San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2020 – 4th 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 October 2020 through December 2020 (2020 – 4th quarter). During 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 averages, only days with 18 or more valid hourly samples (75% or greater completeness) are included.

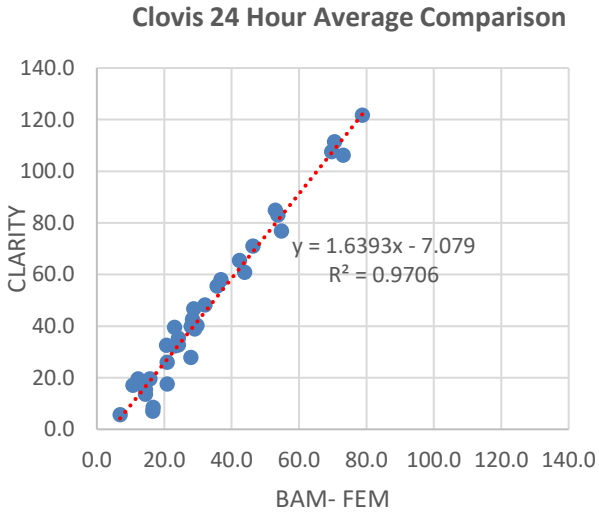
Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Weather systems can influence PM2.5 concentrations by either trapping pollutants near the surface or dispersing them. High pressure systems that built over the region in October 2020 remained in place for longer durations than normal. Much of October saw elevated PM2.5 concentration due to extended periods of strong stability and wildfire smoke impacts. Wildfire smoke impacts subsided in November 2020 and PM2.5 concentrations were able to decrease. An alternating pattern of high and low pressures systems moved through region during December, however, the trajectories of most of the low pressure systems that passed through were such that they did not provide good dispersion for the Valley. Thus the majority of December was governed by stability and elevated PM2.5 levels.

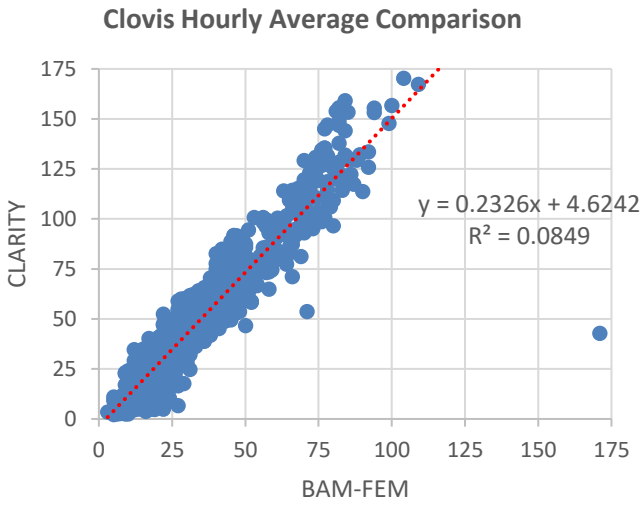
*****This Quarter 4 2020 report is the final quarterly analysis report for the Clarity Node sensor. No further quarterly analyses will be completed.*****

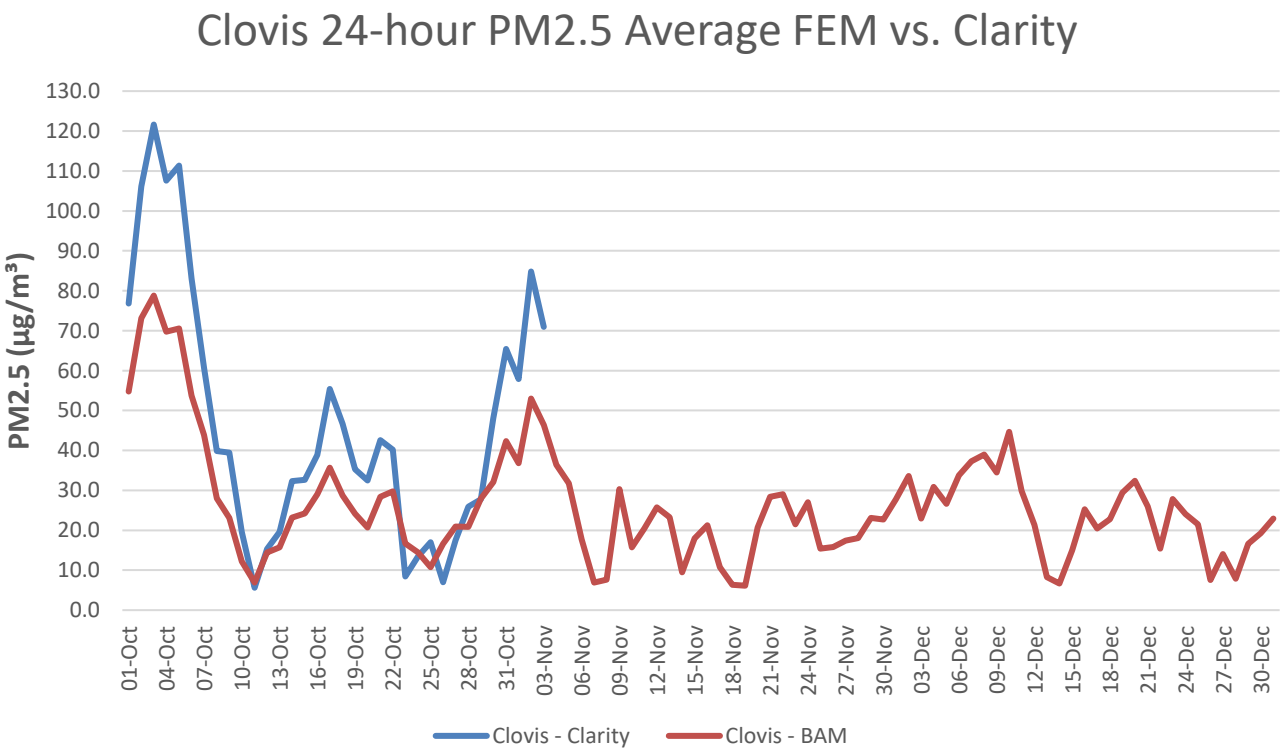
Site Specific Analysis of Clarity-Node Sensor Performance

Clovis-Villa

For the 24-hour average, Clarity data had a 14.1 µg/m^3 high bias during the October 2020 through December 2020 period. For the hourly average, Clarity data had a 14.1 µg/m^3 high bias over the same period.

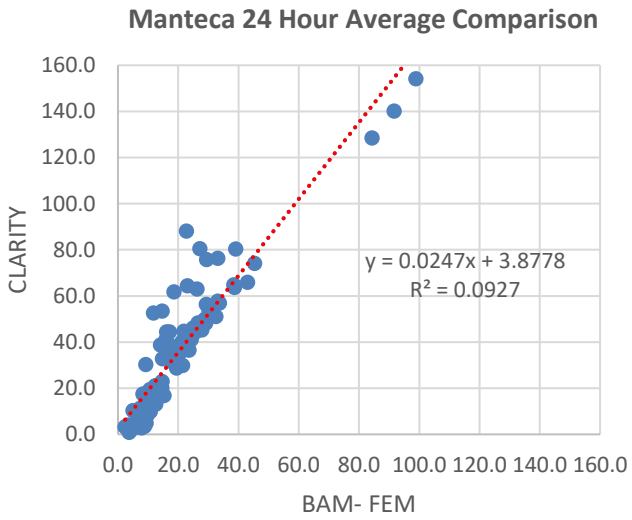


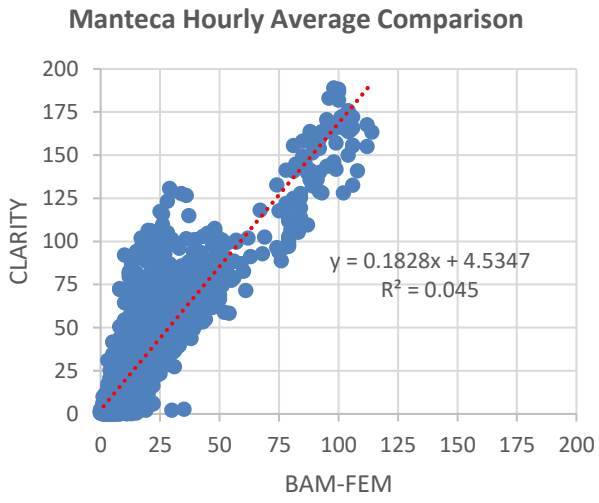


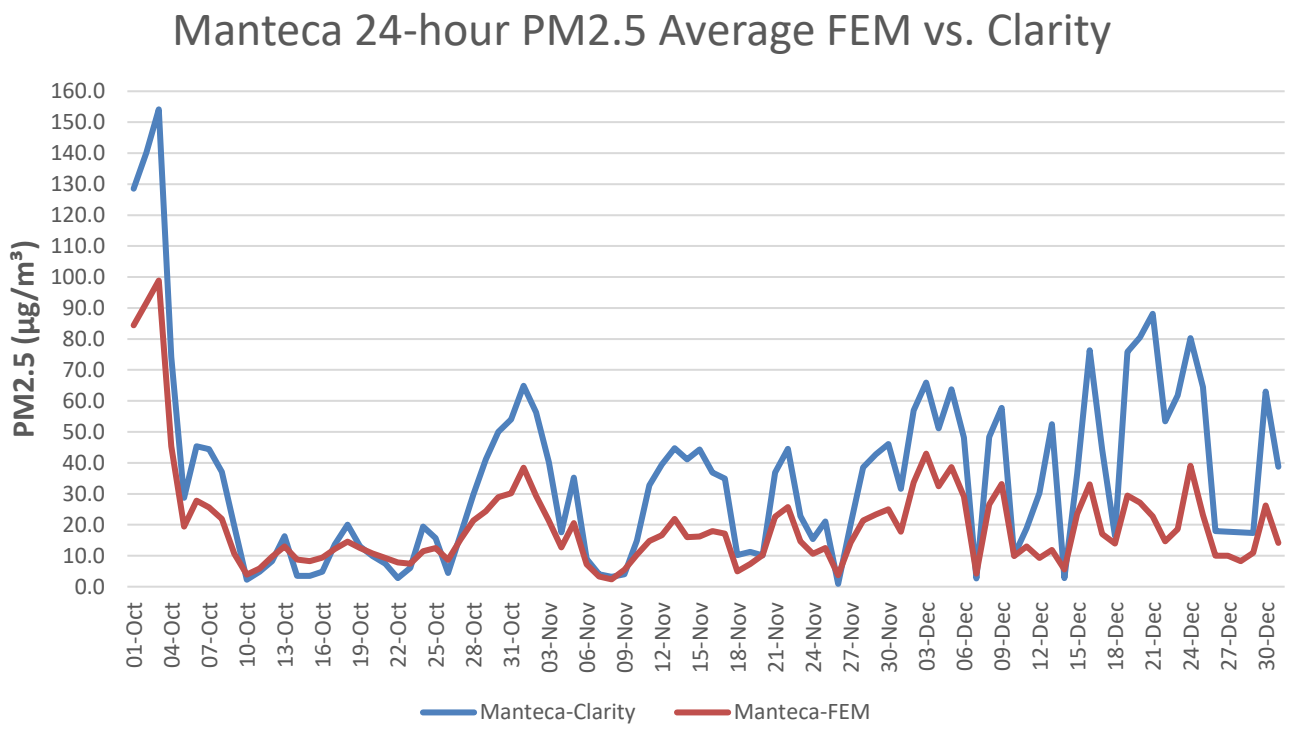


Manteca

For the 24-hour average, Clarity data had a 15.5 µg/m^3 high bias during the October 2020 through December 2020 period. For the hourly average, Clarity data had a 15.6 µg/m^3 high bias over the same period.

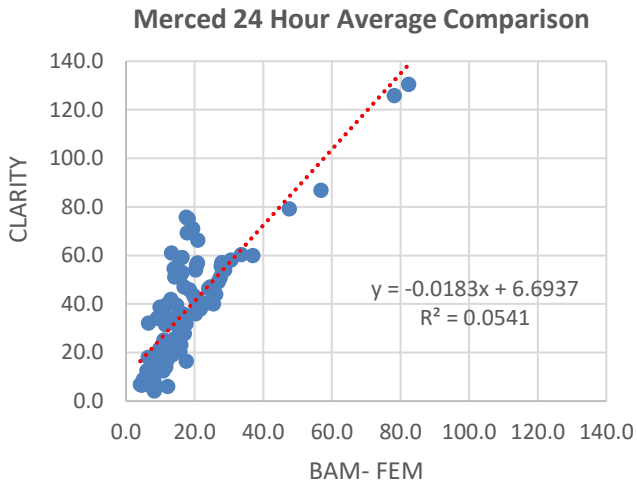


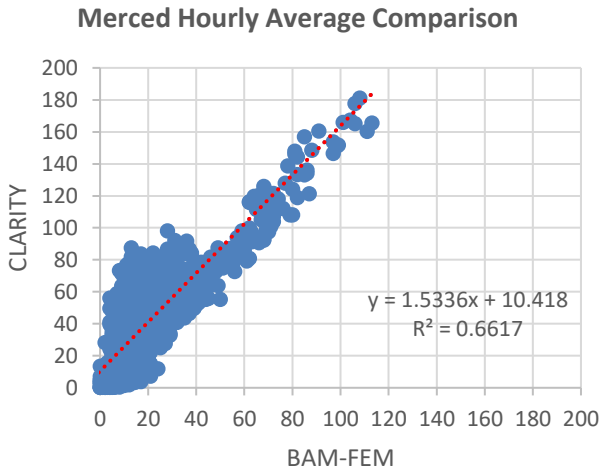


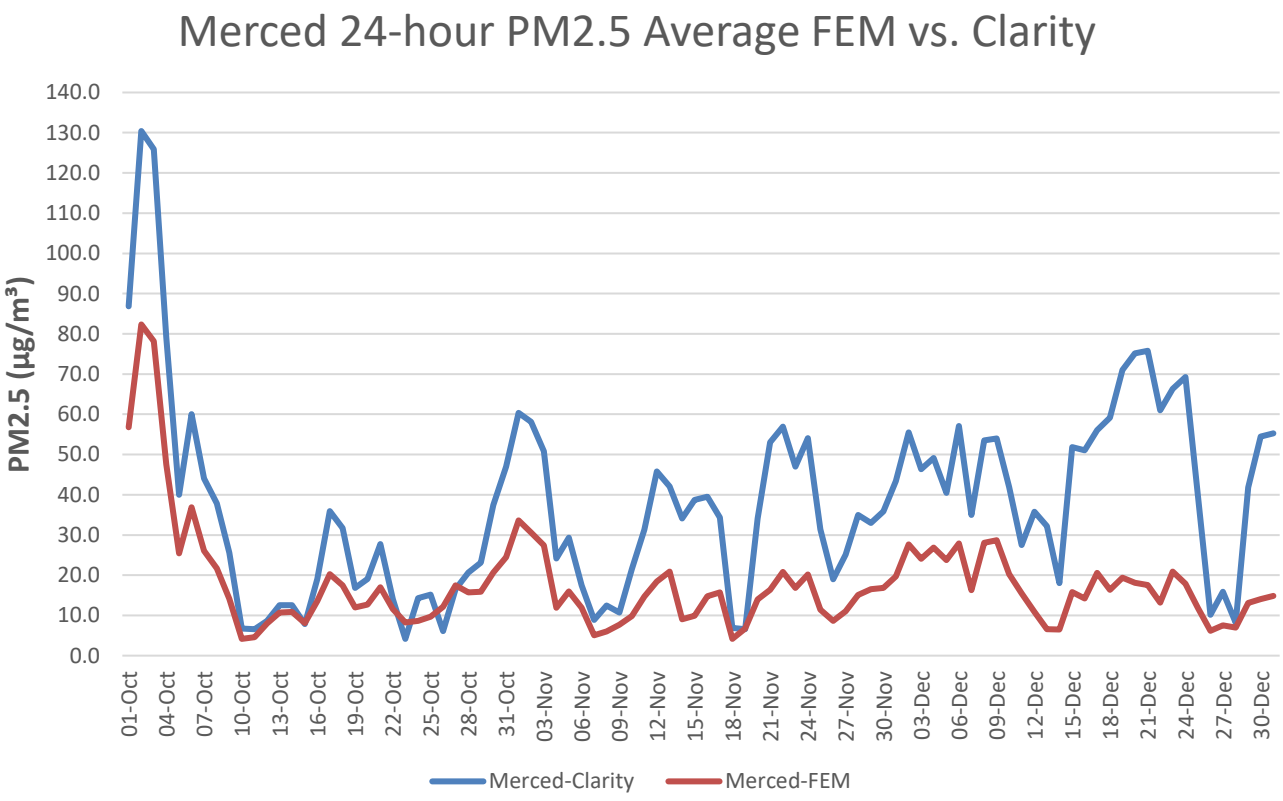


Merced-Coffee

For the 24-hour average, Clarity data had a 20.0 µg/m^3 high bias during the October through December 2020 period. For the hourly average, Clarity data had a 20.0 µg/m^3 high bias over the same period.

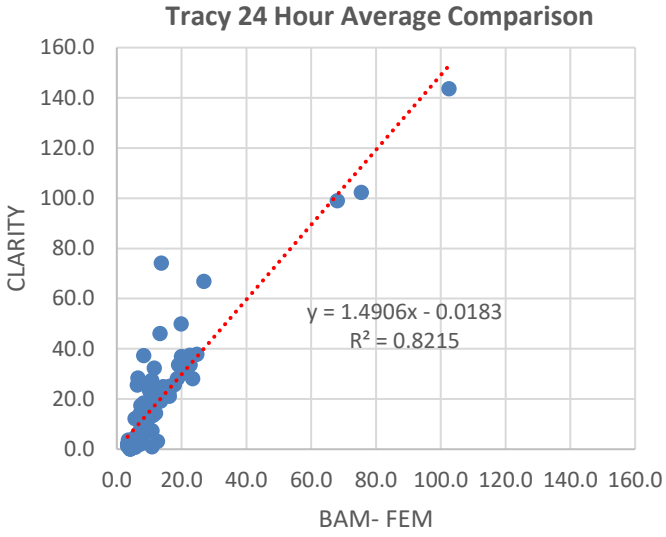


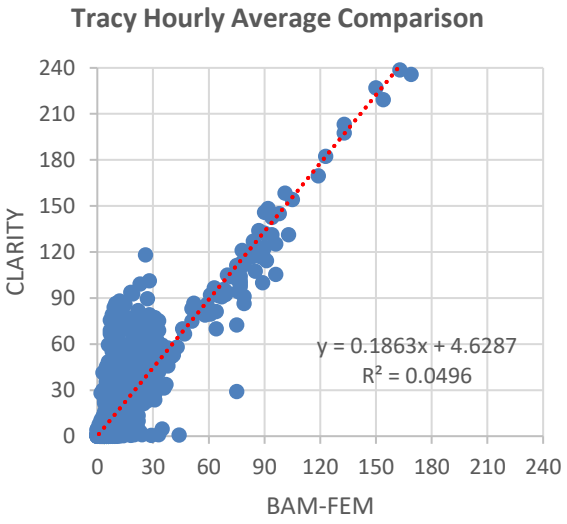


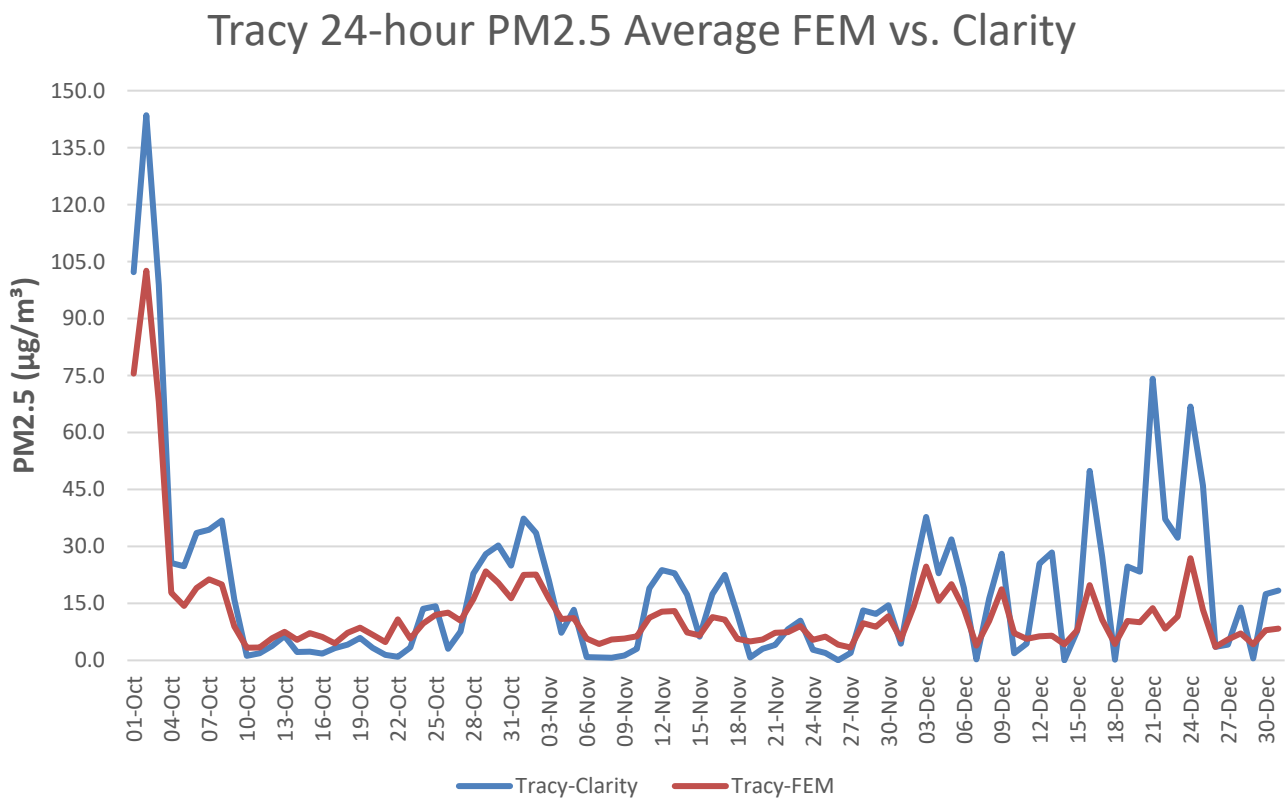


Tracy-Airport

For the 24-hour average, Clarity data had a 6.2 µg/m^3 high bias during the October through December 2020 period. For the hourly average, Clarity data had a 6.2 µg/m^3 high bias over the same period.

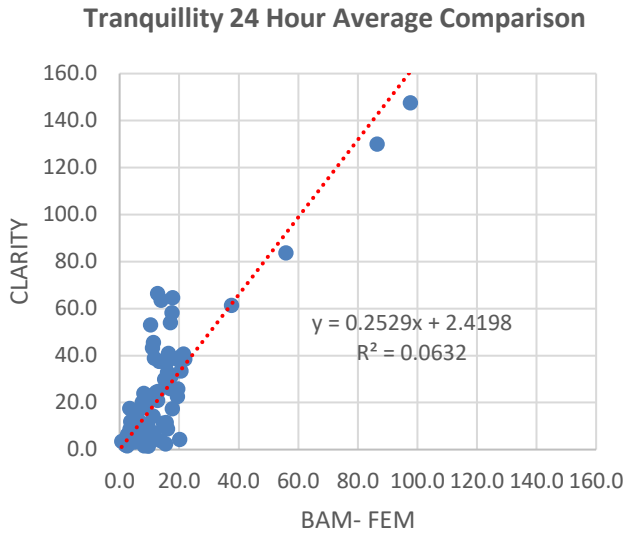


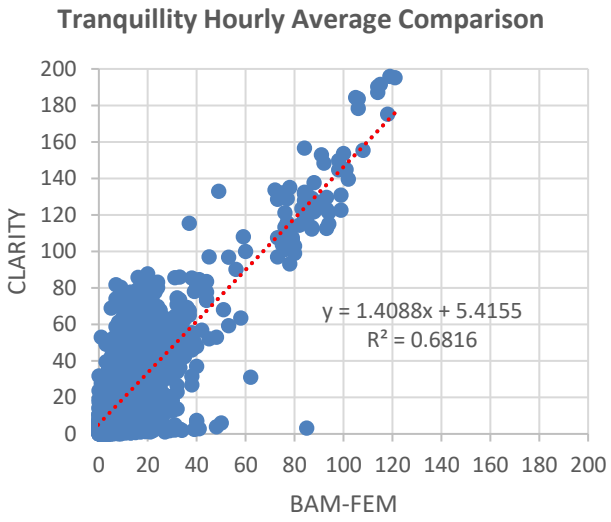


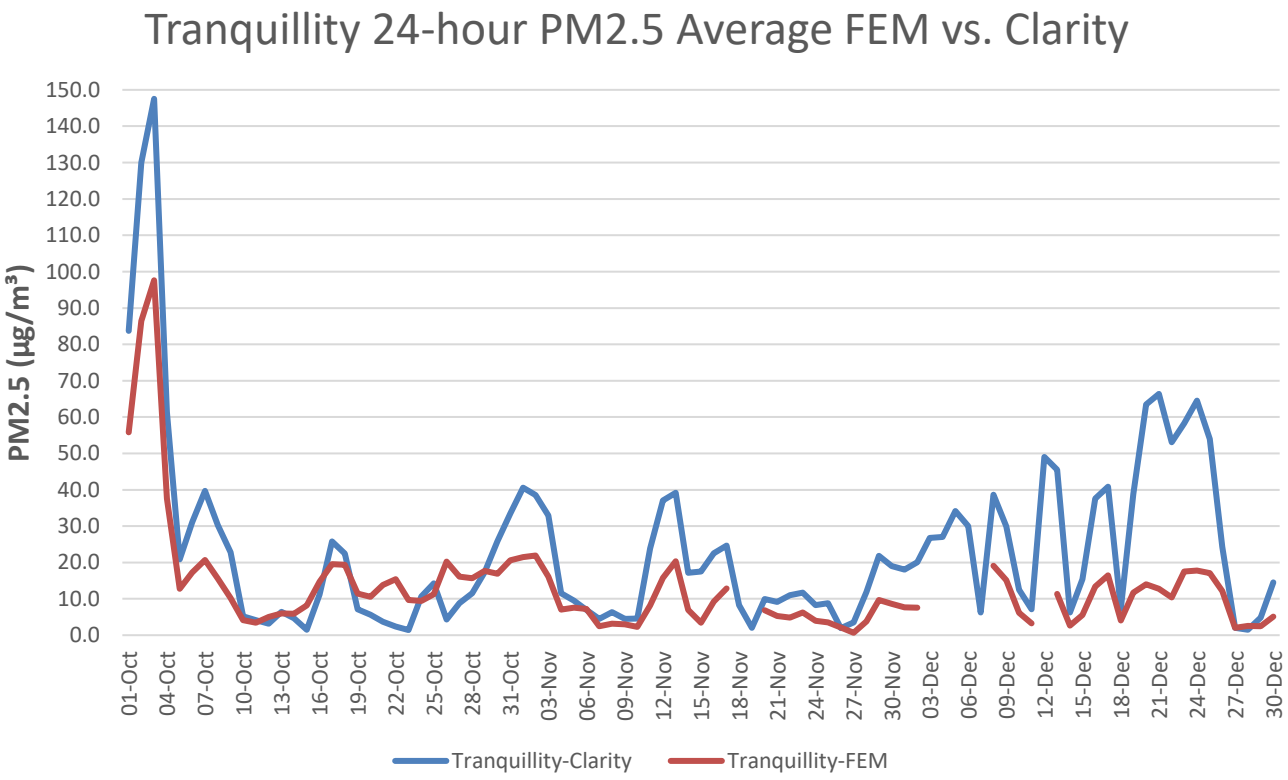


Tranquillity

For the 24-hour average, Clarity data had an 11.0 µg/m^3 high bias during the October through December 2020 period. For the hourly average, Clarity data had an 11.1 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	25.8	19.9	17.9	12.6	13.1
Sensor Avg	47.3	35.4	37.9	18.8	24.0
FEM 1-hr Max	171.0	114.0	113.0	169.0	121.0
Sensor 1-hr Max	170.3	189.0	181.1	238.6	195.8
FEM 24-hr Max	78.8	98.9	82.3	102.6	97.6
Sensor 24-hr Max	121.6	154.2	130.4	143.5	147.5
1-hr R^2	0.0849	0.045	0.6617	0.0496	0.6816
1-hr Slope	0.2326	0.1828	1.5336	0.1863	1.4088
1-hr Intercept	4.6242	4.5347	10.418	4.6287	5.4155
24-hr R^2	0.9706	0.0927	0.0541	0.8215	0.0632
24-hr Slope	1.6393	0.0247	-0.0183	1.4906	0.2529
24-hr Intercept	-7.079	3.8778	6.6937	-0.0183	2.4198