SOUTH COUNTY COMMUNITY MONITORING PROJECT

Appendix D – Exploring Other Aspects of the Data Set

ADDITIONAL ANALYSIS OF OCEANO DATA

Analysis of Oceano PM_{10} Data Before and After Expanded Street Sweeping

Comparisons of the Community Monitoring Project data to the Phase2 data in theory could be used to measure the effectiveness of the street sweeping efforts of State Parks and San Luis Obispo County in reducing PM_{10} concentrations impacting the area; this comparison, however, is not so straightforward. The Phase2 Oceano data was collected with a hi-volume sampler that measured 24-hour average concentrations on a one in six day schedule for an entire year. The Community Monitoring Project data is composed of hourly concentrations measured continuously with an EBAM during the 3-month spring windy season when the highest concentrations would likely occur. Salt analysis was performed on all of the Phase 2 hi-volume filters; as mentioned previously, performing salt analysis on all hourly filter samples from the Community Monitoring Project would be prohibitively expensive. Additionally, the Phase2 site was located on the east side of Lakeside Avenue, while the Community Monitoring Site O-D was located directly across Lakeside Avenue due to unavailability of the old Phase2 location. These differences between the Phase2 data and the Community Monitoring Project data make definitive comparisons between the two data sets very difficult.

One approach to evaluating any potential changes in PM_{10} levels in Oceano between the two measurement projects is to look at the relationship between PM_{10} measurements performed at Oceano, CDF and the Mesa2 monitoring stations. The data shows a strong relationship between high PM_{10} at Oceano (from windblown sand, not salt) and high PM_{10} measured at CDF and Mesa2. This relationship is likely due to wind being the driving force behind the high concentrations in both areas.

As discussed earlier, salt content in PM_{10} samples is low and quite consistent in the numerous measurements from the Nipomo Mesa, but PM_{10} measurements from Oceano vary widely in salt concentrations; these differences alter the relationship in the PM_{10} data between the two areas. The ideal way to deal with this problem would be to analyze and subtract out the salt from all samples, but that is not feasible. As an alternative, the data from both studies was evaluated and any days with a high contribution from salt was excluded. Data from Phase 2 was evaluated based on the actual salt analysis from the Oceano filters; data from the Community Monitoring Project was evaluated by looking at PM_{10} levels in relation to wind speed. This comparative analysis identified three days with a high salt contribution in both data sets; those days were excluded from this analysis.

A simple comparison is to average the highest dust events from both sampling periods under the same conditions and compare the data relationship between Oceano, CDF and Mesa2. These data will also likely be the least influenced by sea salt. The Table D-1 below presents this data.

Table D-1 – Data Comparison between Phase2 Study and Community Monitoring Project

Phase 2 Data			
Site	Oceano	CDF	Mesa2
Top 5 24 Hr. Avg.	92.6	100.7	90.2
% diff. Oceano Vs Nipomo Site		8%	-3%
Community Monitoring Data			
Site	Oceano	CDF	Mesa2
Top 5 24 Hr. Avg.	86.9	156.9	122.3
% diff. Oceano Vs Nipomo Site		57%	34%
% Change from Phase2 to Community Monitoring Data		49%	37%

A more complex analysis is to calculate the least square linear regression of the relationship between Oceano and each Nipomo Mesa site for both the Phase2 and Community Monitoring data sets (with the three days identified as being heavily influenced by sea salt excluded) and comparing these regressions. Figure D-1 below presents the comparison of Oceano PM_{10} to CDF PM_{10} from both the Phase2 and Community Monitoring Project. Figure D-2 below presents the comparison of Oceano PM_{10} to Mesa2 PM_{10} from both the Phase2 and Community Monitoring Project.

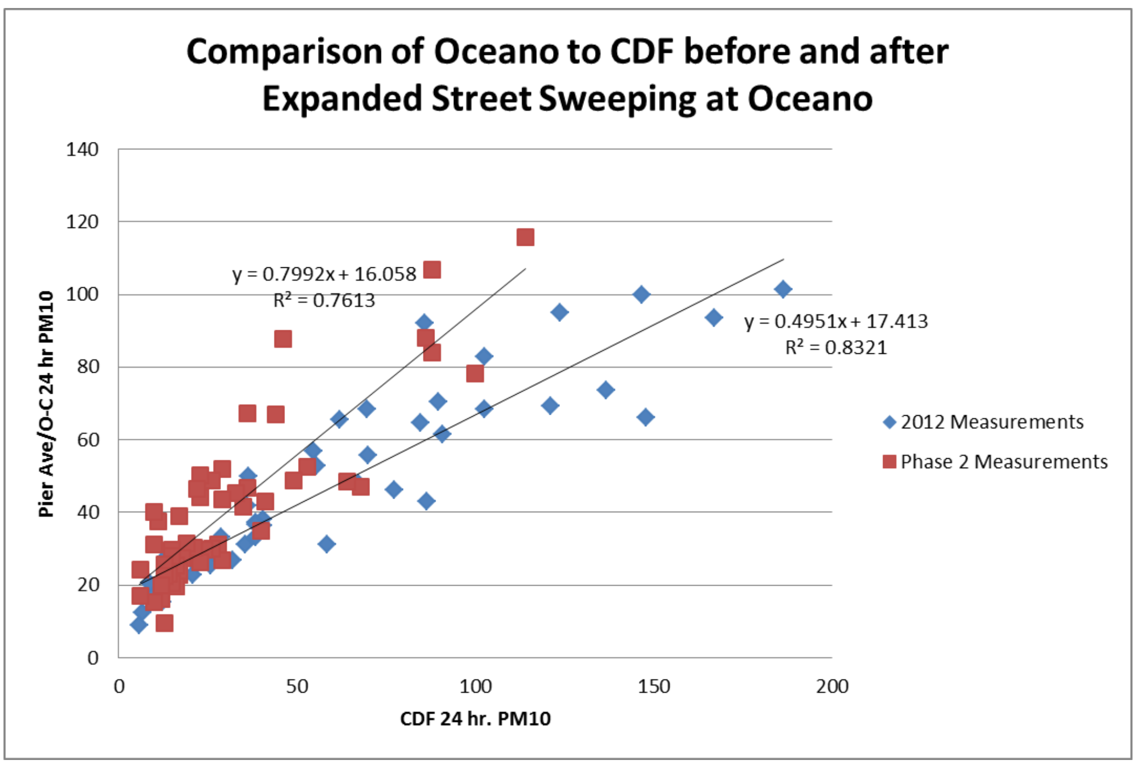

Figure D-1 – Change in PM_{10} Relationship Between Oceano and CDF

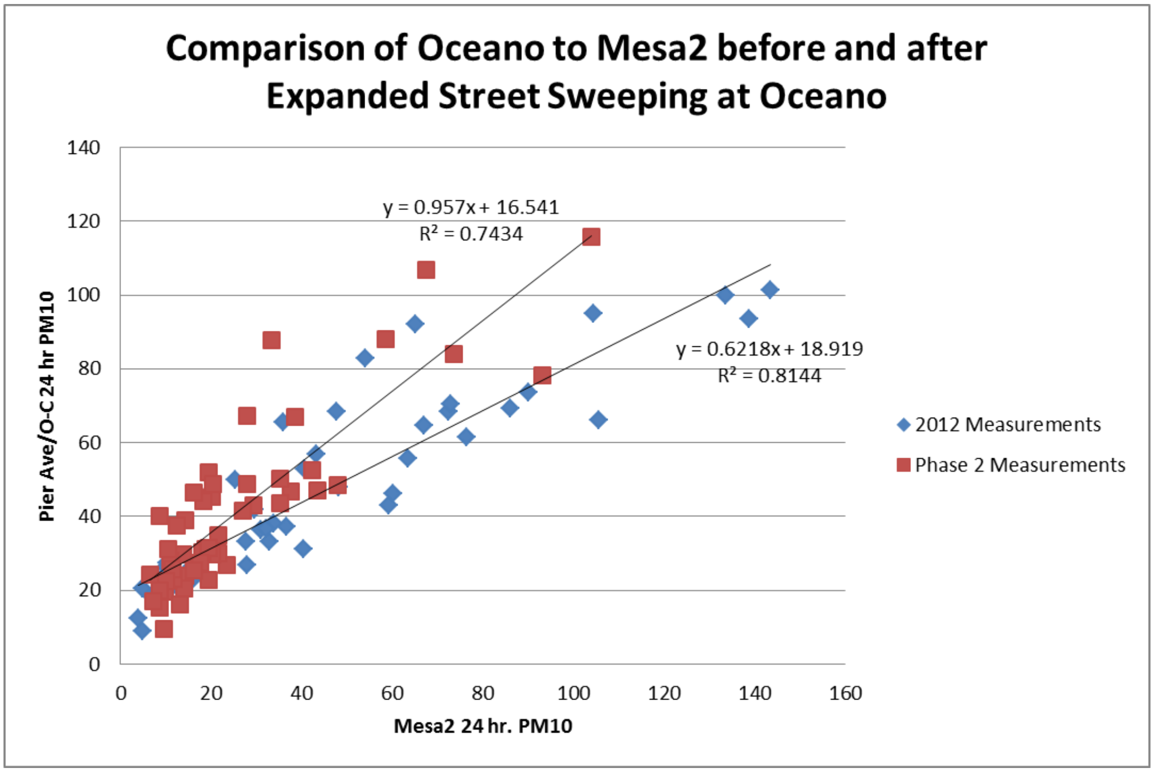

Figure D-2 – Change in PM_{10} Relationship Between Oceano and Mesa2

Both Figures D-1 and D-2 show a clear reduction in PM_{10} concentrations in Oceano relative to the PM_{10} levels on the Nipomo Mesa when comparing the two monitoring programs. Due to the scatter in the data (likely due to the influence of salt and other variables) the exact magnitude of the relative reduction is unclear, but it appears to be greater than 30%. This apparent change could be due to a variety of reasons. For instance, it is possible, but unlikely, there has been no improvement in Oceano, but instead degradation in Nipomo. Given, however, that the enhanced street cleaning effort on Pier Avenue in Oceano is the only known significant factor that has changed between the two monitoring projects makes this a more logical cause.

As noted above, there are numerous differences in the two measurement programs that could possibly account for the observed improvement, so this analysis should not be considered conclusive and is only presented as the best attempt with the limited data to evaluate the influence of the street sweeping program. Further investigation by comparing periods with and without street sweeping, using the exact same sampling location and measurement method would be needed to provide a more definitive conclusion. In addition, it is clear, even with the lower relative PM_{10} levels measured in Oceano since enhanced street sweeping efforts began, that the state 24-hour PM_{10} health standard is still exceeded occasionally in the areas closest to Pier Avenue and the disturbed beach sand.

<u>Influence of Sea Salt in Oceano</u>

Oceano's close proximity to the ocean makes understanding the PM_{10} impacts there considerably more complicated than in the Nipomo area due to the added influence of sea salt. Detailed measurements of salt in PM samples from the Nipomo Mesa area in the APCD Phase1 and Phase2 studies demonstrate the salt content in PM_{10} samples collected in that area is quite consistent, typically comprising between

5-10% of the sample. However, measurements at the Pier Avenue site during the Phase2 study, as well as measurements at Grover Beach about one mile to the north and a similar distance from the ocean, both showed wide fluctuations in salt content. The Grover Beach measurements were hourly and occasionally showed PM_{10} concentration spikes above 400 ug/m3; chemical analysis confirmed these spikes to be salt. As one would expect, data from Grover Beach showed the highest salt content under calm conditions when dispersion was poor. The 24-hour samples taken from Pier Avenue as part of the Phase2 study also showed wide variations in salt content, with over 50% salt content found in some samples while others contained only trace amounts.

For the Community Monitoring Project, the cost of performing salt analysis on every hourly filter sample from Oceano was prohibitive. As a compromise, approximately 50 hourly samples under a variety of conditions were selected from the Oceano sites for salt analysis, to be used to better understand the role of salt in the entire data set.

The salt data is presented in Table D-2 below. Note that samples taken during wind events typically contain between 5% and 10% salt. This consistency in the data allows comparisons of PM_{10} measurements during wind events without much consideration of salt content. However, because the high salt concentrations occur during calm periods, comparing non-wind event hours and 24-hour average concentrations requires more care and must take potential salt impacts into consideration.

Table D-2 – Summary of Oceano Sea Salt Analysis

Oceano Sea Salt Data	Site O-C			Site O-D			Site O-A			Site O-A	
Sample	EBAM PM10	Salt		EBAM PM10	Salt		EBAM PM10	Salt		Wind Speed	
Time	ug/m3	ug/m3	% Salt	ug/m3	ug/m3	% Salt	ug/m3	ug/m3	% Salt	mph	Comment
4/16/12 14:00	176	14.1	8.0%							12.3	wind event
4/17/12 14:00	205	19.3	9.4%							11.2	wind event
4/18/12 15:00	271	21.3	7.8%							12.5	wind event
4/20/12 7:00	186	108.0	58.2%							1.8	Calm Condition Salt Event
5/22/2012 11:00	141	11.0	7.8%	108	10.5	9.7%				11.4	wind event
5/22/2012 12:00	412	13.1	3.2%	235	10.9	4.6%	235	10.1	4.3%	15.0	wind event
5/22/2012 13:00	345	15.3	4.4%	342	11.1	3.2%	164	11.4	7.0%	15.9	wind event
5/22/2012 14:00	313	15.3	4.9%	400	12.5	3.1%	177	11.5	6.5%	13.9	wind event
5/22/2012 15:00	180	17.3	9.7%	319	12.3	3.9%				11.2	wind event
5/22/2012 16:00	123	15.8	12.9%	170	13.7	8.1%				10.5	wind event
5/22/2012 17:00				173	14.6	8.4%				7.8	Wind Event ending
5/22/2012 18:00	103	20.4	19.8%							6.0	Wind Event ending
5/22/2012 23:00	75	72.5	96.7%							1.6	Calm Condition Salt Event
5/23/2012 10:00	104	21.3	20.4%							13.2	Wind Event beginning
5/23/2012 12:00	223	25.2	11.3%	229	21.8	9.5%				14.1	wind event
5/23/2012 13:00	245	23.8	9.7%	276	22.7	8.2%				14.1	wind event
5/23/2012 14:00	257	24.5	9.5%	269	22.6	8.4%				13.9	wind event
5/23/2012 15:00	196	28.2	14.4%	238	21.3	8.9%				13.0	wind event
5/23/2012 16:00	155	26.2	16.9%	189	22.6	11.9%				13.0	wind event
5/23/2012 17:00	108	31.7	29.3%	169	23.2	13.7%				7.2	Wind Event ending
5/23/2012 18:00	138	31.9	23.2%	100	28.6	28.5%				5.2	Wind Event ending
5/23/2012 19:00				158	39.2	24.8%				4.7	Wind Event ending
5/23/2012 21:00	107	60.8	57.0%							2.5	Calm Condition Salt Event
5/24/2012 9:00				109	25.4	23.2%				9.0	Wind Event beginning
5/24/2012 10:00	140	25.2	18.0%	158	29.3	18.5%				11.0	Wind Event beginning
5/24/2012 13:00	307	21.0	6.9%	211	20.7	9.8%				14.8	wind event
5/24/2012 14:00	197	20.5	10.4%	265	19.7	7.4%				13.2	wind event
5/24/2012 15:00	199	23.1	11.6%	223	17.7	7.9%				12.1	wind event
5/24/2012 16:00	119	26.5	22.2%	191	17.4	9.1%				12.1	wind event
5/24/2012 17:00	51	27.9	54.6%	189	21.9	11.6%				10.1	Wind Event ending
5/24/2012 19:00	123	32.1	26.1%	120	25.2	20.9%				6.0	Wind Event ending

Variations in Oceano Plume Impacts

Looking at the hourly data from various wind/dust episodes for the Oceano study area, a more complex pattern is revealed than the average measurements between site O-C and O-D. There are episodes where site O-C PM_{10} measurements are higher than O-D and other episodes where the opposite is true. Figure D-3 below is the peak hour of an episode where O-C consistently measured higher PM_{10} values than O-D. Figures D-4 through D-8 below present consecutive hours of the main portion of a wind/dust event that demonstrates how variable the relationship between the PM_{10} concentrations at O-C and O-D are. Figure D-4 begins at 11:00 with the event just beginning. On hour 12, site O-C recorded over 400 ug/m3, twice the PM_{10} value from site O-D. Then on hour 13, sites O-C and O-D measured similar PM_{10} concentrations. However, on hour 14, the relationship between the two sites PM_{10} values reverses, with O-D measuring about 100 ug/m3 higher than O-C. On hour 15 nearing the end of the episode, O-D continues to record significantly higher PM_{10} than O-C.

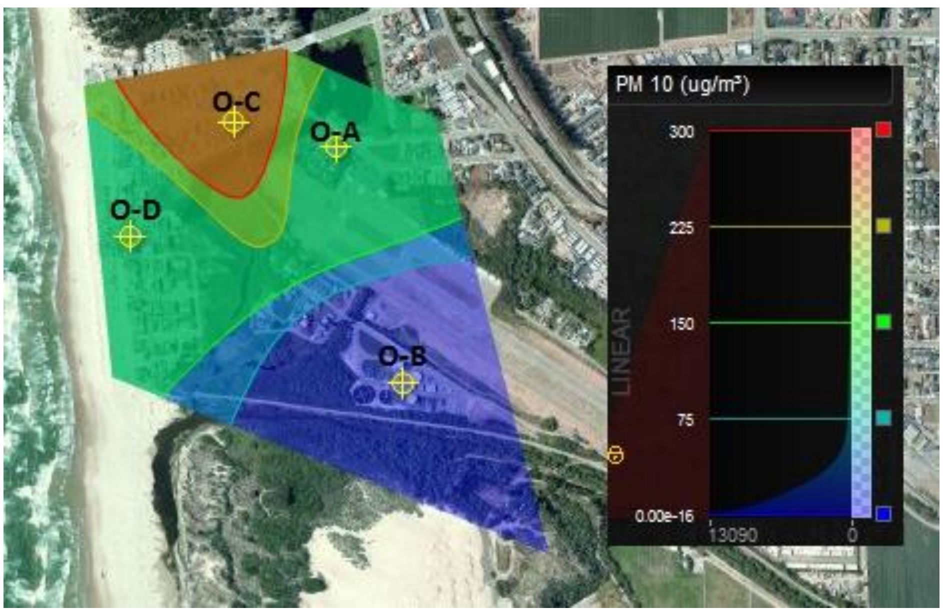

Figure D-3 – Oceano 5/28/12 hour 13

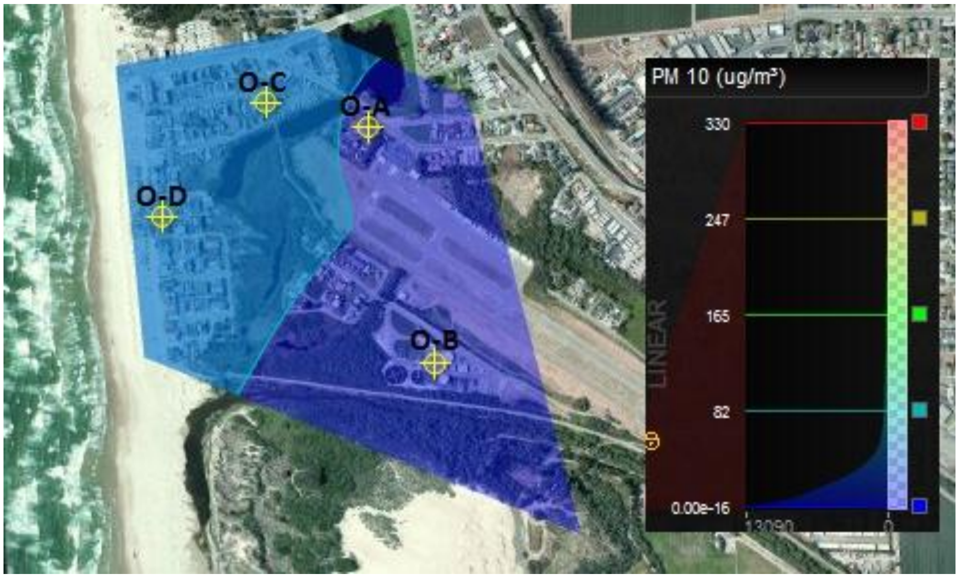

Figure D-4 – Oceano 5/22/12 11:00

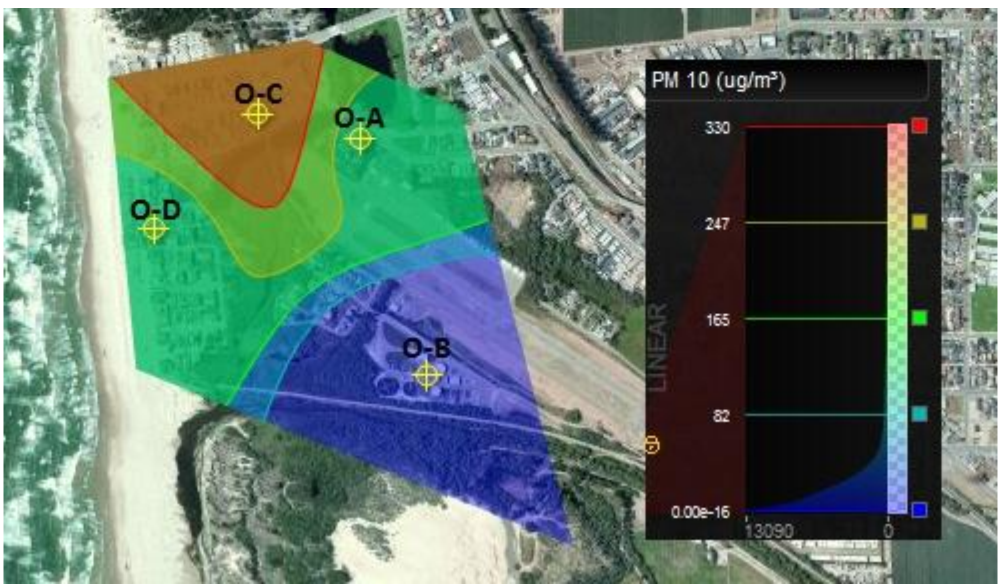

Figure D-5 – Oceano 5/22/12 12:00

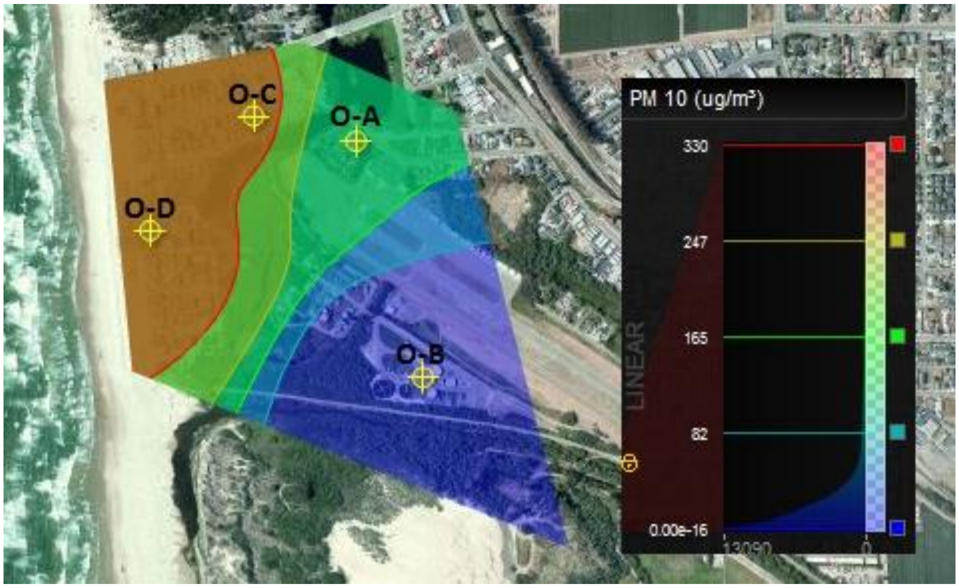

Figure D-6 – Oceano 5/22/12 13:00

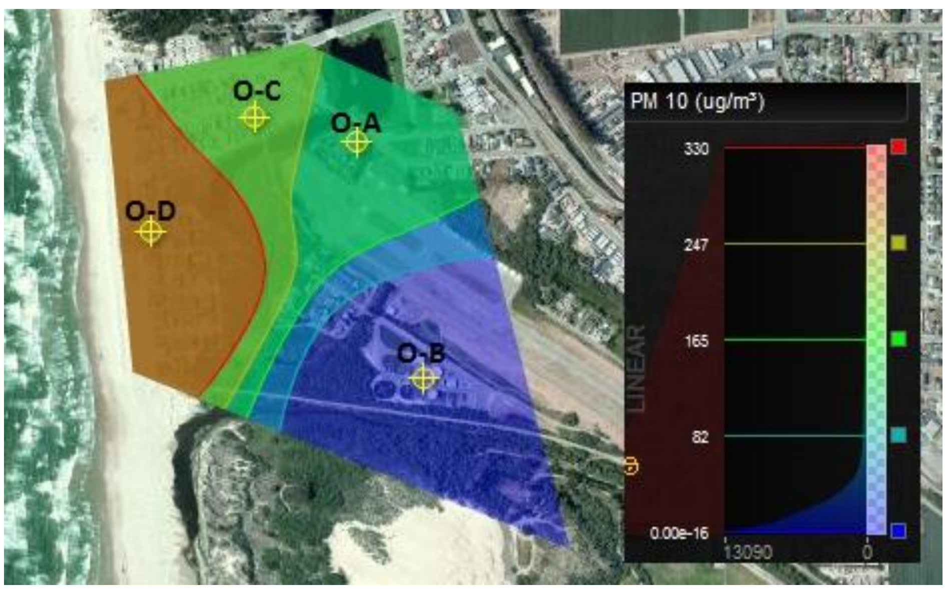

Figure D-7 – Oceano 5/22/12 14:00

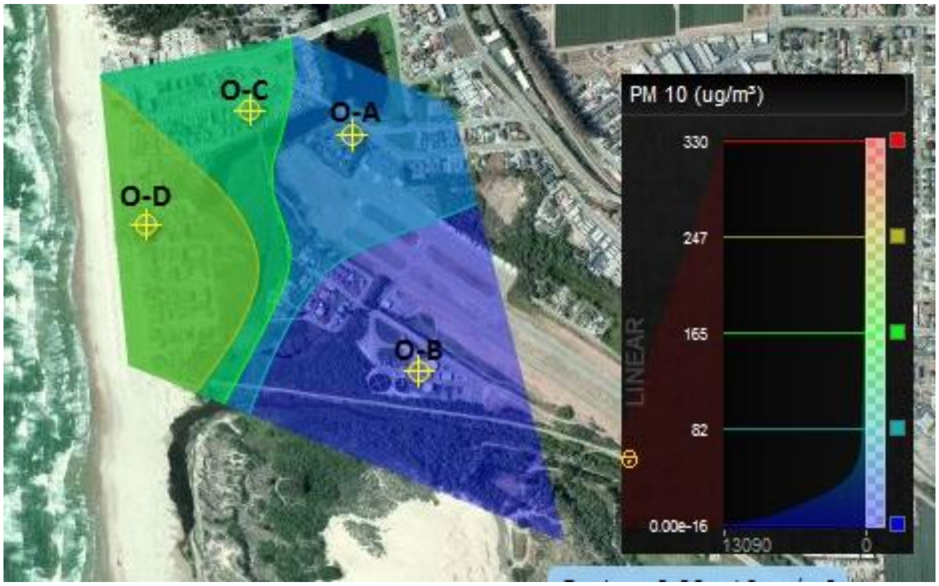

Figure D-8 – 5/22/12 15:00

The cause(s) of the shifting relationship in PM_{10} concentration between site O-C and O-D is unresolved. State Parks in coordination with San Luis Obispo County has increased the street sweeping of Pier Avenue as a potential mitigation effort. The sweeping is a possible variable in the changing relationship of PM_{10} concentrations between sites O-C and O-D. Another potential variable is that State Parks periodically moves large quantities of sand that build up next to wind fences. This sand movement is a routine maintenance activity that takes place by the wind fences right in front of the houses on Strand Way (where site O-D is located). State Parks personnel, using large earth moving equipment, moves the built up sand away from the wind fences and dumps the sand on the beach upwind of these fences. This activity causes significant disturbance to the sand surface, which could also be a factor in the changing relationship in PM_{10} readings between these two sites. Attempts to correlate shifts in the PM_{10} gradient between these two sites with the sparse records available for these activities were inconclusive in identifying any consistent pattern. It is worth noting, however, that State Parks records show sand moving activities to maintain the wind fencing occurred on the day depicted in the series of data plots above in Figures D-4 to D-8, when a significant shift in the relationship between the PM_{10} concentrations at these sites also occurred.

Discussion of Peer Review Comment

In supporting the major conclusions of the study, one of the project peer reviewers theorized that, in addition to direct PM impacts on the Nipomo Mesa from the Oceano Dunes, there may be a secondary impact where particles deposited along the plume path from previous episodes are re-entrained by later strong episodes. One piece of data the reviewer cited in making this comment is from the May 23 episode, which had the highest PM concentrations measured at CDF during the project. In this episode, the reviewer notes that the PM_{10} concentration at Site 15A was almost as high as the value measured at CDF for the peak hour of the event. Seeing little drop in concentration between the CDF site and the further downwind 15A site for this one hour, the reviewer postulated that particles deposited along the plume path from previous dust events might be re-entrained on subsequent events, leading to the higher than expected concentration at 15A for that hour. Close examination of the May 23 event, presented in Figure D-9 below, shows that indeed the site 15A concentration for the peak hour of the episode was only slightly lower than the corresponding value from the CDF site. However, PM_{10} concentrations at site 15A during all other hours of the episode were significantly lower than the corresponding measurements at CDF.

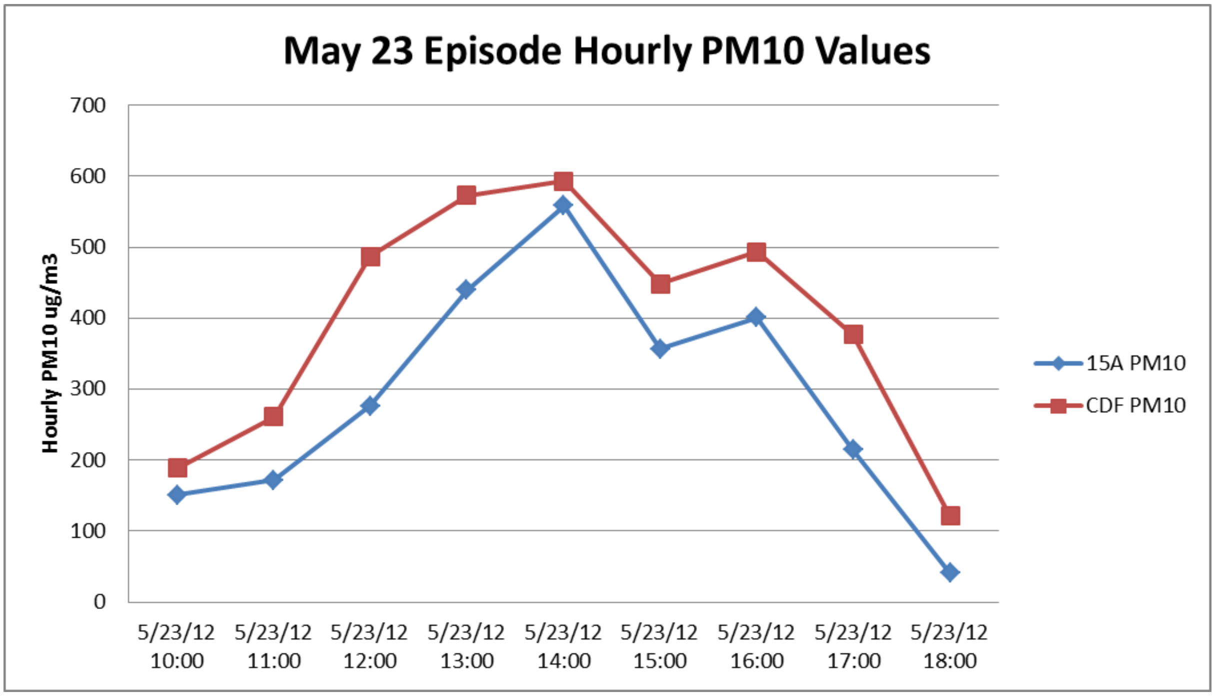

Figure D-9 – Relationship between hourly PM10 at CDF and Site 15A for 5/23/12 Episode

The hourly data set of wind event hours for the entire project period is compared in Figure D-10 below for both the CDF and 15A sites, with the 5/23/12 episode peak hour (hour 14) highlighted. This figure clearly shows that the peak hour of the 5/23/12 episode does not fit with the vast majority of the data. Indeed, when one looks at the average relationship between these sites, an expected pattern of decreasing concentration as the plume moves downwind is apparent. These average relationships between sites for episode days are presented in Table 1 in the main portion of this report.

It is not completely clear why the one peak hour of the highest episode of the study exhibited such a different pattern between the CDF and 15A sites. It is certainly possible, as the reviewer suggests, that the particle deposition that occurs during an episode can be followed by re-entrainment of those particles in subsequent strong wind events. However, the data set suggests the possibility of this having a measurable effect on local PM levels during an episode to be a rare event. Another possibility is that a local disturbance or emissions from a localized source at or near site 15A caused this one hour to be biased high. Such local influence has been noted on a handful of other data values from other sites in the study network. Site 15A was located just a few feet downwind from disturbed soil in a livestock area, and about 0.15 miles downwind from a dirt road. These two small, local sources could potentially emit PM due to both mechanical disturbance and/or wind re-entrainment. However, as noted in the detailed discussion of local sources in Appendix A, such sources have a very limited spatial influence due to their small size, and the PM emissions they might generate will be significant only a tiny fraction of the time. Regardless of the mechanism that caused this outlier value, the data set demonstrates it is a rare occurrence, not the typical or average pattern of the data.

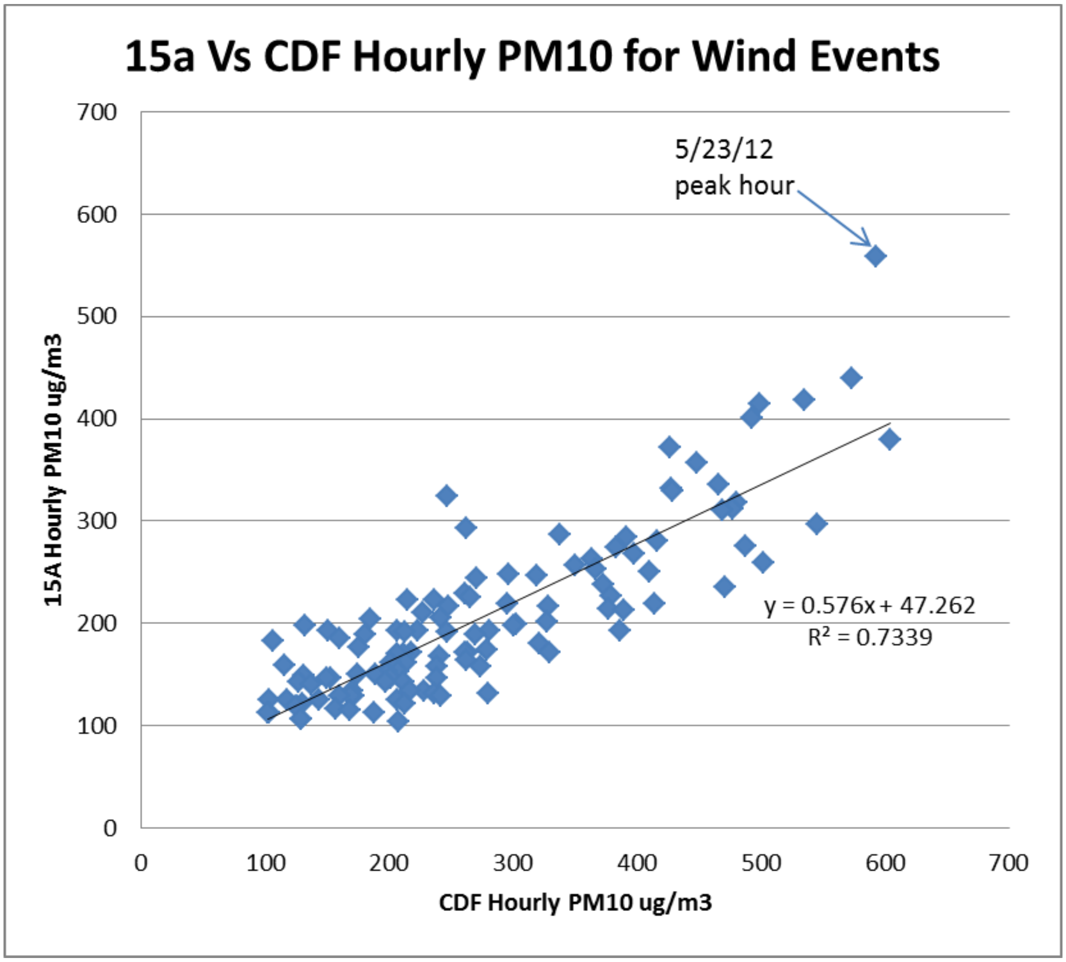

Figure D-10 – Comparison of hourly PM_{10} concentrations at CDF vs. Site 15A for all wind event hours