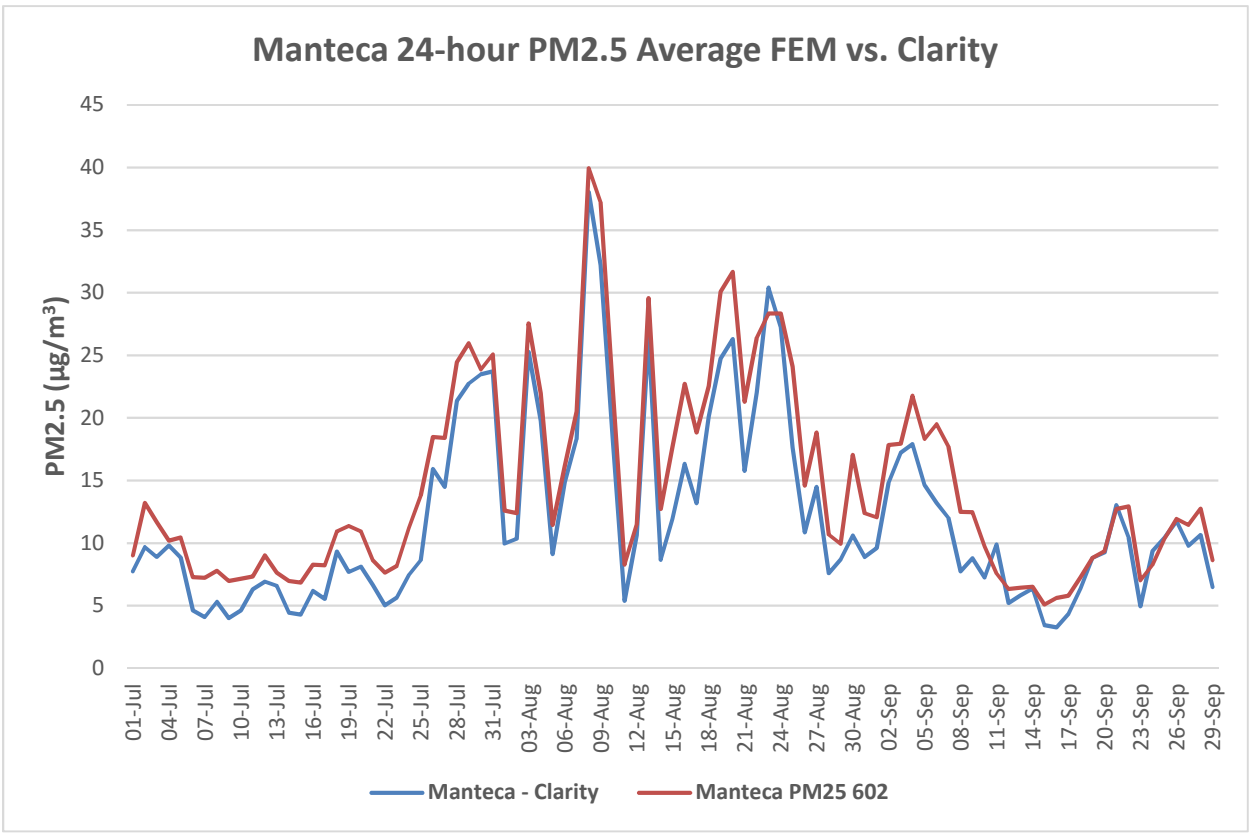


Manteca

For the 24-hour average, Clarity data had a 2.6 µg/m^3 high bias during the July 2018 through September 2018 period. For the hourly average, Clarity data had a 2.6 µg/m^3 high bias over the same period.

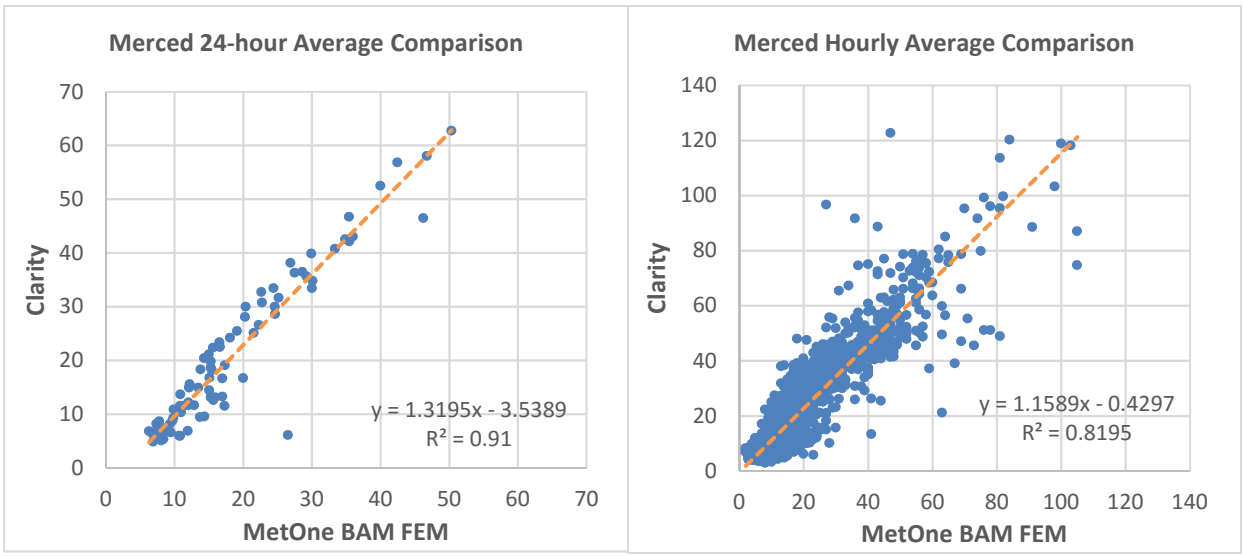


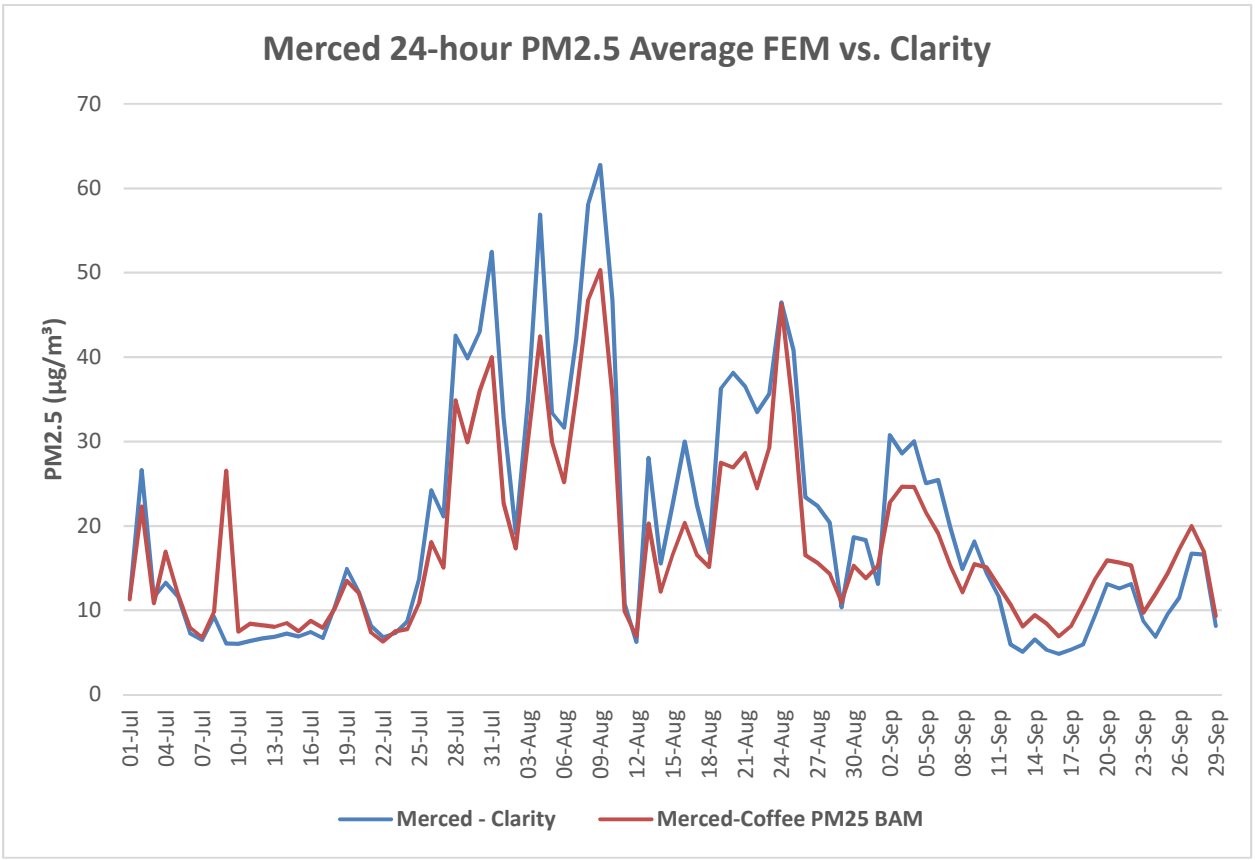




Merced-Coffee

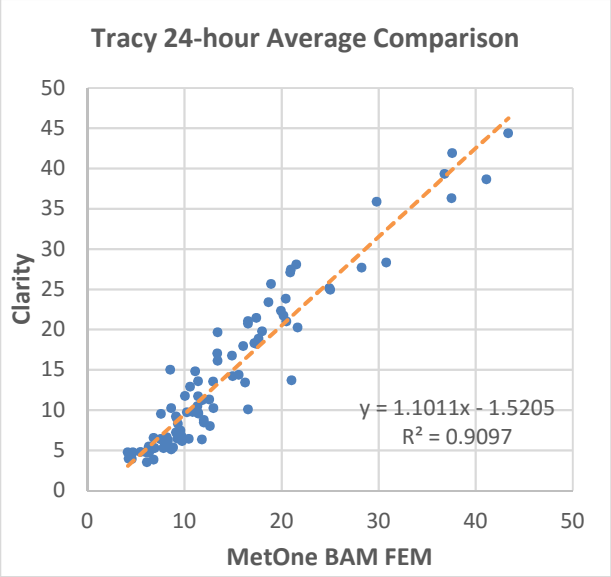
For the 24-hour average, Clarity data had a 2.3 µg/m^3 high bias during the July through September 2018 period. For the hourly average, Clarity data had a 2.2 µg/m^3 high bias over the same period.

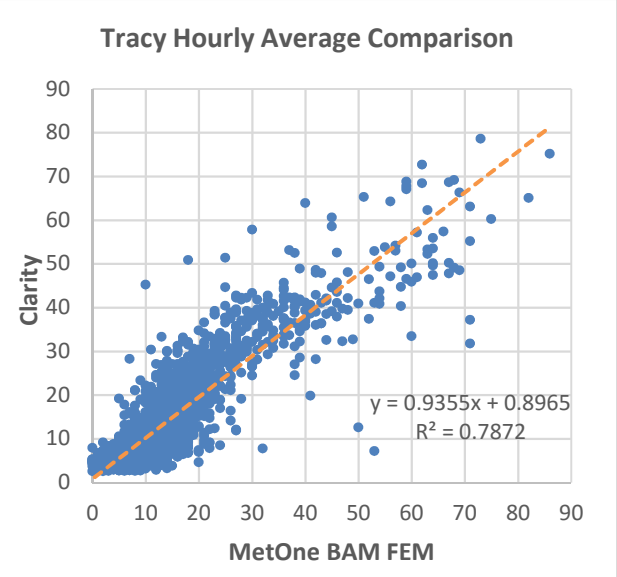


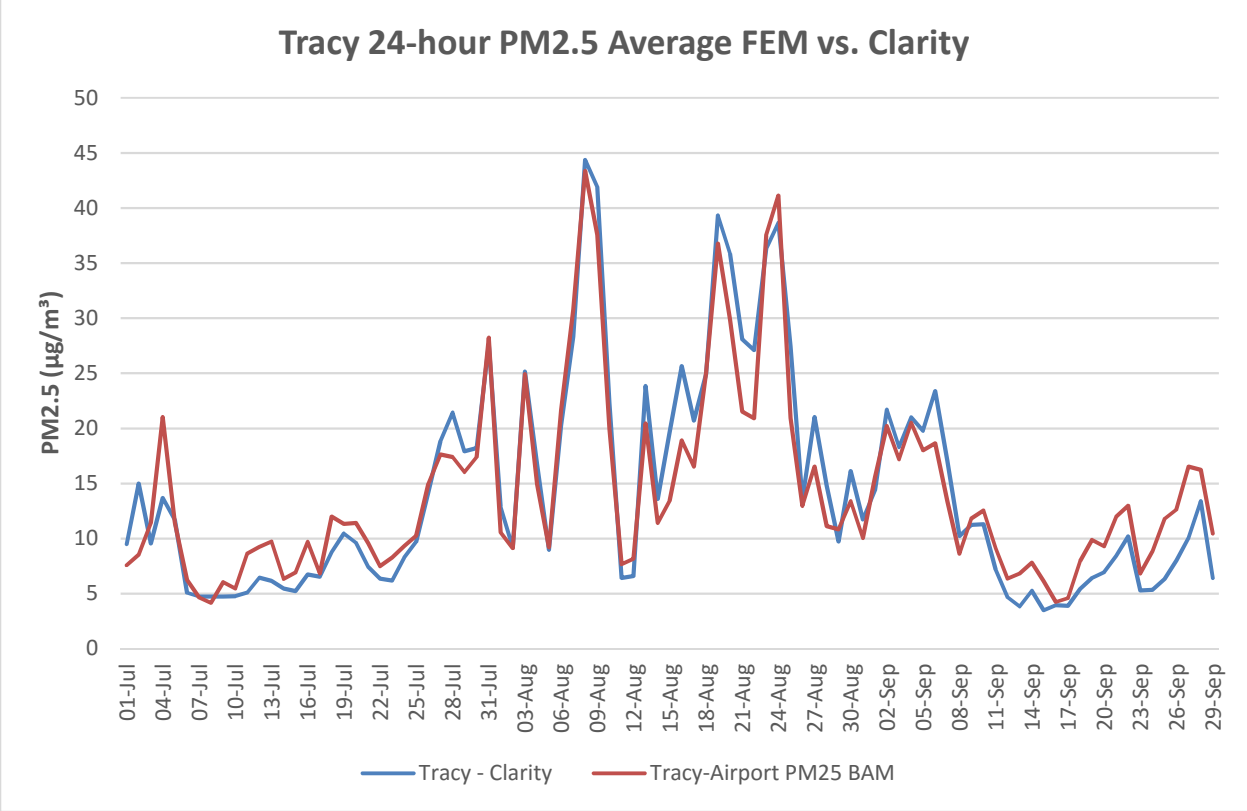


Tracy-Airport

For the 24-hour average, Clarity data had a 0.0 µg/m^3 bias during the July through September 2018 period. For the hourly average, Clarity data had a 0.1 µg/m^3 low bias over the same period.

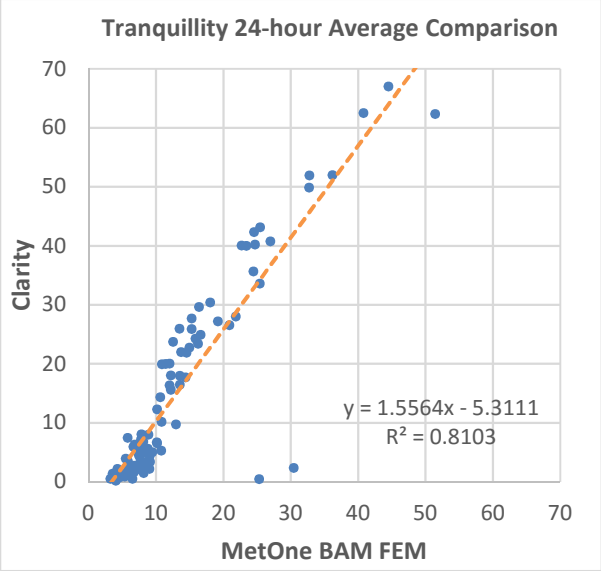


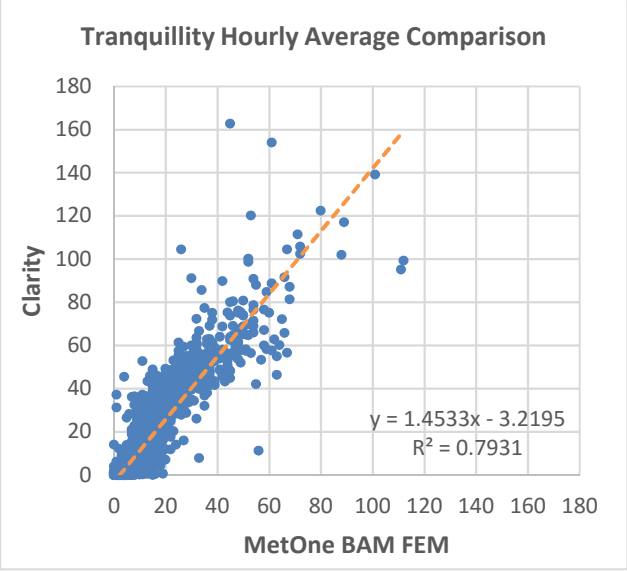


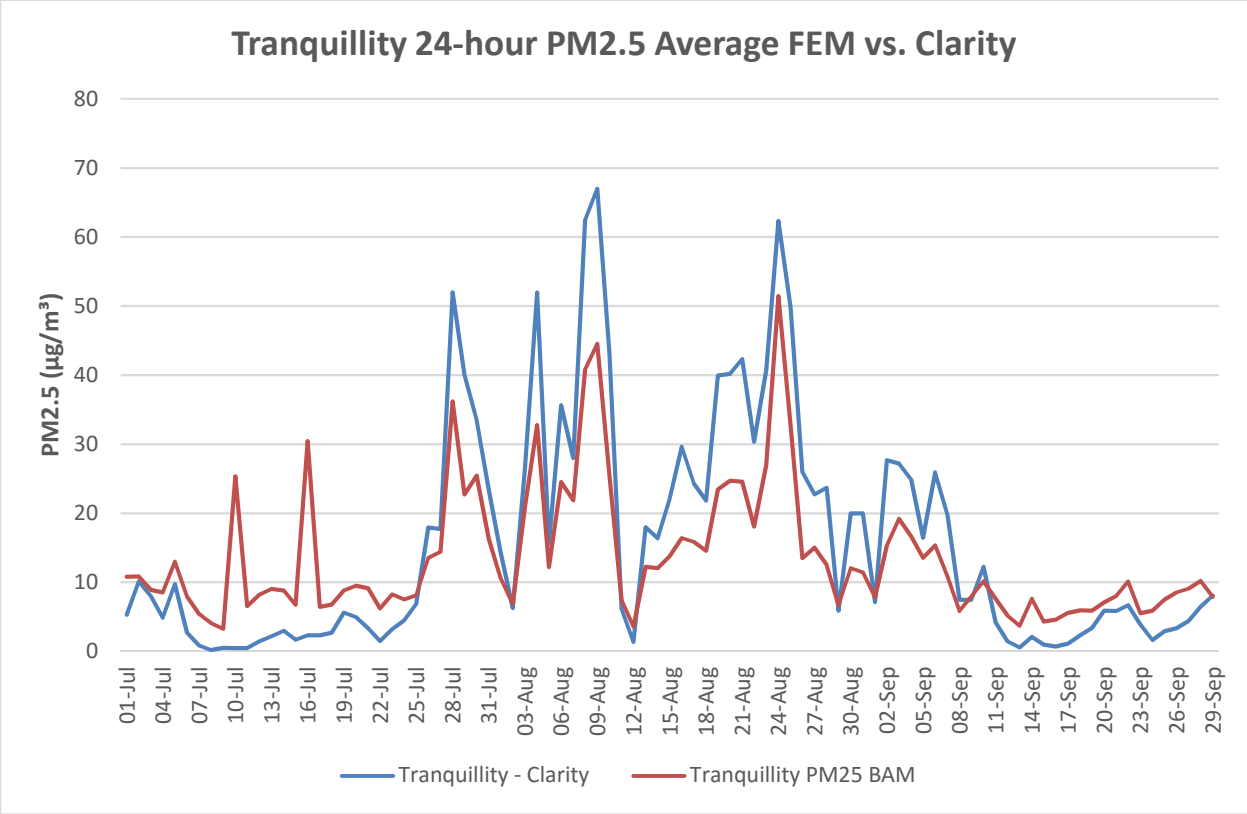


Tranquillity

For the 24-hour average, Clarity data had a 2.7 µg/m^3 high bias during the July through September 2018 period. For the hourly average, Clarity data had a 2.2 µg/m^3 high 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	17.3	14.6	17.8	14.2	13.4
Sensor Avg	16.3	12.0	19.8	14.4	15.6
FEM 1-hr Max	89.5	86.6	105.0	86.0	112.0
Sensor 1-hr Max	99.5	66.4	122.8	78.6	162.7
FEM 24-hr Max	60.1	39.9	50.3	43.4	51.5
Sensor 24-hr Max	57.1	38.0	62.8	44.4	67.0
1-hr R^2	0.8140	0.6812	0.8195	0.7872	0.7931
1-hr Slope	0.8733	0.7615	1.1589	0.9355	1.4533
1-hr Intercept	2.6601	5.4340	-0.4297	0.8965	-3.2195
24-hr R^2	0.9660	0.9462	0.9100	0.9097	0.8103
24-hr Slope	1.0311	1.0320	1.3195	1.1011	1.5564
24-hr Intercept	0.1243	2.1849	-3.5389	-1.5205	-5.3111