SOUTH COUNTY COMMUNITY MONITORING PROJECT

Appendix A – Project Quality Assurance/Quality Control

Preliminary Evaluation of EBAM Samplers

Maintaining and operating the large number of samplers with a small project staff required extensive planning and testing of samplers prior to deployment in the field to ensure adequate quality and completeness of data collected in this project. Most samplers utilized for this project were borrowed from other government agencies; in most cases, the sampler's maintenance history and performance were largely unknown. Upon receipt from the loaning organization each sampler was set up in the APCD laboratory, existing configuration documented, and thoroughly cleaned following procedures that exceeded the manufacture's recommendations. Each sampler was then configured to the standard configuration utilized by the APCD for this project, ensuring the configuration of all samplers was identical and appropriate for this application. Table A1 below presents this standard configuration with criteria not specific to each instrument highlighted.

Table A1 – EBAM Configuration

Baud: 9600
ConcRef: 0
ConcDacMode: 1
DacRefFS: 0
SamplePeriod: 3600
LogPeriod: 3600
LocID: 19
FlowSetPt: 16.7
FlowType: 0
IGain: 100
K: 1.080
Bkgd: -0.001
AbsZero: 0.350
AbsSpan: 0.976
Usw: 0.285
RHSetPt: 35
DTSetPt: 15
RHCtrl: 1
FactoryMode: 0
PumpProtect: 0
LoVacuum: 228.6
HiVacuum: 266.7
MachineType: 1
ExtSensor: 0
MinRestart: 12.50
StandardTemp: 25

While some of the configuration variables are specific to each sampler, ensuring all samplers are configured identically for the parameters not specific to each sampler was important for comparative measurements.

Zero Background Test

Next each sampler was set up for a zero background test in an enclosed area to prevent drastic temperatures changes and exclude ambient dust. The zero background test is performed by allowing the instrument to sample in normal mode with a HEPA filter attached to the inlet. The filter prevents any particulate matter greater than 0.3 micrometers from entering the sampler's sample path, which results in the sampler sampling ambient air containing essentially a concentration of zero. The zero background test is useful in identifying samplers with a noisy response. The EBAM samplers, even under perfect conditions are known to have a higher signal to noise ratio than similar federally approved permanent beta attenuation monitors such as the MetOne BAM1020 due to the greater distance between the beta source and detector. In addition to the EBAM source/detector distance contributing to greater variability in response, other aspects of the EBAM design can also contribute to higher variability in readings. For example, the beta source being located in the sample path has been shown to accumulate particulate and at some point as more and more particulate is deposited on the source; particles of the size of a grain of sand will fall off, depositing on the filter tape, resulting in a spike in the PM_{10} data for that hour. Additionally, due to the very small size of the sampler's inlet heater (40 watts as compared to 250 watt in the BAM1020), in moist environments, it is possible for water to condense on the filter tape, again resulting in a positive spike in the PM_{10} data for that hour.

The zero background test is run over at least 3 days. The data from the test is downloaded and the first few hours discarded. The remaining next 72 hours are evaluated for mean value as well as variability. Figure A1 below presents the results of the zero background tests for each sampler used in this project. The green marker on each vertical line is the mean zero value and the top and bottom of each line represents two standard deviations on each side of the mean as a measure of variability. Most samplers' results show that the typical variability is approximately +/- 5 to 10 ug/m3. When looking at data from the EBAMs, one needs to keep these estimates of the sampler's inherent variability in addition to other mentioned variables in mind. It is also important to note that the EBAM cannot measure less than -5 and most samplers had readings of -5 for some hours of the zero background test, so these estimates of variability are likely somewhat lower than reality. There were two samplers with significantly higher variability, indicating a noisy sampler. These two samplers were cleaned and serviced prior to deployment for the collocation measurement period.

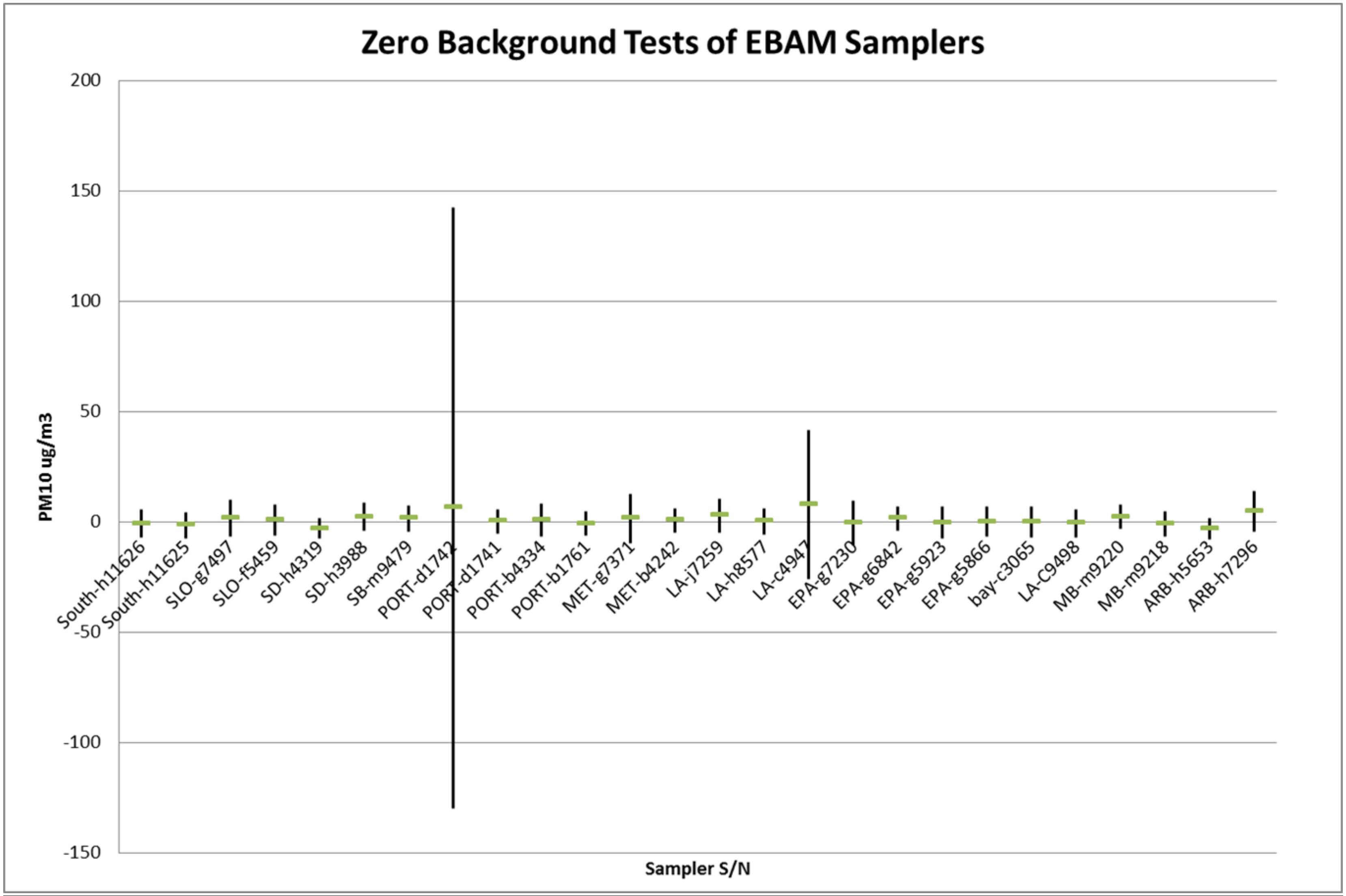


Figure A1 – Zero Background Test Results

Evaluation During Collocation Period

EBAMs were then collocated with BAM 1020 PM monitors at APCD permanent monitoring stations for several weeks. The main purpose of the collocation period was to establish the relationship between each EBAM and the federally approved beta attenuation samplers An additional important benefit of the collocation period is to further investigate any sampler problems and correct these issues. The two main problems with samplers that were identified during the collocation period were inlet heater problems and noisy response by some samplers that were not identified by the zero background tests.

The initial review of collocated data from the EBAM samplers identified a few samplers that had more problems of controlling the inlet humidity than other samplers. Further investigation identified that these samplers were manufactured with a slightly different configuration, to allow for an external AC powered pump, rather than the standard internal DC pump. In discussions with MetOne design engineers, project staff discovered that the samplers with internal pumps were designed to utilize the waste heat from the internal DC pump to help in heating the inlet, to better control the humidity of the sample. Without the waste heat from the pump, the samplers with external pumps were unable to provide adequate control of sample humidity. In consultation with MetOne, project staff designed an add-on inlet heater to provide a substitute source of heat for the missing pump. After installing these added heater assemblies, these samplers sample humidity control was improved.

The initial review of collocated data from the EBAM samplers also identified four samplers that had a noisy response. It is quite interesting that these four samplers (g5866, g7230, h3988, and g7497) had good results in the zero background test, designed to identify samplers with a noisy response. But, once these samplers were deployed for the collocation period, the ambient data clearly identified them as having excessive variability in their response. Discussions with MetOne failed to positively identify why these samplers exhibited normal variability on the zero tests, yet when sampling ambient sample had excessive variability. It is possible that because the zero test was performed indoors, with less variations in humidity, or the presence of particulate on ambient sampling contributed to this difference. Regardless, others should use caution on relying on the zero background test to identify noisy samplers. Figures A2 and A3 below present example data comparing a typical EBAM response to one of these noisy samplers with the trace from the Mesa2 permanent monitor as reference.

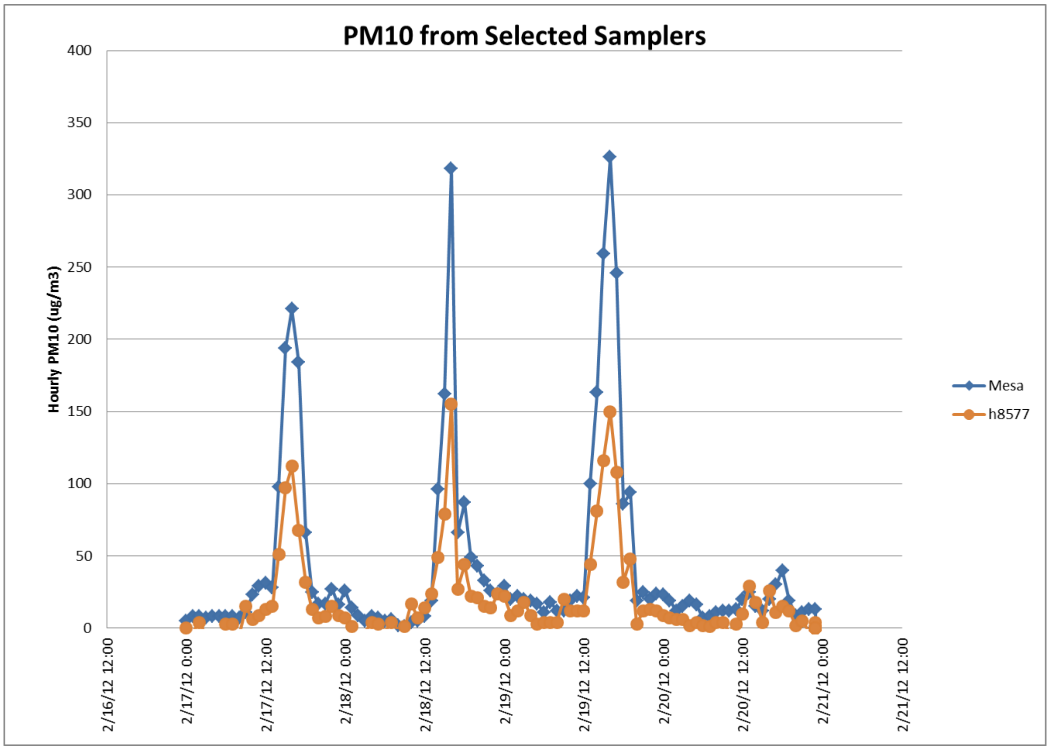


Figure A2 – Example of an EBAM with Typical Variability

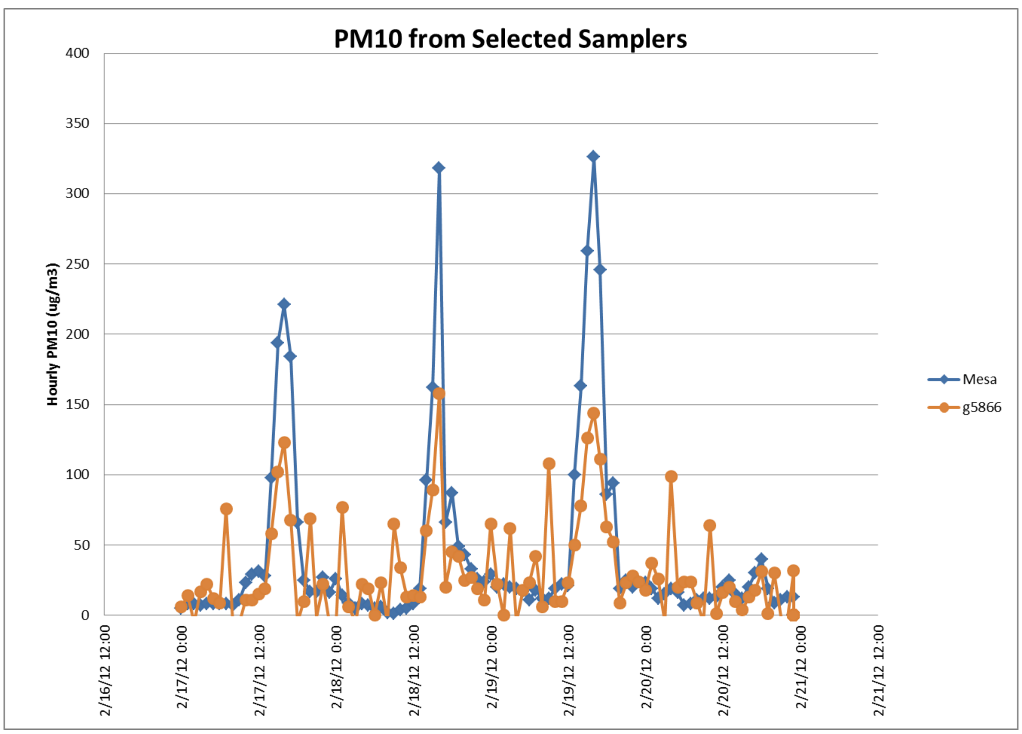


Figure A3 – Example of an EBAM with Excessive Variability

Note also in Figures A2 and A3 that the EBAM sampler's response to the dust events (peaks) is lower than the Mesa2 BAM1020 readings. This is due to the operational differences between the BAM 1020 sampler and the EBAM sampler that causes the EBAM to read lower when measuring sample with most mass in the >7 micron region, and is why a correction factor is needed to make the EBAM samplers measure windblown dust accurately.

The samplers with excessive variability were serviced and found that the beta source was extremely dirty. Following a cleaning of the beta source, all of these units exhibited typical variability in their readings.

In addition to the two above main issues identified and corrected during the collocation period, numerous additional problems were found with many of the samplers. These issues included dirty beta detectors, bad o-ring seals, and weak pumps.

Sampler Operations

Operation of all samplers followed the San Luis Obispo County APCD standard operating procedures for EBAM samplers as well as the Community Monitoring Project Monitoring Plan (See Appendix E). In general, these procedures required bi-weekly quality control checks to be performed on each sampler throughout the entire sampling program. These checks involved the following tasks:

- General Inspection of sampler, noting any issues that might influence sampler operations.
- Verification that sampler external temperature, pressure, and sample flowrate are within allowable limits. Certified standards traceable to National Institute of Standards and Technology (NIST) standards were utilized for these verifications.
- Verification that met sensor boom is aligned to true north.
- Verification that wind speed and direction sensors are reading correctly.
- Performance of any maintenance required such as replacing filter tape.
- Correct any malfunctions or other problems with the sampler.
- Download data from sampler (performed weekly).

In addition to performing the bi-weekly QC checks, a full calibration of the sampler was performed at the beginning and end of the project, following re-location or any major repairs. The procedures for the full calibration are contained in Appendix E. Records of all QC checks, calibrations, or other activity with each sampler were documented on paper forms that were later transcribed to electronic records.

After each data download, project staff reviewed all data looking for indications of possible problems with each sampler. Whenever a possible problem was identified in the data after download, investigation and corrective action were taken.

Validation Criteria

PM_{10} data from all EBAMs were first automatically validated based on the sampler's internal recordings for each hour. The criteria utilized for the preliminary automated validation is listed below:

- Sample Flowrate recorded by sampler for each hour must be within +/-5% of design value of 16.7 l/min
- No internal sampler alarms that could influence validity can be present for that hour

Following the preliminary validation, sampler logs and quality control records were reviewed by project staff for final validation of data. Any period of data not bracketed in time by QC checks showing the sampler to be within tolerance, or periods where tape punching occurred were invalidated.

Data Completeness

Identifying and responding to sampler failures from 25 deployed samplers proved to be quite a challenge. An additional problem was that none of the samplers were equipped with any data telemetry. Without telemetry, a sampler could be offline for as much as a week before staff could know of the problem (samplers were visited once a week). Regardless, the overall data recovery for PM_{10} data from the EBAM samplers during the period the samplers were deployed for saturation monitoring exceeded 80%, the typical data recovery rate goal for monitoring ambient pollutants.

Unfortunately, as luck would have it, the distribution of lost data was not uniform across time and location. Figure A4 below presents the data recovery rate for the monitoring period.

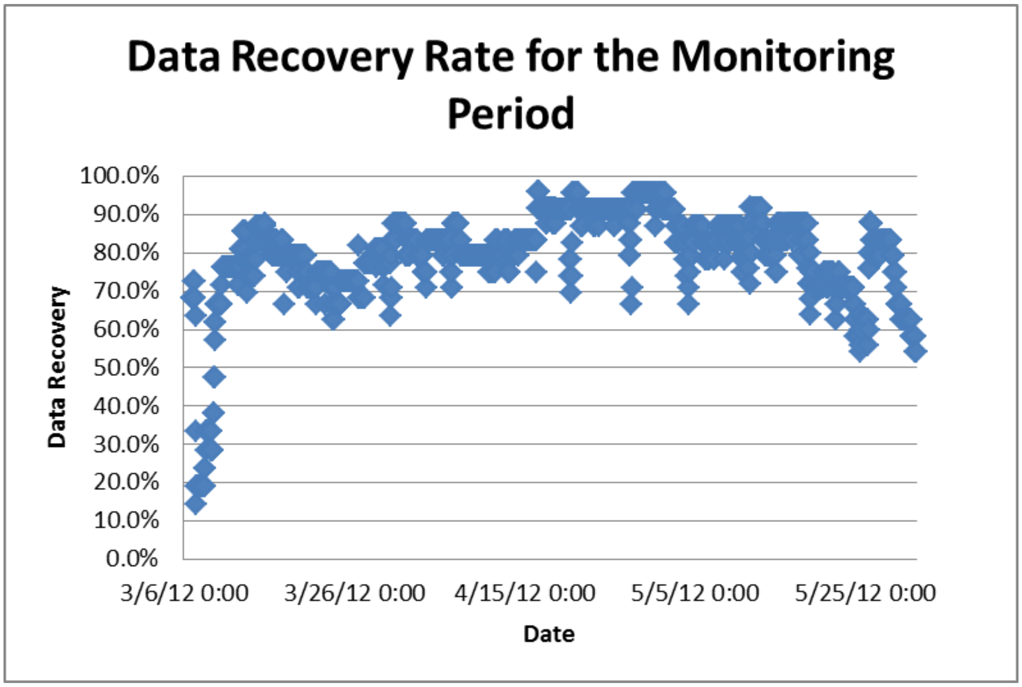


Figure A4 – PM_{10} Data Recovery for Monitoring Period

Figure A4 shows the data recovery rising in early March as samplers are being deployed to their respective monitoring locations. The data recovery averages approximately 80% through mid April where it increases to above 90%. Then in mid-May a string of failures drops the recovery rate to approximately 70%. Most unfortunately on May 23-25th, a series of additional failures drops the recovery rate below 60%. This is one of the most unfortunate times for these failures to occur as this is during a period of extreme dust events, including two days that exceeded the 24 hour federal PM_{10} health standard. The sampler failures in this period do not appear connected to the extreme winds or PM concentrations, rather just unlucky timing.

Data recovery for the meteorological parameters was higher than for PM_{10}. However, there were a string of wind speed sensor failures, mostly on the samplers located in the Oceano study area in the second half of the monitoring period. The wind speed sensor failures were a result of the failure of the internal reed switch in the sensor. Reed switches have a finite number of times they can open and close and it appears these sensors reed switches were near the end of their life.

Determining and Applying Correction Factors for EBAM PM_{10} Measurements

Previous studies performed by the San Luis Obispo County APCD first identified a design issue with EBAM samplers that causes them to read low when sampling a particle size distribution where most of the particle mass in greater than 7 microns. Because windblown dust generally has most mass in this particle size, utilizing EBAM samplers for this application requires developing a strategy to account for this problem. In the Phase2 study, development and use of a correction factor worked successfully by collocating the sampler at the District's Mesa2 monitoring site that is equipped with a federally approved monitor that does not exhibit this bias in measurement. A wind speed "trigger" was used to identify periods when it was likely the sampler would be measuring windblown dust. This "trigger" was used to identify periods during collocation when windblown dust was likely present, as well as during the monitoring period. This system worked well for the Phase2 study as both Mesa2 and the Oso site where the EBAM was utilized were close to the source with few obstructions upwind.

For this Community Monitoring Project it became clear the method utilized to correct EBAM data for the Phase2 study would not work as well for this project. Sampling locations for this project were quite varied, with some directly on the beach and others quite far inland. Previous monitoring had identified that inland site wind speeds were quite variable, depending on proximity to obstructions and distance from the coast. So a simple wind speed trigger would be very inaccurate at predicting if the sample contained windblown dust.

Other ideas were explored to identify a trigger that would be reliable in predicting the presence of windblown dust that would be workable for this project. The "trigger" that appears to work the best is a combination of a PM_{10} value above a threshold and sand movement in the source area.

State Parks has installed a sensor designed to detect sand movement by the wind at their S1 meteorological station in the source area. This sensor, called a Sensit, essentially counts how many sand particles impact the sensing element each hour. For accurate measurements of sand flux, the sensor must be "calibrated" by maintaining the sensor height above the sand surface. In this location, this requires daily adjustments to the sensor height to account for shifts in the sand surface, which State Parks does not perform. However, even though the sensor is "uncalibrated", review of the data shows it to be a very reliable method for detecting periods of sand movement, or lack thereof, in the dunes.

Analysis of the effect of particle size distribution on EBAM response

Previous work demonstrated that when compared to FEM BAM 1020s, EBAMs systematically yield low readings during windblown dust events. This bias may be caused by design differences between the BAM 1020 and the EBAM, specifically the arrangement of beta source/beta detector assembly and the sample path. In the BAM 1020, the beta source/beta detector assembly is beside the sample path, and the tape shuttles between the two. In the EBAM, the beta source and beta detector are in line with the sample path, and particles must pass around the source before being deposited on the tape. Such an obstacle in the sample path should have a greater effect on larger particles than smaller ones. Specifically, large particles would be expected to be diverted toward the edges of the sample path more so than smaller particles. This effect may account for the donut shaped spots observed on EBAM tapes during wind-blown dust events, which tend to have a large fraction of coarse PM (see Figures A-5 and A-6 below). Since the beta-particle emissions are focused through the middle of the tape—i.e. through the donut hole—this effect could explain the low EBAM readings during wind-blow dust events.

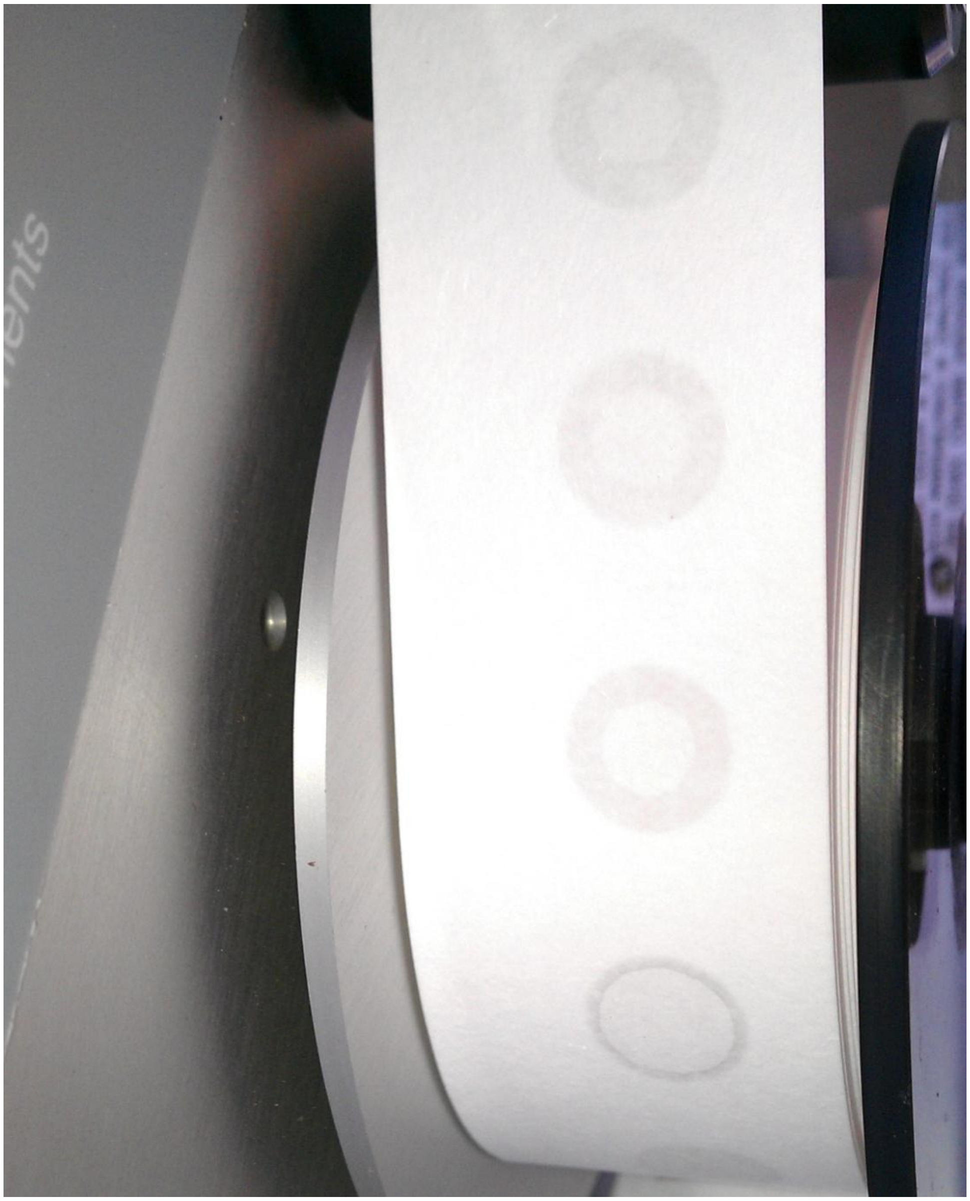


Figure A-5 Example of "doughnut" pattern of tape deposit

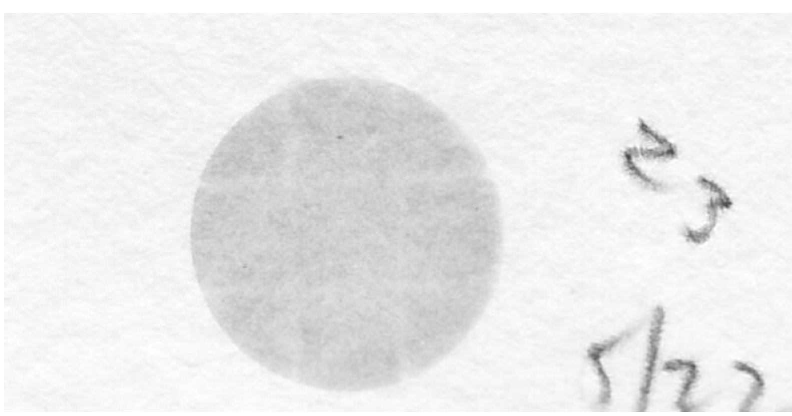


Figure A-6 Example of normal tape deposit

This theory predicts that as particle size increases (or as the fraction of large particles increases), EBAM readings should be increasingly biased low. While the specialized technology to fully characterize particle size distribution was not available for this project, the Mesa2 site does have BAM 1020s continuously monitoring both PM_{10} and $PM_{2.5}$. Thus the masses of particles in the 0 to 2.5 micron and 2.5 to 10 micron ranges are known, and a limited analysis of the effect of particle size distribution on EBAM response is possible. This analysis is presented below.

By definition, PM_{10} is the sum of $PM_{2.5}$ and PM_{coarse}, where PM_{coarse} is the mass of particles in the 2.5 to 10 micron size range. If the FEM BAMs at Mesa2 are considered to provide "true" $PM_{2.5}$ and PM_{10} values, and if the EBAM does indeed attenuate the mass of large particles more than small, it is expected that for a collocated EBAM:

$$EBAM_{10} = c_1 * PM_{coarse} + c_2 * PM_{fine} + c_3 \quad \text{(Eq. 1)}$$

then

$$c_1 < c_2$$

where

$$EBAM_{10} = EBAM\ PM_{10}\ reading$$
$$PM_{coarse} = PM_{10}\ BAM\ reading - PM_{2.5}\ BAM\ reading$$
$$PM_{fine} = PM_{2.5}\ BAM\ reading$$

and c_1 and c_2 are coefficients and c_3 is an intercept term that ideally should be zero. The coefficients c_1 and c_2 should also be less than or equal to one.

To test this, collocation data from Mesa2 was analyzed by least squares linear regression, and parameters c_1–c_3 where derived for each EBAM. Each EBAM was analyzed separately, and only hours with valid EBAM, PM_{10} BAM, and $PM_{2.5}$ BAM readings were included in the analysis. The results are shown in Table A2 below.

Table A2 - Regression analysis results for $EBAM_{10}$ vs PM_{coarse} PM_{fine}

EBAM serial number	c_1	c_2	c_3	r^2	n
g5866	0.39 **	1.41 **	1.62 *	0.65	409
g5923	0.33 **	1.14 **	3.68 **	0.87	478
g7230	0.39 **	1.20 **	0.13 (n.s.)	0.88	404
g6842	0.38 **	0.75 **	-0.46 (n.s.)	0.92	285
c4947	0.55 **	0.69 **	6.49 **	0.82	698
h8577	0.43 **	0.97 **	-1.25 **	0.93	696
j7259	0.45 **	1.07 **	-0.51 (n.s.)	0.87	612
b4242	0.31 **	1.41 **	3.80 **	0.85	698
g7371	0.48 **	0.77 **	2.14 **	0.84	779
b1761	0.44 **	1.00 **	0.87 (n.s.)	0.92	699

EBAM serial number	c_1	c_2	c_3	r^2	n
b4334	0.43 **	1.42 **	6.10 **	0.85	698
d1741	0.38 **	1.01 **	2.60 **	0.89	699
d1742	0.46 **	1.04 **	-3.08 **	0.91	559
m9479	0.44 **	1.19 **	2.59 **	0.91	698
h3988	0.38 **	1.41 **	-1.55 (n.s.)	0.83	213
h4319	0.42 **	1.10 **	2.60 **	0.87	779
f5459	0.41 **	1.00 **	-0.45 (n.s.)	0.90	696
g7497	0.33 **	1.57 **	11.24 **	0.66	430
h11625	0.36 **	0.97 **	0.07 (n.s.)	0.90	473
h11626	0.39 **	1.01 **	0.59 (n.s.)	0.88	699
m9220	0.47 **	0.96 **	2.11 **	0.91	779
m9218	0.55 **	0.76 **	-2.29 *	0.75	145
h5653	0.48 **	0.78 **	3.59 **	0.92	741
h7296	0.50 **	0.63 **	6.66 **	0.93	432

n = Number of observations in analysis.
r^2 = Coefficient of determination for the regression.
** = Statistically significant. P-value for coefficient ≤ 0.05.
* = Borderline significant. P-value for coefficient between 0.05 and 0.1.
n.s. = Not statistically significant. P-value for coefficient > 0.1.

As shown in Table A2 above, in all cases regression analyses yielded statistically significant c_1 and c_2 coefficients. The intercept term, c_3, was only significant sometimes. The coefficient of determination, r^2, was above 0.80 in all but three cases, indicating that PM_{fine} and PM_{coarse} are good predictors of EBAM PM_{10} concentrations.

Critically, in every case $c_1 < c_2$, demonstrating that as the fraction of coarse particulates increases, EBAM readings are increasingly biased low. Furthermore, c_1 and c_2 are less than one in all but a few cases and the intercept term, c_3, is generally close to zero. These data support the theory that an obstructed flow path is the cause of the EBAM's downward bias in observed PM concentration. These data also support the use of correction factors during events with high fractions of coarse particulates.

Since EBAMs will be used to predict "true" PM_{10} concentrations in the field, it is useful to rearrange Eq. 1 into a form in which the EBAM reading is the independent variable, such as:

$$truePM_{10} = m * EBAM_{10} + b \qquad \text{(Eq. 2)}$$

where *m* is a slope term and *b* is an intercept term, which is ideally equal or close to zero.

Rearranging Eq. 1 into the form of Eq. 2 yields:

$$PM_{10}\ BAM\ reading = \frac{EBAM_{10}}{c_1 + (c_2 - c_1) * \gamma} - \frac{c_3}{c_1 + (c_2 - c_1) * \gamma} \qquad \text{(Eq. 3)}$$

where

$$\gamma = \frac{PM_{2.5}\,BAM\,reading}{PM_{10}\,BAM\,reading} \quad \text{(Eq. 4)}$$

and thus

$$m = \frac{1}{c_1 + (c_2 - c_1) * \gamma} \quad \text{(Eq. 5)}$$

and

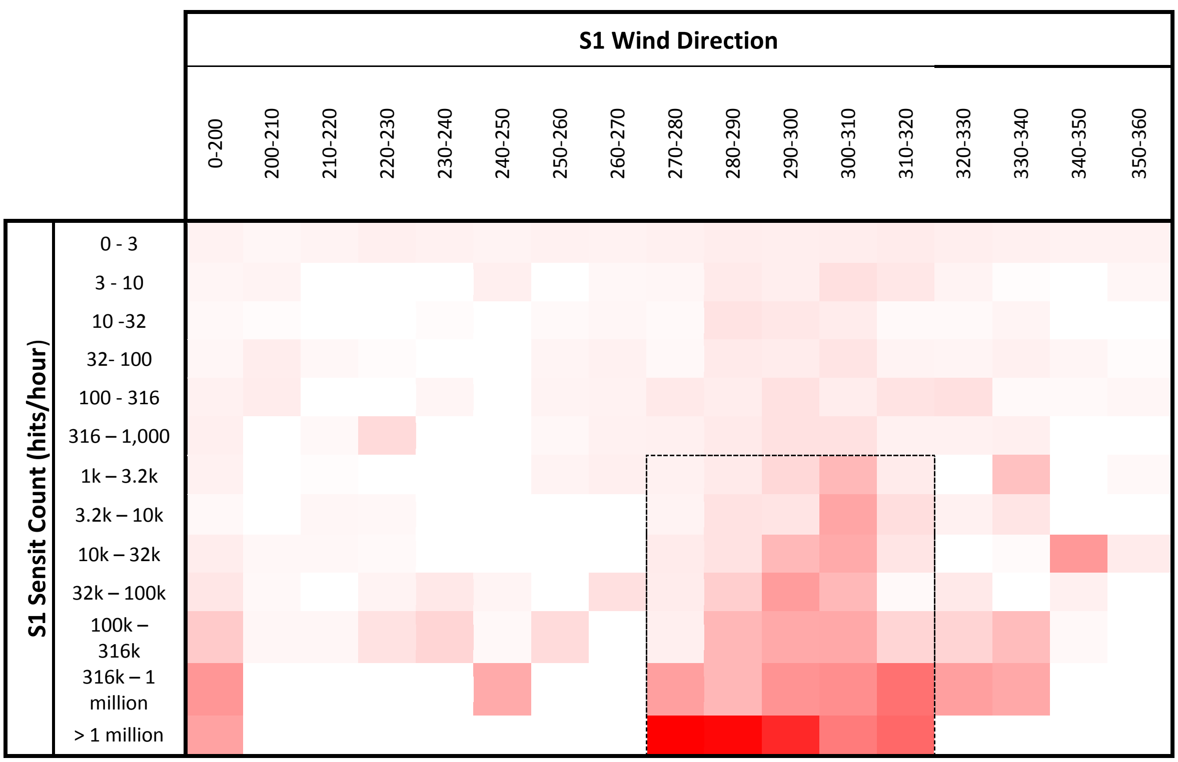
$$b = -\frac{c_3}{c_1 + (c_2 - c_1) * \gamma} \quad \text{(Eq. 6)}$$

This form explicitly shows that the slope term, *m*, needed to scale EBAM readings to "true" PM_{10} values depends on γ, the $PM_{2.5}/PM_{10}$ ratio. Since c_1 is less than c_2 and by definition the ratio γ must be between zero (no $PM_{2.5}$) and one (all $PM_{2.5}$), then the correction factor *m* increases as the $PM_{2.5}/PM_{10}$ ratio γ, decreases. In other words, the higher the fraction of coarse PM, the greater the correction factor, as predicted.

Analysis of Particle Size During Wind-Blow Dust Events

Since EBAM readings tend to be biased low when sampling air with a large fraction of coarse particulate, this suggests that their readings during such events ought to be corrected. As shown in the Table A3 below, PM_{10} at Mesa2 (as measured by the permanent FEM BAM at that site) is highest when the wind direction measured at S1 is between 270 and 320 degrees, and Sensit counts are greater than 1000/hr.

Table A3 - Average Mesa2 PM_{10} vs S1 Wind Direction and Sensit Count*



*During the colocation period, 3/16/12 through 5/31/12. Cells corresponding to Wind Direction/Sensit Count combinations that were not observed are set to zero (i.e. unshaded). The area corresponding to a Sensit count >1000/hr and wind direction between 270 and 320 is marked by the dashed line.

Color coding:

0 ug/m^3
50 ug/m^3
100 ug/m^3
150 ug/m^3
200 ug/m^3
250 ug/m^3
300 ug/m^3

Under these conditions, the average ratio of $PM_{2.5}$ to PM_{10} at Mesa2 during the colocation period was 27%. The average ratio for other conditions was 49%.[1] This shows that the hours when PM_{10} levels at Mesa2 are most elevated tend to correspond to hours when sand is moving on the dunes and the wind direction on the dunes favors transport in the direction of Mesa2. Furthermore, this shows that the particle size distribution during these hours has a higher fraction of coarse particulate. Taken together, this implies that the use of a correction factor during under these conditions is warranted.

Application of correction factor

Since the $PM_{2.5}/PM_{10}$ ratio during wind-blown dust events is lower than the ratio during other times, and since an EBAM's response varies with this ratio (see above), it was desirable to account for this dependency. Two methods were considered: applying, to each hour of each EBAM's dataset, a variable correction factor that depends on that hour's $PM_{2.5}/PM_{10}$ ratio, or using a static, unvarying correction factor that is applied only during hours believed to be influenced by wind-blown dust.

The first method, equivalent to using Eqs. 3-6, is appealing since it does not require identifying hours likely to be influenced by wind-blow dust. The drawback is that this method requires a $PM_{2.5}/PM_{10}$ ratio, γ, for each measurement being corrected, but this ratio is only available for measurements made at Mesa2 and CDF—the only sites in the study area with collocated $PM_{2.5}$ and PM_{10} samplers. If it could be assumed that for each hour γ was constant across the study area, then Eqs. 3-6 could be applied. This assumption does not, however, appear to be valid, since the correlation between the $PM_{2.5}/PM_{10}$ ratio at CDF versus that at Mesa2 for all measurements is very poor (however the correlation between the average episode ratio between the two sites is good).

This leaves the second method, which introduces the complication of needing to determine a trigger for when to apply the correction factor. Fortunately, as discussed above, elevated PM_{10} levels at Mesa2 tend to occur under certain conditions, specifically when the S1 winds are from 270° to 320° and are fast enough to get sand moving, as indicated by a sensit reading greater than 1000. While these criteria are useful for indicating when dust is likely to become aloft and transported to Mesa2, conditions resulting in the transport of dust to the various EBAM field sites may be different. For example, while conditions at S1 may result in elevated PM_{10} at Mesa2, other sites in the study area may be unaffected by the event. It would be undesirable to apply a correction factor to data from these unaffected sites. The converse is also possible: Mesa2 could be unaffected by an event while other sites in the study area are

[1] For the calculation of these average ratios, hours with negative $PM_{2.5}$ or PM_{10} values and/or PM_{10} values of zero were omitted. If $PM_{2.5} > PM_{10}$, a value of 100% was used.

impacted, perhaps because an S1 wind direction of 270° to 320° is optimal only for transporting dust to Mesa2, and other sites may be most affected at other wind directions.

To strike a balance between these competing interests, a trigger based on both S1 conditions and the EBAM's PM_{10} reading was used. Specifically, the sensit reading for the hour must be greater than 1000 and the EBAM's reading must be over a threshold concentration. As discussed in greater detail below, a regression analysis was performed on each EBAM's collocation dataset in order to determine the optimum correction factor and application threshold.

Derivation of Correction Factors
As noted earlier, EBAMs were collocated with FEM BAM 1020s for several weeks in order to collect data from which correction factors could be derived. EBAMs were collocated at Mesa2 or NRP once pre-deployment checks were completed, and they were removed as they were needed in the field. Many EBAMs had some periods of collocation data invalided due to failed QC checks, power failures, and other issues. Therefore, each EBAM had a unique, final collocation dataset. In all cases only hours with both a valid EBAM reading and valid collocated BAM reading were used.

Most EBAMs were collocated only at Mesa2 (22 units) or NRP (one unit, c3056), but two units (h4319 and g7491) were moved between NRP and Mesa2 for the entire project. In these cases the collocation periods were first analyzed separately. After determining that results with the NRP-only dataset did not differ significantly from those using only the Mesa2 data (see below for more details), NRP and Mesa2 collocation data was combined, and the analyses re-run on the merged dataset. Across the 25 collocation datasets, the average number of paired EBAM/BAM hourly values was 653.

For each EBAM, a subset of "criteria data" was then selected from the collocation dataset, to be used in regression analysis. Criteria data were those hours with a sensit count greater than 1000 and an S1 wind direction between 270° to 320°. (Note that S1 wind direction is not included in the criteria for correcting field data, since the optimal S1 wind direction ranges for transporting dust from the dunes to the various EBAM deployment sites is not known. In contrast, 270° to 320° is optimal for transporting dust to Mesa2.) The number of observations in the criteria datasets ranged from 43 to 242.

Measurements were not evenly distributed across the EBAM's measurement range of -5 to 1000 $\mu g/m^3$, but rather were clustered toward the low end. Therefore, a weighting scheme was applied to the criteria data. The EBAM range was divided into 10 $\mu g/m^3$ bins from -10 to 480 $\mu g/m^3$ plus a bin for >480 $\mu g/m^3$, and the number of points in each bin was determined. Each observation in the criteria data set was then assigned a weight equal to the reciprocal of the number of points in its bin. The intent of this weighting scheme was to ensure that the influence of the large number of measurements clustered at the low end of the EBAM's range did not overwhelm the influence of the few points at higher concentrations. This weighting scheme reduces error on the high end of the scale at the expense of increased error on the low end and slightly higher error overall.

Previous experience with the EBAM suggested that it gives a very noisy response to background levels of PM_{10}. Scatterplots of collocation data confirmed that at the low end of the EBAM's range (~<50 $\mu g/m^3$), there was high degree of scatter. Therefore, a segmented linear regression approach was pursued. It was anticipated that below some threshold EBAM concentration, the correlation would be poor and/or not significantly different from a slope of 1 and intercept of 0, while the data above the threshold would yield a good fit and a slope different from 1, and possibly a non-zero intercept. (A slope of 1 and intercept of 0 would indicate that no correction of the EBAM data was necessary). The threshold would be optimized to give the best overall fit, and would be used as the trigger (along with the S1 sensit count) for when to apply the correction factor(s) derived from the analysis to EBAM field data.

Therefore for each EBAM, the criteria data was analyzed by the following segmented weighted regression:

$$\begin{cases} PM_{10}BAM\ reading = m_U * PM_{10}EBAM\ reading + b_U & \text{for } PM_{10}EBAM\ reading \geq T \\ PM_{10}BAM\ reading = m_L * PM_{10}EBAM\ reading + b_L & \text{for } PM_{10}EBAM\ reading < T \end{cases} \quad \text{Eq. 7}$$

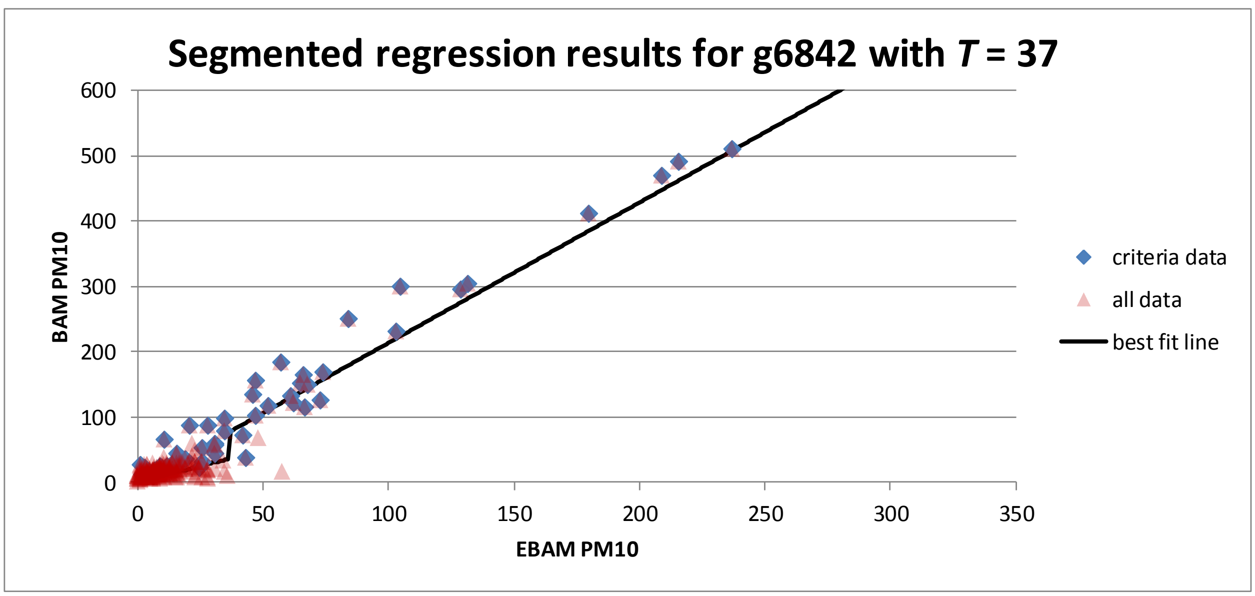
where

$$T = \text{EBAM threshold concentration}$$
$$m_U = \text{slope of weighted linear regression for data above T}$$
$$b_U = \text{intercept of weighted linear regression for data above T}$$
$$m_L = \text{slope of weighted linear regression for data below T}$$
$$b_L = \text{intercept of weighted linear regression for data below T}$$

An arbitrary threshold, *T*, was selected, and all EBAM values below *T* were regressed against their corresponding BAM values. Thus preliminary correction factors m_L and b_L for the lower part of the EBAM range were derived. At the same time, a regression was performed on data points above the threshold, *T*, yielding correction factors m_U and b_U for the upper part of the range. Coefficients of determination, r^2_U and r^2_L, were calculated for the two regressions, and an overall coefficient of determination for the model, r^2_{All}, was also determined.

Table A4 below shows the results of these regressions with *T* optimized, and Figure A-7 shows the results for a typical EBAM. (The method for optimizing *T* is discussed later.) With the exception of c3056 (which was collocated at NRP) in all cases r^2_{All} was greater than 0.90, indicating the model derived from segmented linear regression fits the data well. As expected, the lower end regressions (i.e. the regressions on data with EBAM readings less than the thresholds) yielded poorer results than the upper end regression. This is indicated by the fact r^2_U is greater than r^2_L for almost all EBAMs and by the larger standard errors of m_L as compared to m_U. For most EBAMs, values of m_L and b_L are not statistically significantly different from 1 and 0, respectively, as expected.

Figure A-7



Scatter Plot for the segmented regression for g6842, with *T* at its optimum value of 37. Blue squares indicate criteria data used in the regression analysis. The best fit line from the upper and lower regressions is shown in black. Every collocation data point, whether used in the regression analysis or not, is shown with a red triangle.

Table A-4: Result of Segmented Regression of Criteria Data

EBAM Serial number	Threshold, *T* (ug/m^3)	Lower regression on data with EBAM observations <*T*				Upper regression on data with EBAM observations ≥ *T*				Overall Model	
		r^2_L	N_L	m_L (s.e.) [a]	b_L (s.e.) [a]	r^2_U	N_U	m_U (s.e.) [a]	b_U (s.e.) [a]	R^2_{All}	N_{All}
g5866	36	0.82	33	0.84 (0.41) (n.s.)	13 (8) (n.s.)	0.98	13	2.22 (0.16) **	-39 (14) **	0.95	46
g5923	39	0.95	34	1.39 (0.93) (n.s.)	8 (20) (n.s.)	0.95	45	2.02 (0.11) **	11 (17) (n.s.)	0.95	79
g7230	57	0.96	30	0.98 (0.28) (n.s.)	13 (9) (n.s.)	1.00	7	1.92 (0.09) **	10 (19) (n.s.)	0.99	37
g6842	37	0.96	23	1.81 (0.64) (n.s.)	9 (13) (n.s.)	0.96	24	2.14 (0.15) **	21 (21) (n.s.)	0.96	47
c4947	76	0.84	80	0.96 (0.34) (n.s.)	12 (14) (n.s.)	0.93	33	1.52 (0.15) **	26 (29) (n.s.)	0.91	113
h8577	30	0.96	47	0.75 (0.67) (n.s.)	20 (10) *	0.96	66	1.76 (0.08) **	20 (12) *	0.96	113
j7259	51	0.89	67	1.22 (0.39) (n.s.)	13 (10) (n.s.)	0.95	35	1.85 (0.19) **	-1 (22) (n.s.)	0.93	102
b4242	70	0.91	86	1.55 (0.33) (n.s.)	3 (13) (n.s.)	0.98	29	2.09 (0.13) **	-1 (21) (n.s.)	0.96	115
g7371	54	0.80	96	1.07 (0.48) (n.s.)	17 (14) (n.s.)	0.94	36	1.89 (0.15) **	-17 (26) (n.s.)	0.91	132
b1761	70	0.93	81	1.55 (0.26) **	4 (10) (n.s.)	0.97	32	1.81 (0.12) **	9 (21) (n.s.)	0.96	113
b4334	85	0.86	86	1.13 (0.26) (n.s.)	11 (12) (n.s.)	0.97	28	1.60 (0.12) **	22 (25) (n.s.)	0.94	114
d1741	42	0.94	62	1.65 (0.79) (n.s.)	3 (18) (n.s.)	0.96	52	1.97 (0.11) **	7 (16) (n.s.)	0.95	114
d1742	34	0.95	49	1.28 (0.60) (n.s.)	13 (10) (n.s.)	0.97	39	1.65 (0.08) **	23 (14) (n.s.)	0.96	88
m9479	44	0.97	57	1.44 (0.52) (n.s.)	3 (12) (n.s.)	0.96	58	1.82 (0.08) **	-11 (13) (n.s.)	0.97	115
h3988	30	0.97	14	1.31 (0.86) (n.s.)	6 (15) (n.s.)	0.94	29	1.99 (0.16) **	-9 (17) (n.s.)	0.95	43
h4319 [b]	64	0.98	177	1.35 (0.22) (n.s.)	11 (7) (n.s.)	0.98	122	1.85 (0.08) **	-7 (13) (n.s.)	0.98	299
f5459	34	0.94	57	1.21 (0.65) (n.s.)	15 (11) (n.s.)	0.97	56	2.05 (0.09) **	-7 (12) (n.s.)	0.97	113
g7497 [b]	87	0.85	216	1.28 (0.16) *	6 (7) (n.s.)	0.99	26	1.71 (0.12) **	-16 (17) (n.s.)	0.95	242
h11625	32	0.97	25	0.64 (0.85) (n.s.)	21 (13) (n.s.)	0.92	52	2.11 (0.14) **	5 (19) (n.s.)	0.93	77
h11626	48	0.91	70	1.46 (0.54) (n.s.)	13 (13) (n.s.)	0.96	45	2.12 (0.12) **	-14 (18) (n.s.)	0.95	115
m9220	56	0.95	81	1.25 (0.32) (n.s.)	9 (10) (n.s.)	0.99	59	1.78 (0.09) **	-3 (12) (n.s.)	0.97	140
m9218	25	0.80	16	0.58 (0.65) (n.s.)	16 (8) *	0.99	5	1.67 (0.20) **	3 (15) (n.s.)	0.95	21
h5653	48	0.99	47	1.19 (0.33) (n.s.)	14 (8) *	0.97	82	1.85 (0.09) **	-7 (12) (n.s.)	0.98	129
h7296	65	0.98	23	1.14 (0.31) (n.s.)	5 (10) (n.s.)	0.96	39	1.89 (0.14) **	-11 (19) (n.s.)	0.97	62
c3056 [c]	6	0.68	28	-0.70 (2.63) (n.s.)	18 (9) **	0.81	83	1.65 (0.19) **	-2 (10) (n.s.)	0.80	111

Notes and Abbreviations:

[a] The format for these columns is as follows: parameter value (standard error) statistical significance. ** = Statistically significant (p-value < 0.05), * = Borderline significant (p-value between 0.05 and 0.1), (n.s.) = not significant (p-value > 0.1).

[b] Data from collocation at both Mesa2 and NRP.

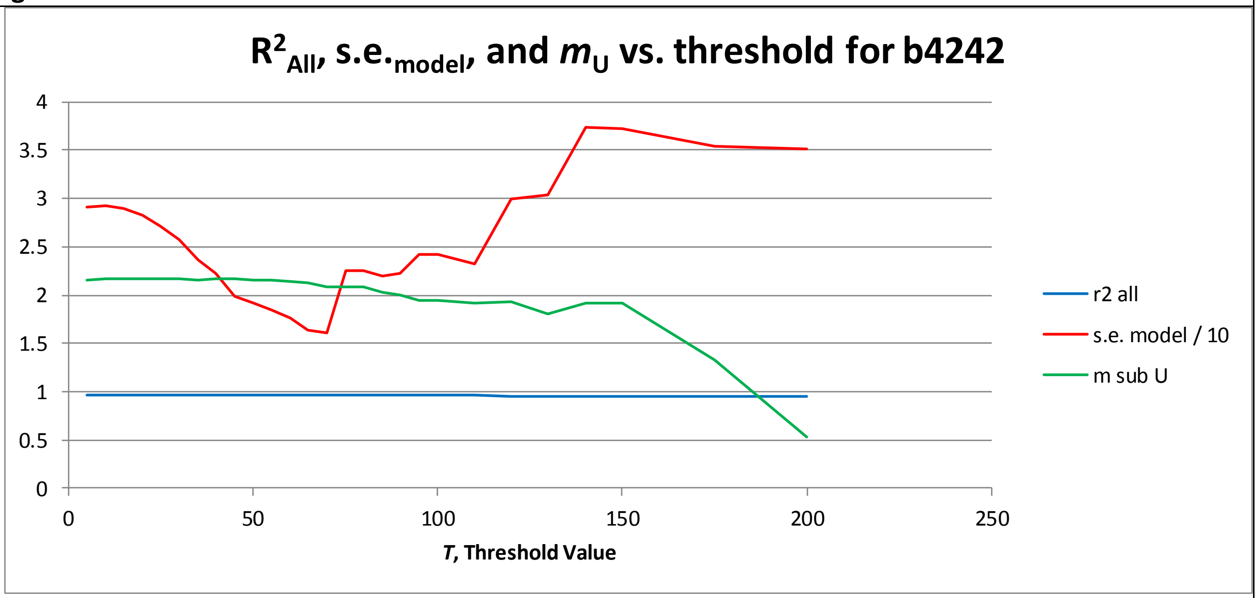
[c] Data from NRP collocation only.

T = Threshold from Eq. 7. N = Number of observations in analysis. Subscripts “U”, “L”, and “All” indicate, respectively, whether the parameter applies to the upper range regression on data above the threshold, the lower range regression on data below the threshold, or the application of the model to all the criteria data.

To determine the optimum value for the threshold *T* for each EBAM, the correction factors derived with Eq. 7 were applied to each EBAM's entire collocation dataset, including both criteria and non-criteria data, however only slopes that differed significantly from 1 and intercepts that differed significant from 0 were used. Non-significant slopes and intercepts were set to 1 and 0, respectively. Statistical significance was assessed using two-tailed T-tests and selecting a p-value of 0.05 as the threshold for significance. Using these slopes and intercepts, predicted BAM values were calculated from the observed EBAM values. Predicted BAM values were subtracted from the observed BAM values to yield residuals. From the sum of squared residuals, statistics assessing how well the model fit the data were calculated, including the coefficient of determination for the model, r^2_{Model}, and the standard error for the model, $s.e._{Model}$.

Typically, r^2_{All}—the combined r^2 for the upper and lower end regressions on criteria data—did not vary much as *T* increased, but $s.e._{Model}$ decreased gradually before rising sharply. *T* was optimized when $s.e._{Model}$ was at its minimum. The results for a typical EBAM are shown in Figure A-8, below.

Figure A-8



Graph showing how r^2_{All}, $s.e._{Model}$, and m_U vary with the threshold, *T*. Note that $s.e._{Model}$ has been divided by 10 to bring its values on scale with those of r^2_{All} and m_U. In this case, the optimum value for *T* is 70, which is where $s.e._{Model}$ is minimized. Also note that m_U, the slope of the regression on criteria data greater than *T*, does not change much until $s.e._{Model}$ starts to rise.

Table A5 below summarizes the results. For each EBAM, the optimized value for *T*, along with the final upper and lower end slopes and intercepts is shown. (These slopes and intercepts are denoted with the subscript "Model", to differentiate them from slopes and intercepts derived from Eq. 7 and displayed in the previous table. Since in this part of the analysis only statistically significant slopes and intercepts were used, $m_{L,Model} = m_L$ if m_L was significant, otherwise it was set to 1. The m_Us were treated the same way. Intercepts were treated similarly, except non-significant intercepts were set to 0.) The table also provides statistics describing the goodness of fit of the model, r^2_{Model}, and the standard error for the model, $s.e._{Model}$.

Table A5 – EBAM Threshold and Correction Factors

EBAM serial number	Threshold, T (ug/m^3)	$m_{L,Model}$	$b_{L,Model}$	$m_{U,Model}$	$b_{U,Model}$	N_{Model}	r^2_{Model}	s.e.$_{Model}$
g5866	36	1.00	0	2.22	-39	409	0.75	11.5
g5923	39	1.00	0	2.02	0	478	0.90	19.4
g7230	57	1.00	0	1.92	0	404	0.94	12.7
g6842	37	1.00	0	2.14	0	285	0.93	18.3
c4947	76	1.00	0	1.52	0	698	0.87	18.6
h8577	30	1.00	0	1.76	0	696	0.92	14.8
j7259	51	1.00	0	1.85	0	612	0.87	14.1
b4242	70	1.00	0	2.09	0	698	0.91	16.1
g7371	54	1.00	0	1.89	0	779	0.87	17.2
b1761	70	1.55	0	1.81	0	699	0.93	14.1
b4334	85	1.00	0	1.60	0	698	0.90	16.5
d1741	42	1.00	0	1.97	0	699	0.92	15.4
d1742	34	1.00	0	1.65	0	559	0.90	16.7
m9479	44	1.00	0	1.82	0	698	0.92	15.1
h3988	30	1.00	0	1.99	0	213	0.79	22.3
h4319[a]	64	1.00	0	1.85	0	1816	0.89	19.8
f5459	34	1.00	0	2.05	0	696	0.92	15.2
g7497[a]	87	1.00	0	1.71	0	1305	0.61	21.5
h11625	32	1.00	0	2.11	0	473	0.91	18.9
h11626	48	1.00	0	2.12	0	699	0.90	16.9
m9220	56	1.00	0	1.78	0	779	0.94	12.3
m9218	25	1.00	0	1.67	0	145	0.75	11.4
h5653	48	1.00	0	1.85	0	741	0.94	16.2
h7296	65	1.00	0	1.89	0	432	0.96	13.3
c3056[b]	6	1.00	18	1.65	0	603	0.48	11.5

[a]Data from collocation at both NRP and Mesa2. [b]Data from collocation at NRP only.

As mentioned earlier, the slopes and intercepts for the lower end regressions were usually not significantly different 1 and 0, and thus most values for $m_{L,Model}$ and $b_{L,Model}$ are 1 and 0, respectively. This is equivalent to leaving the data that is less than the threshold uncorrected. Most values for $b_{U,Model}$ are also 0, as most b_L were non-significant. In contrast, all of the values of the slope for the upper end regression, m_L, were significant. The average m_L was 1.88, indicating that during windblown dust events the EBAM is low by a factor of almost 2.

These final correction factors were applied to the data as follows: when the sum of the previous and current hourly S1 sensit reading is above 1500, then EBAM's reading was multiplied by $m_{U,Model}$ if it's value equaled or exceeded T. If $b_{U,Model}$ was non-zero, this term was also applied. If the EBAM reading was less than T, then $m_{L,Model}$ and $b_{L,Model}$ were applied, but with two exception these are always equal to 1 and 0, respectively, so the application of these lower end correction factors leaves the data unchanged.

The figures below demonstrate the application of the correction factors to a typical EBAM. In Figure A-9, Mesa2 PM_{10} BAM data and uncorrected S/N b1761 EBAM data from the collocation period are plotted on the same graph. Figure A-10 presents the same data but with correction factors applied to the EBAM data. Note how the corrected EBAM data tracks the Mesa2 BAM data much more closely that the uncorrected data.

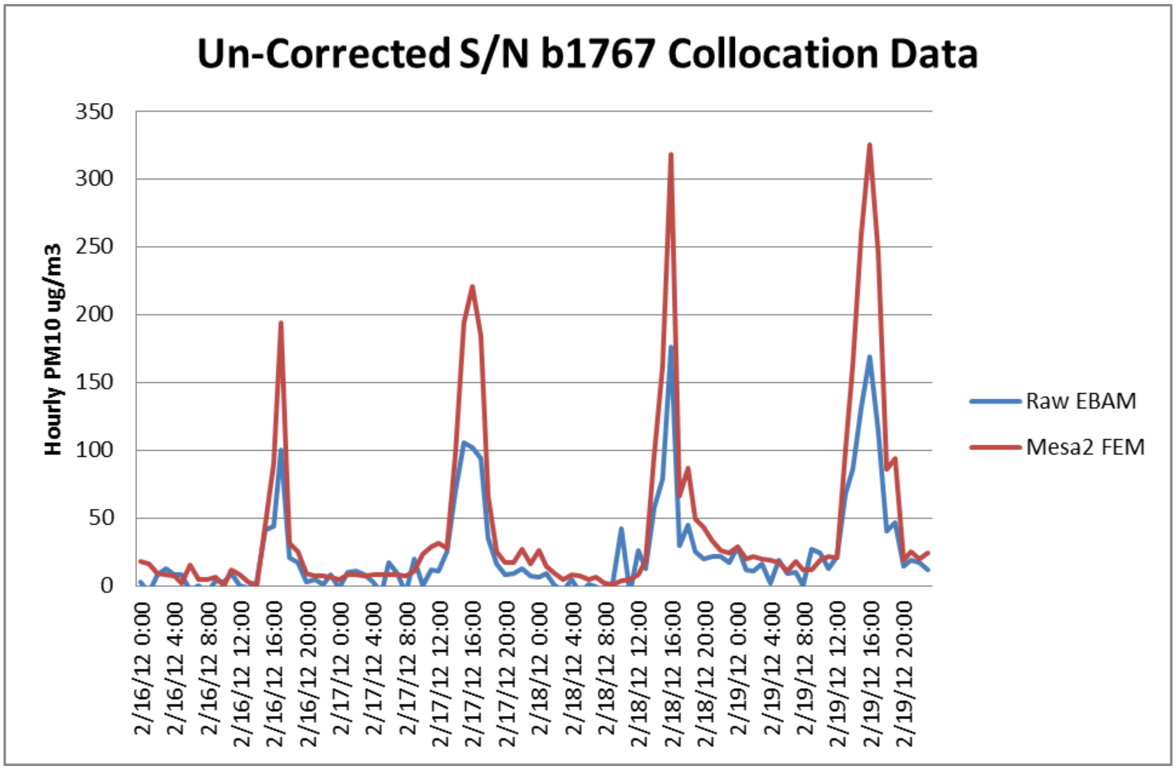


Figure A9 – Uncorrected EBAM S/N b1767 Data Compared to Mesa2 FEM

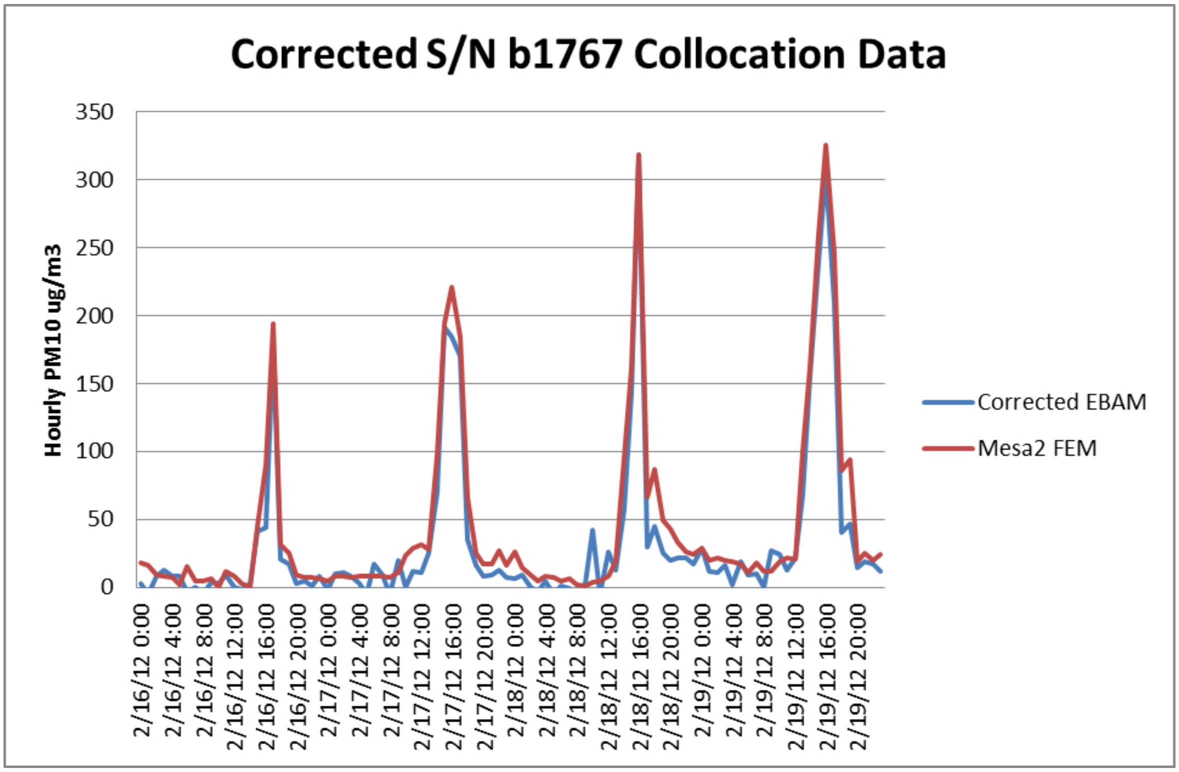


Figure A10 – Corrected EBAM S/N 1767 data Compared to Mesa2 FEM

Collocation at Mesa2 vs NRP

EBAMs h4319 and g7497 were moved between Mesa2 and NRP, and the final correction factors in the Table A5 above are derived from data collected at both sites. As the $PM_{2.5}/PM_{10}$ ratio at NRP was not likely to be exactly the same as that at Mesa2, it was thought that correction factors derived from NRP collocation data might differ from those derived using Mesa2 data. Therefore, prior to merging the data from Mesa2 and NRP, the collocation periods were analyzed separately to determine whether the location of collocation was important.

EBAM h4319 was first installed at Mesa2, then moved to NRP, then reinstalled at Mesa2. Examining the two Mesa2 collocation periods individually yielded nearly identical results: both had an optimum threshold of 52 and insignificant $m_{L,Model}$, $b_{L,Model}$, and $b_{U,Model}$. The upper end slopes, $m_{U,Model}$, for the first and second Mesa2 to collocation periods were 1.93 (with a standard error of 0.09) and 1.85 (with a standard error of 0.08), respectively. An analysis of covariation (ANCOVA) showed no significant difference between the upper end slopes and yielded a merged $m_{U,Model}$ of 1.88 (s.e. 0.06).

Regression analysis of h4319's NRP colocation period by itself yielded non-significant results at all values of *T*, with all slopes and intercepts non-significant. A likely cause of this was the narrow range of the NRP data—the highest EBAM reading at the site was only 89 $\mu g/m^3$. In contrast, this EBAM registered PM_{10} values as high as 343 $\mu g/m^3$ during collocation at Mesa2. When analyzed together, ANCOVA showed no significant difference between the merged Mesa2 collocation periods and the NRP collocation period. The correction factors derived from the merged dataset (shown in the table above) are nearly identical to those derived from the Mesa2-only dataset. The main difference is that including the NRP data increases $s.e._{Model}$—with NRP data excluded, $s.e._{Model}$ = 15.1, with it included $s.e._{Model}$ = 19.8.

EBAM g7497 had one period each of collocation at Mesa2 and NRP. When analyzed individually, the datasets yielded nearly identical optimum cutoffs of 71 and 70, respectively. The corresponding $m_{U,Model}$ values were 1.53 (s.e. 0.19) and 2.13 (s.e. 0.15), respectively, both of which were statistically significant. In addition, $b_{U,Model}$ for the regression of the Mesa2 dataset was also significant, with a value of -83.4 (s.e. 21.71). When analyzed jointly, ANCOVA showed no significant difference between the two collocation periods, so the dataset were merged and the segmented regression rerun. Only $m_{U,Model}$ was statistically significant, and at 1.71 (s.e. 0.12), it was nearly the average of the NRP-only and Mesa2-only slopes.

Finally, EBAM c3056 was collocated at NRP only. The instrument had the lowest r^2_{All}, with a value of 0.80 and also the worst r^2_{Model}, 0.48. A likely explanation for this the correlation is the narrow spread of the NRP data. The highest PM_{10} value recorded by the EBAM during the collocation period was only 83. In contrast, EBAMs collocated at Mesa2 experienced much higher PM_{10} levels.

Additional Corrections to the Dataset

On a few occasions, EBAM flow modes were accidently temporarily changed from “actual” to “STP”. Both the SLOAPCD EBAM SOP and the EPA FEM designation for the BAM 1020 call for flow regulation to be set to the actual mode. In this mode, the EBAM maintains a constant sample flow of 16.7 LPM during the sample collection period. When set to STP, the EBAM maintains a sample flow of 16.7 SLPM (Standard Liters Per Minute); the difference being that under STP, flows are adjusted to standard temperature and pressure of 25 °C and 760 mmHg. Under the temperature and pressure conditions encountered during this study, LPM and SLPM flow can differ by as much as 5%.

Inspection of EBAM settings files (which were downloaded along with data files at least 2 weeks) revealed the three instances when EBAMs inadvertently had their flow modes set to STP. In these cases, equations 8 and 9 were used to correct EBAM flow and PM_{10} concentration back to actual conditions.

$$flow\ corrected\ PM_{10} = raw\ PM_{10} * \frac{P}{760} * \frac{298}{T + 273} \qquad \text{(Eq. 8)}$$

$$corrected\ EBAM\ flow = raw\ flow * \frac{760}{P} * \frac{T + 273}{298} \qquad \text{(Eq. 9)}$$

where

P = actual atmospheric pressure in mmHg, estimated from sampler altitude
T = actual temperature recorded by the EBAM for the hour

In all cases, raw EBAM PM_{10} values were corrected by Eq. 8 before the collocation correction factor was applied or before being used in the derivation of correction factors.

In addition to flow modes being improperly set, site checks and the review of QC data revealed some occasions when EBAM wind direction sensors were misaligned, causing measured wind directions to be off. If the beginning and end of the period of improper alignment could be accurately identified, then the wind direction data was corrected, otherwise it was invalidated. Table A6 below summarizes these corrections.

Table A6 - Additional Corrections Applied to the Dataset

Sampler S/N	Site	Begin Adjustment	End Adjustment	Parameter Adjusted	Adjustment Amount	Reason for Adjustment
g5866	O-D	5/10/2012 17:00	5/23/2012 9:00	Flow, PM10	STP to Actual	Accidently set to STP Mode
g5923	1A	3/8/2012 12:00	3/23/2012 10:00	WD	13	Boom Alignment Error
g7230	O-B	3/19/2012 14:00	3/23/2012 11:00	WD	-100	Boom Alignment Error
g7230	O-B	3/23/2012 12:00	5/31/2012 23:00	WD	-26	Boom Alignment Error
c4947	1B	3/8/2012 15:00	3/23/2012 11:00	WD	13	Boom Alignment Error
h8577	8A	3/9/2012 14:00	3/23/2012 11:00	WD	-16	Boom Alignment Error
j7259	6A	3/8/2012 14:00	3/23/2012 13:00	WD	56	Boom Alignment Error
g7371	O-C	4/12/2012 16:00	5/24/2012 8:00	Flow, PM10	STP to Actual	Accidently set to STP Mode
f5459	17A	3/9/2012 14:00	3/16/2012 15:00	WD	180	Boom Alignment Error
m9218	O-A	3/21/2012 14:00	4/3/2012 11:00	WD	180	Boom Alignment Error
h7296	COP	5/3/2012 15:00	5/23/2012 10:00	Flow, PM10	STP to Actual	Accidently set to STP Mode

Salt Analysis of Oceano Samples

Approximately 50 hourly EBAM samples were selected from Oceano EBAM filter tapes for chloride ion analysis in order to better understand the widely fluctuating influence of sea salt on the data collected in Oceano. Previous studies have demonstrated that locations in such close proximity to the ocean can have a widely variable influence from sea salt, while these same studies have demonstrated a relatively consistent, low level of sea salt in samples collected from the Nipomo Mesa.

Performing chloride ion analysis from particulate filters is quite common; however, few if any analytical laboratories have ever performed this analysis on BAM filter media. Project staff worked with Desert Research Institute's (DRI) analytical laboratory to investigate the feasibility of performing this analysis on samples collected using this filter media.

Prior to initiation of sampling, blank filter media was analyzed by DRI to test the methodology as well as determine if the un-exposed BAM filter media contained any chloride. These tests by DRI proved the analytical method adapted to this filter media was workable and also that the un-exposed BAM tapes did contain a small quantity of chloride. Numerous samples of blank tape analyses, from both unopened filter tape as well as blank filter tape punches from the same Oceano sampler demonstrated that the blank BAM tapes chloride concentration was quite consistent at a level that translates to a salt concentration of between 1-2 ug/m3. These consistent blank concentrations were subtracted from the actual field samples to yield the final chloride concentration utilized.

Sample handling of the selected filter sections followed established good laboratory practices including use of gloves, storage of filter samples in glassine envelopes, sealing each sample with EPA sample seals, as well as use of chain of custody documentation. A detailed discussion of the results of the salt analyses for Oceano is provided in Appendix D.

Influence of Local Sources

In the review and analysis of the project data a very small number of data values were identified that do not fit the typical spatial pattern or PM_{10} concentrations seen on the overwhelming majority of measurements. While these outliers do not change any of the conclusions and findings supported by the vast majority of data, they are interesting to examine, and may provide added insight into PM measurements and PM issues in the region.

There are a variety of possible causes of these data outliers. As previously discussed, when sampling coarse particulate, over time the EBAM samplers will accumulate dust on the beta source that will eventually drop off and land on the filter tape. Once on the tape, it gets measured as mass and causes a large positive bias in that one hour's PM_{10} measurement; these positive artifacts occur infrequently and somewhat randomly, usually affecting a single hour.

Another possible cause of these outliers is potential local activity in close proximity to the sampler that is emitting large amounts of particulate for a short period. Examples would be a barbeque, idling vehicle, or active disturbance to the soil next to the sampler (e.g. - plowing a field, farm animal activity, or driving on a dirt road).

A final possible cause could be wind entrainment of soil particles from an open disturbed area directly upwind from a sampler. Most of the study area is covered by thick vegetation, some of which is irrigated, and many groves of eucalyptus trees that will dramatically lower the downwind wind speed; thus, windblown emissions from these areas are very unlikely. However, there are a few small areas of open, disturbed soil in some portions of the study area. Because of their small size, however, the impact of any emissions from these potential sources would be small and very localized, especially on a significant episode day where emissions from the Oceano Dunes dust plume overwhelm those from small local sources.

The largest potential alternative dust source in the area is the agricultural fields in the Santa Maria Valley. Data analysis does show these fields can occasionally be a moderate source of airborne particulate pollution for short periods under some high wind conditions. As discussed in detail in Appendix B, however, detailed analysis of the particle size distribution downwind from these fields indicates that on the northwest wind events that produce the dust plume episodes from the dunes, the agricultural fields have a minor, if any, impact. Additionally, while manning the temporary sampling site (S-E) in the Santa Maria Valley, project staff observed no visible dust emissions on any day except for 5/25/12.

Table A-7 below presents a listing of all identified data values that do not fit the surrounding data pattern and/or appear to be caused by something other than windblown dust originating from the coastal dunes. The majority of outliers listed are from site 13A; this site is located just downwind from a large agricultural field with an upwind fetch of about ½ mile across the planted fields. The fields also have a grid of dirt roads for worker access to them. The fields upwind from site 13A were planted using plastic mulch covering most of the ground surface area during the project. It is interesting that excluding the 5/25/12 day where it is clear there were some windblown dust sources in the area, all but one outlier from site 13A occurred on the weekend.

Table A-7 – Listing of All Outlier Data Values Identified in the Project Data Set

Day of Week	Date	Site	Hour	Comment	Likely Cause
Thursday	4/5/2012	14A	13-14	Site 14a ~100 ug/m3 above CDF, other hours look normal. WS in region are high.	Local disturbance, sampler artifact, or local wind blown dust
Friday	4/6/2012	10B	5	Single hour ~160 ug/m3, low WS	Sampler artifact
Friday	4/27/2012	12A	13	Single hour outlier ~200 ug/m3 above nearby sites. WS at 13A and 6A increase on hour 14, yet PM_{10} at12A drops	Local disturbance or local windblown dust
Friday	5/4/2012	13A	12-13	Both hours ~100 ug/m3 above nearby sites. Hour 13 to 14 WS goes from 12.3-12.1 but PM_{10} drops to below surrounding sites levels on hour 14	Local disturbance or local wind blown dust
Saturday	5/5/2012	15A	9	Single hour spike ~175 ug/m3, low wind speed	Sampler artifact or local disturbance
Sunday	5/6/2012	13A	11	Very low WS from north, single hour spike >1000ug/m3	Sampler artifact or local disturbance
Saturday	5/12/2012	SE-E	11	Winds low in region, single hour spike >550 ug/m3	Sampler artifact or local disturbance
Tuesday	5/15/2012	12A	16	Winds low in region, single hour spike >800 ug/m3	Sampler artifact or local disturbance
Tuesday	5/15/2012	14A	17	Winds lower than typical at 14A for wind event, single hour spike >500 ug/m3	Sampler artifact or local disturbance
Saturday	5/19/2012	13A	11-14	Winds during period low and PM does not correlate with wind speed.	Local disturbance
Tuesday	5/22/2012	13A	15	Single hour >1800 ug/m3. Following hour WS increases from 11 - 12.1 and PM_{10} drops to levels in surrounding sites	Sampler artifact, local disturbance, or local wind blown dust
Friday	5/25/2012	S-E, 17A, 13A, 12A	13-15	Unusual meteorological pattern, higher WS inland than on the coast. Wind speeds in vicinity of affected sites highest of project. Santa Maria PM2.5/10 ratio indicates impacts from ag. fields.	Local windblown dust

These outliers have been retained in the study data set, so anyone interested can examine them in further detail. While interesting to investigate, the outlier values represent only a tiny fraction (0.07%) of the large amount of data gathered and evaluated for this project and thus do not change, or significantly affect, the overall findings.