San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2020 – 1st 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

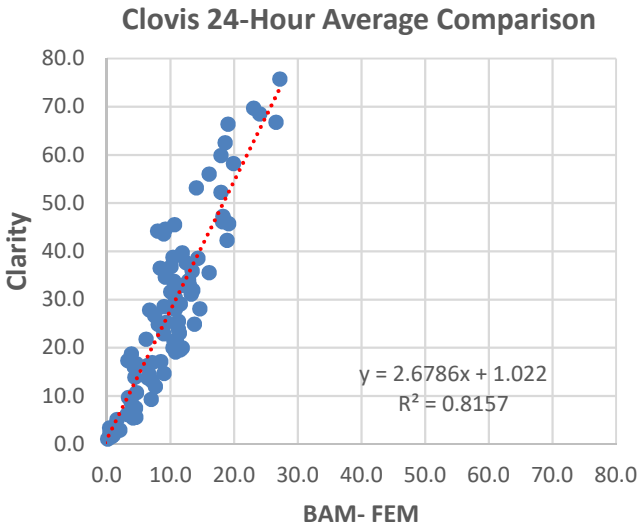
This assessment compares the Clarity Node performance against PM2.5 monitors operating in the District's network – the MetOne BAM-1020. The analysis for this report covers the time period of January 2020 through March 2020 (2020 – 1st quarter). During this this period, hourly data was removed from the calculation of bias when either the Clarity 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. For this quarter analysis, the Clarity sensor at the Clovis and Manteca sites were compared to data from the BAM as the 602 was removed from the sites. The 602 had been used in previous quarterly analyses.

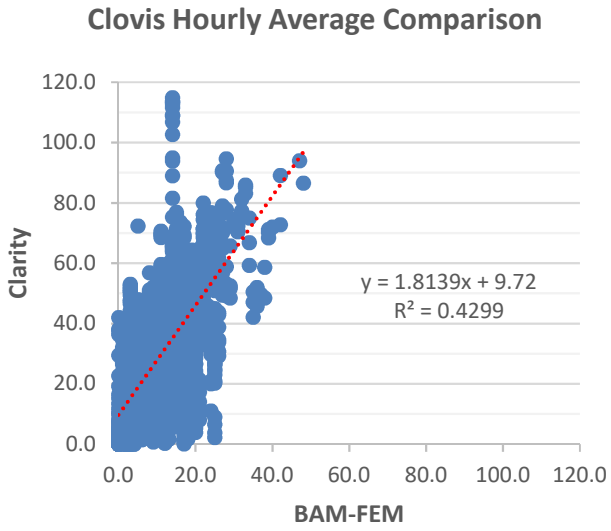
Concentrations during January and February 2020 were influenced by alternating high pressure systems and low pressure systems. As such, January and February saw PM2.5 concentrations fluctuate; increasing when high pressure and poor dispersion were present, and decreasing when dispersion improved. In contrast, PM2.5 concentrations were lower in through March and into April 2020 due to longer periods of improved dispersion conditions resulting from low pressure systems passing through the region more regularly.

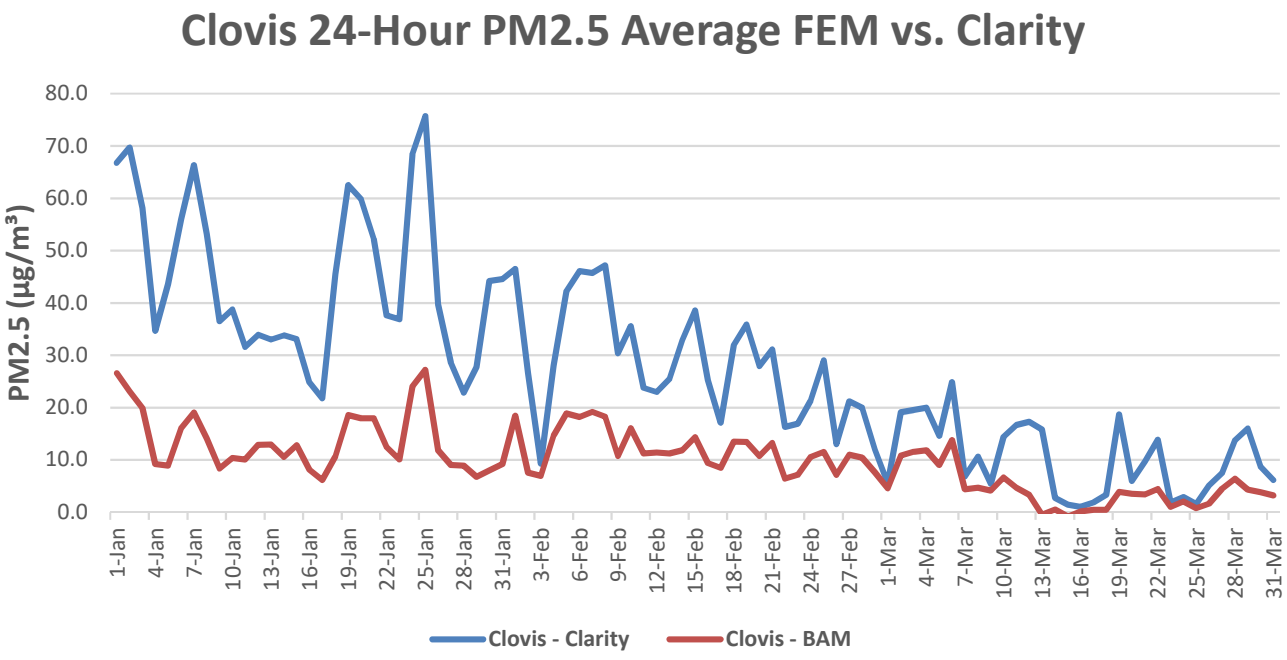
Site Specific Analysis of Clarity-Node Sensor Performance

Clovis-Villa

For the 24-hour average, Clarity data had a 17.7 µg/m^3 high bias during the January 2020 through March 2020 period. For the hourly average, Clarity data had a 17.9 µg/m^3 high bias over the same period.

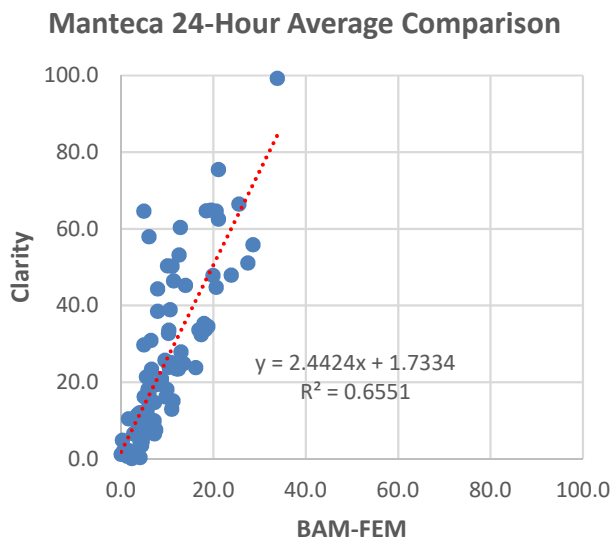


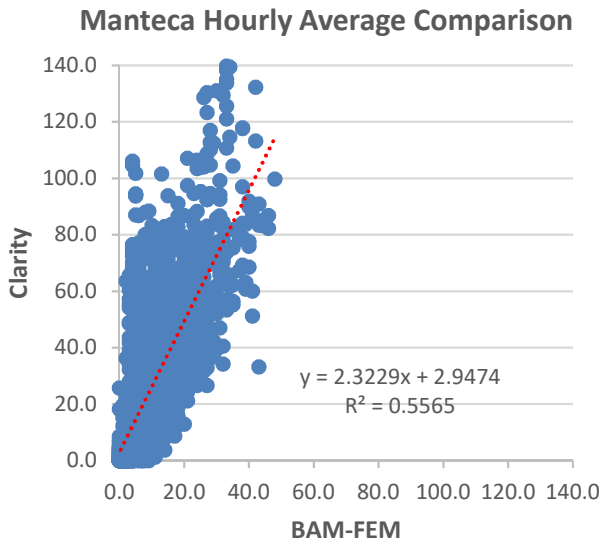


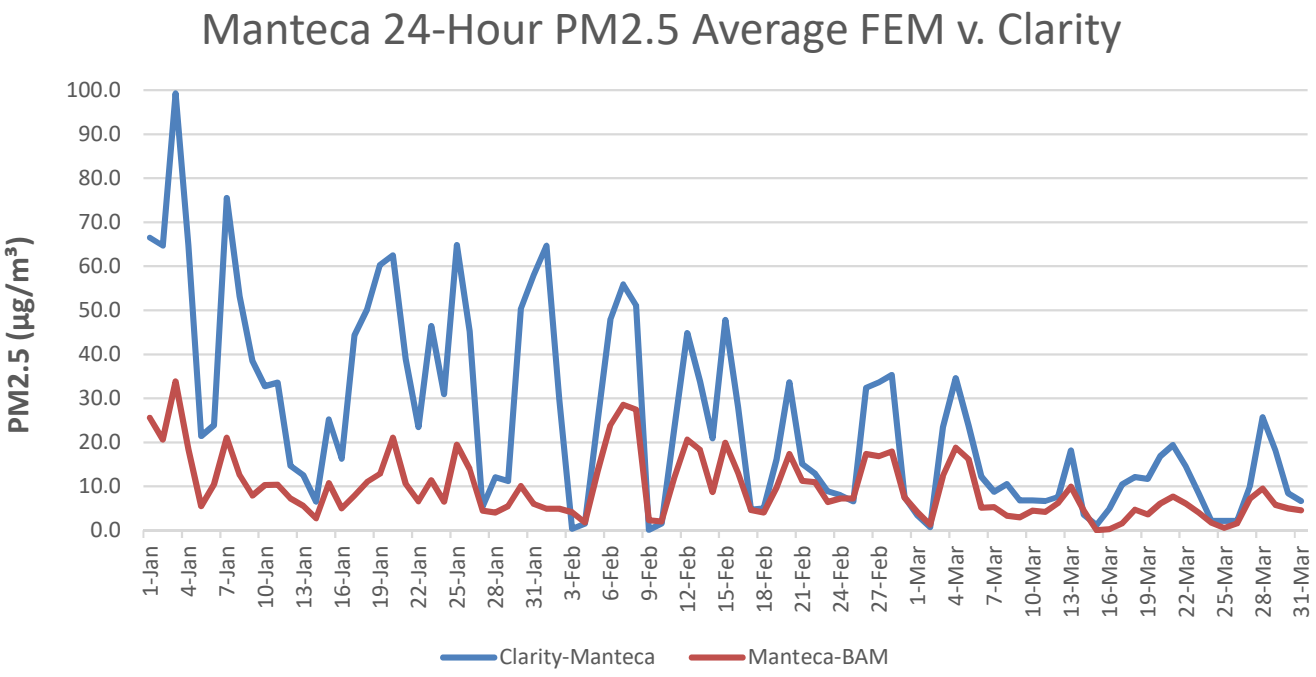


Manteca

For the 24-hour average, Clarity data had a 17.0 µg/m^3 high bias during the January 2020 through March 2020 period. For the hourly average, Clarity data had a 15.6 µg/m^3 high bias over the same period.

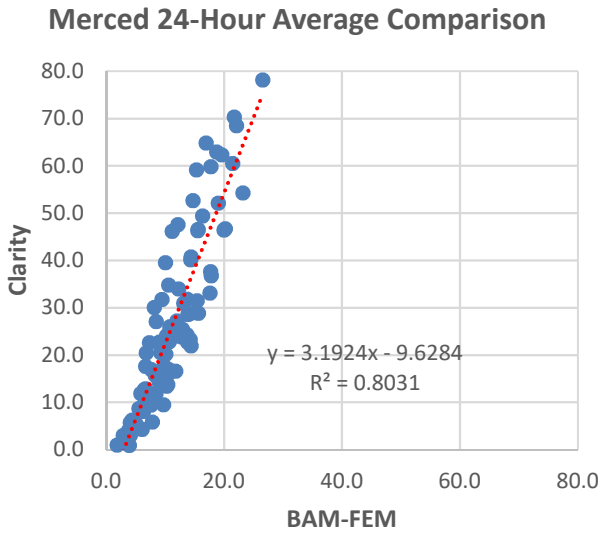


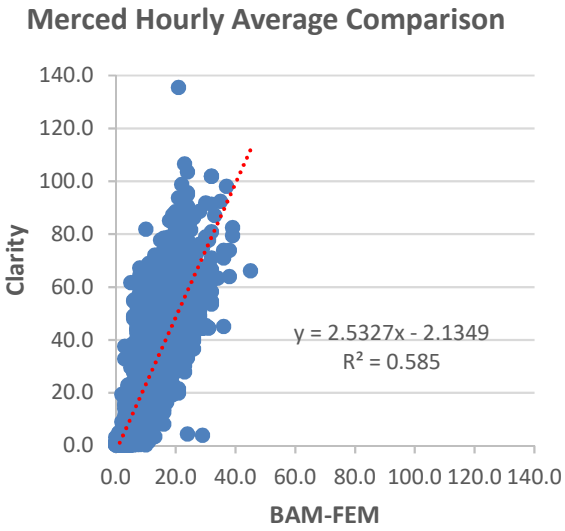


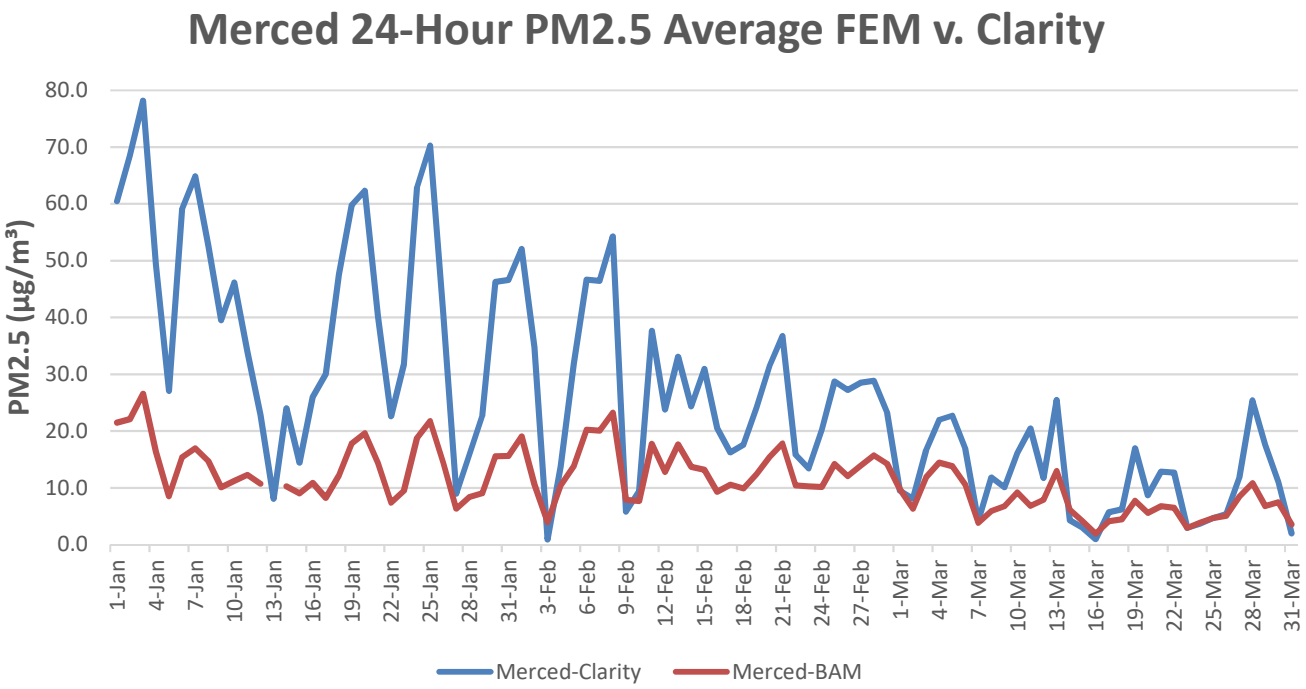


Merced-Coffee

For the 24-hour average, Clarity data had a 15.3 µg/m^3 high bias during the January through March 2020 period. For the hourly average, Clarity data had a 15.3 µg/m^3 high bias over the same period.

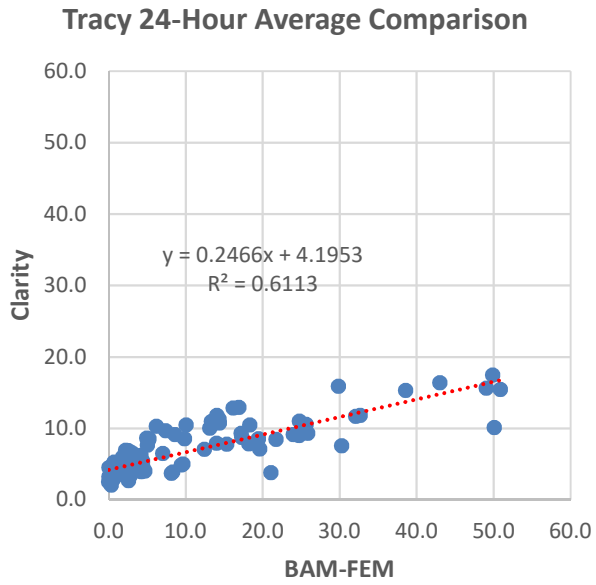


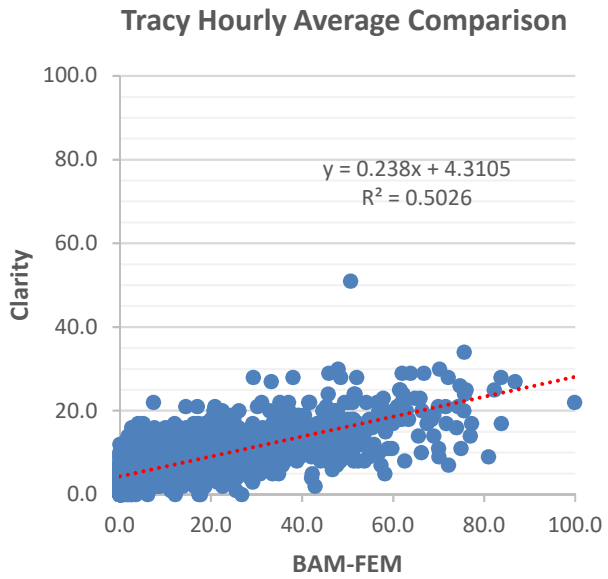


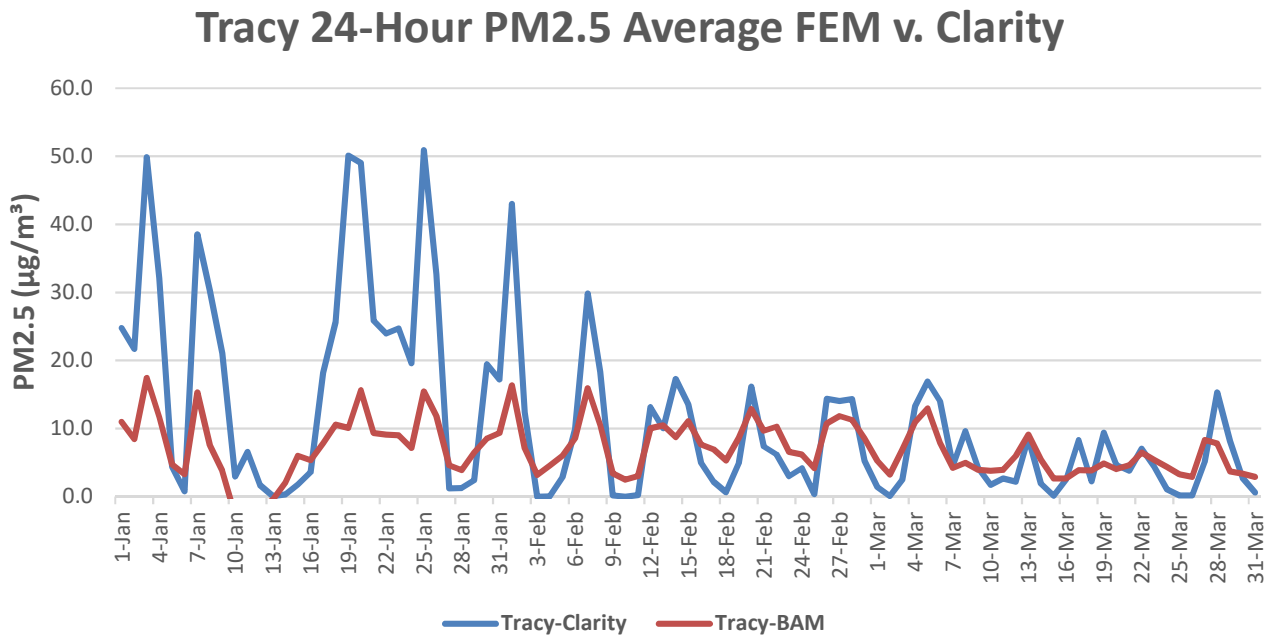


Tracy-Airport

For the 24-hour average, Clarity data had a 4.3 µg/m^3 high bias during the January through March 2020 period. For the hourly average, Clarity data had a 4.3 µg/m^3 high bias over the same period.

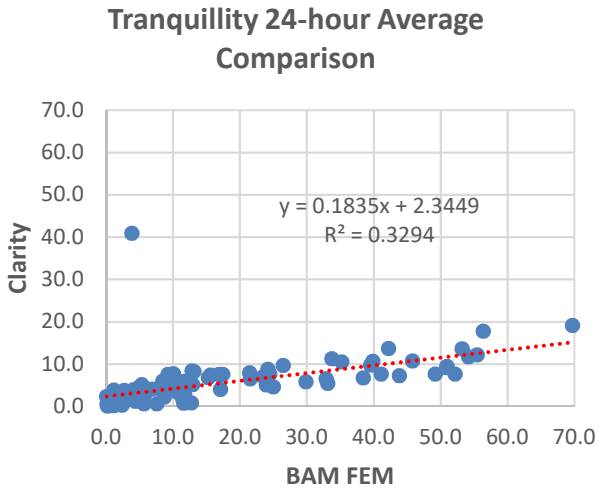


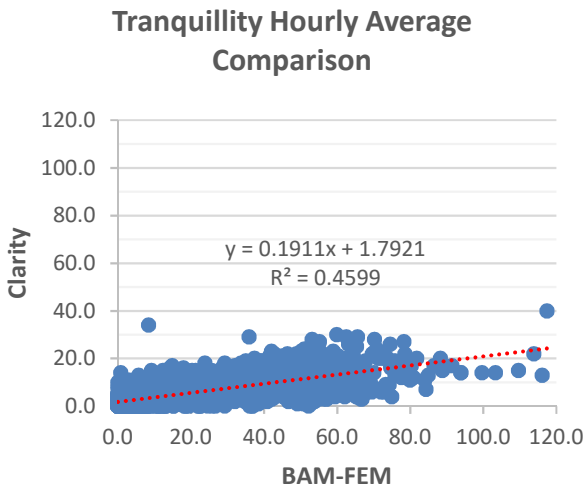


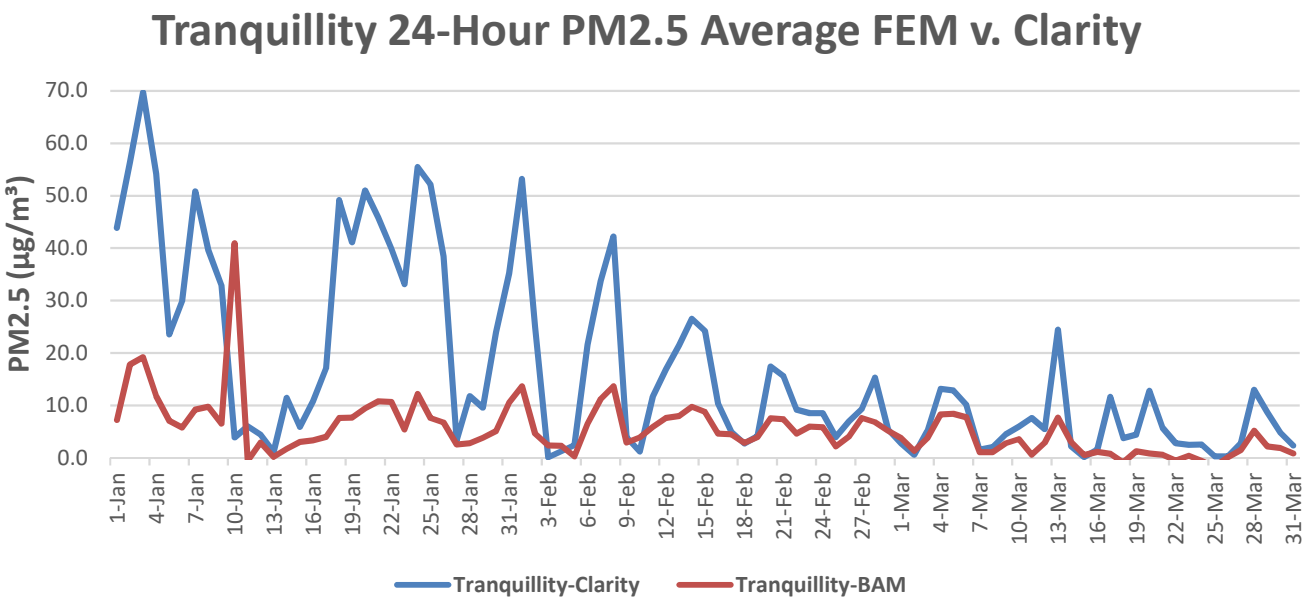


Tranquillity

For the 24-hour average, Clarity data had an 11.4 µg/m^3 high bias during the January through March 2020 period. For the hourly average, Clarity data had an 11.9 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	9.9	9.6	11.4	7.0	5.4
Sensor Avg	27.6	25.2	26.5	11.3	16.9
FEM 1-hr Max	48.0	48.0	45.0	51.0	40.0
Sensor 1-hr Max	114.8	139.7	135.4	99.9	117.4
FEM 24-hr Max	27.2	33.8	26.6	17.5	40.9
Sensor 24-hr Max	75.7	99.3	78.2	50.9	69.7
1-hr R^2	0.4299	.5565	0.585	0.5026	0.4599
1-hr Slope	1.8139	2.3229	2.5327	0.238	0.1911
1-hr Intercept	9.72	2.9474	-2.1349	4.3105	1.7921
24-hr R^2	0.8157	.6551	0.8031	0.6113	0.3294
24-hr Slope	2.6786	2.4424	3.1924	0.2466	0.1835
24-hr Intercept	1.022	1.7334	-9.6284	4.1953	2.3449