Science v. Regulation: The Nipomo Mesa's PM10 and Oceano Dunes

by

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CHAPTER 1: *A Goldilocks Setting for Sand Dunes and Recreation*

The Oceano Dunes State Vehicular Recreation Area (Oceano Dunes) is in the coastal dunes south of Pismo Beach. It is approximately 3,500 acres and managed by the California Department of Parks and Recreation (State Parks). On less than 1,000 of those acres, State Parks allows shoreline camping for $10 per night per vehicle, as well as off-highway vehicle (OHV) recreation.

The park lies within the 18,000 acre Guadalupe-Nipomo Dunes Complex, which stretches from Pismo Beach to dunes south of the Santa Maria River mouth.

Oceano Dunes and Vicinity (modified and rescaled from Google Maps)

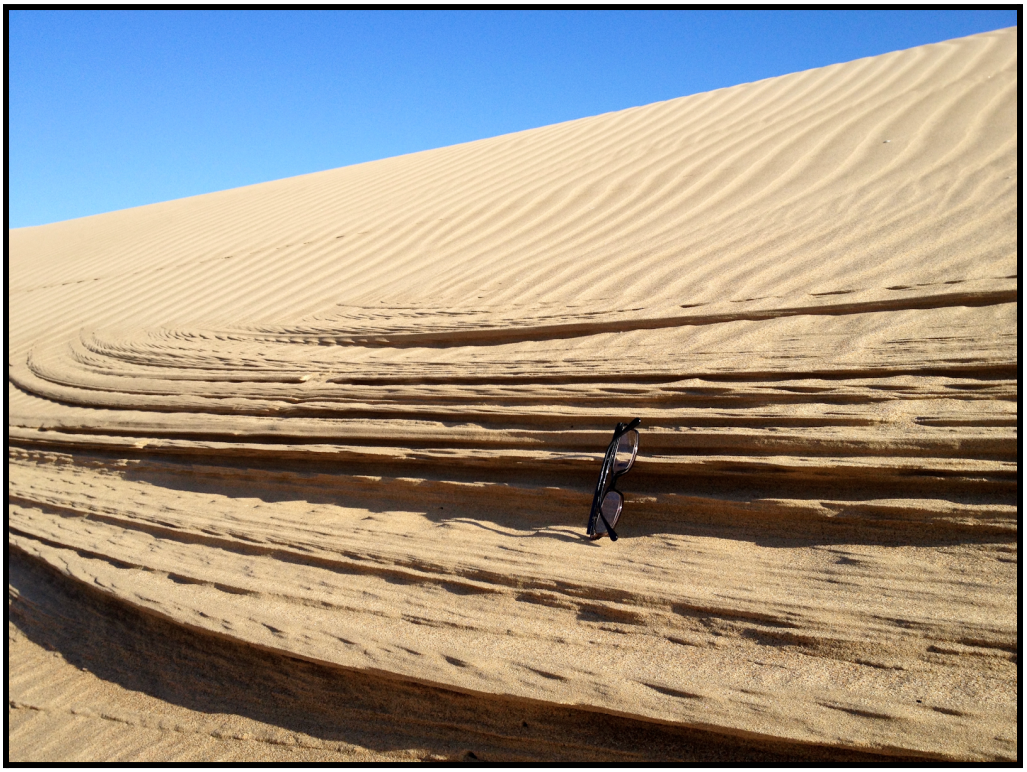
Sand dunes have formed here for hundreds of thousands of years thanks to three ingredients:

1. Lots of sand that is essentially stockpiled offshore—sand provided by local streams and rivers, and the longshore current.
2. Strong prevailing winds blowing onshore from the west and northwest. These winds blow predominantly in the spring and to a lesser extent in the fall.
3. A low-lying, west-facing shoreline, which acts as a catcher's mitt of sorts, receiving the brunt of the prevailing winds.

CHAPTER 2: *Saltation Maketh the Dunes*

The subdued, nearly flat topography along the shoreline of Oceano Dunes provides a low ramp for the tides and surf to feed sand to the upper reaches of the beach. The sand is then pushed by the wind, causing the grains to creep and bounce further up from the shore in a process called saltation.

The sand forms small ripples that inch downwind. Each ripple works conveyor-like, laying down a thin layer of sorted sand as the ripple rolls over the landscape. These layers build on each other, sand ripple by sand ripple, to create the dunes.



Sand Ripples and Underlying Layers within a Sand Dune, Oceano Dunes SVRA (Photo: Will Harris)

The topmost sand layers are ephemeral, obliterating whenever the wind shifts, or when the dunes are stepped on or driven over. The layers form again when the wind blows strongly enough to reinitiate the saltation process.

CHAPTER 3: *The Nipomo Mesa, the SLOAPCD, and PM10*

The Nipomo Mesa (Mesa) is a semi-rural region of south San Luis Obispo County that is a bit more than a mile east of Oceano Dunes. Since 2010, the San Luis Obispo County Air Pollution Control District (SLOAPCD) has blamed OHV recreation at the state park for elevated concentrations of particulate matter, or PM10, detected on the Mesa.

PM10 refers to any airborne particle that is 10 micrometers in diameter or smaller. Instruments used to measure PM10 detect dust, smoke, water vapor and other aerosols—even sea salt in the air—as the same generic thing: particles suspended within a known volume of air.

Powerful winds from over the ocean roll onto this stretch of the central California coast every spring and fall. Mostly in the spring, when these prevailing winds are strongest, the SLOAPCD's air monitoring stations on the Mesa record PM10 concentrations that exceed California's air quality standard for PM10. The California PM10 standard is 50 micrograms of PM10 per cubic meter of air averaged over 24 hours.

That's a bit jumbled, so let me break it down a bit: Each automated instrument the SLOAPCD uses to monitor PM10 collects a measurement every hour. That means of course that each instrument takes 24 measurements every day. The average of the 24 PM10 measurements made at any station on any given day provides the official PM10 reading for that day at that station. That average is then compared to the state's PM10 standard to determine if there has been an exceedance of the standard at that location.

The SLOAPCD's "CDF" Air Monitoring Station on Nipomo Mesa (Photo: Will Harris)

CHAPTER 4: *The Shifting Rationale to Regulate and The Silica Scare*

Since 2011, the SLOAPCD has attempted to regulate and fine State Parks for PM10 exceedances on the Mesa.

Over the years, the SLOAPCD has given varying reasons as to why State Parks should be held to account. Their initial reasons attempted to directly associate OHV recreation with the PM10. They claimed the recreational activity itself was causing the high PM10 on the Mesa, which is more than a mile downwind from the OHV recreation. They said there was a crust on the dunes, akin to desert salt flats, and that when OHV's broke the crust, fine particles of dune sand were exposed and then lofted by the wind to the Mesa. And they claimed a statistical correlation between OHV recreational activity and elevated PM10 concentrations on the Mesa. But all of these reasons did not bear up to scientific scrutiny, and so they were dropped from the SLOAPCD's parlance of complaint regarding Oceano Dunes.

The Silica Scare

The SLOAPCD also reasoned that because the sand grains are mostly composed of the silica mineral quartz, the dust from sand saltation must also contain silica in the form of tiny bits of quartz. They repeatedly warned the community and agencies such as the California Coastal Commission about what they perceived to be an acute health risk associated with silica—something far more serious than just PM10 (Allen, 2017). This garnered fevered support for the SLOAPCD's attempts to regulate State Parks (Carl, 2017).

But the SLOAPCD never analyzed the sand or the PM10 for silica content.

Had they bothered to conduct a basic review of the geological literature regarding the dunes, they would have discovered that the sand grains are mostly feldspar, which is not a silica mineral. And had they sampled and analyzed the PM10 for silica, which is what industrial hygienist John Kelse and I did in 2017 and 2018 on behalf of State Parks, they would have found, per John Kelse, that there was "no evidence of a realistic pulmonary inhalation risk with respect to crystalline silica" (Kelse, 2018).

REFERENCES

Allen, L., 2017. Letter from SLOAPCD Air Pollution Control Officer Larry Allen to Dan Carl, District Director for Central Coast District of the California Coastal Commission, March 17, 2017. Subject: "2017 Dust Mitigation Proposal for the Oceano Dunes SVRA."

Carl, D., 2017. Letter from District Director for Central Coast District of the California Coastal Commission Dan Carl to Ronnie Glick, State Parks, Oceano Dunes SVRA, March 29, 2017. Re: 2017 Dust Mitigation Proposal to Comply with APCD Rule 1001.

Kelse, J., 2018. Report to Matt Fuzie, Deputy Director, California Department of Parks and Recreation, from John W. Kelse, Industrial Hygienist, March 16, 2018. Subject: Determination of Airborne Crystalline Silica (Quartz) Exposure at Oceano Dunes SVRA and CDF Air Monitoring Station, 2391 Willow Road, Arroyo Grande, CA

CHAPTER 5: *Enter the Scientific Advisory Group and its Search for Delta*

In 2018, the SLOAPCD imposed a stipulated order of abatement (SOA) against State Parks. The SOA effectively required State Parks to eliminate ongoing violations of the state PM10 standard on the Mesa.

To implement the SOA, the SLOAPCD, with tacit approval from State Parks, appointed a team of specialists known as the Scientific Advisory Group (SAG). Each SAG member has some expertise relevant to sand dunes, air quality, or botany.

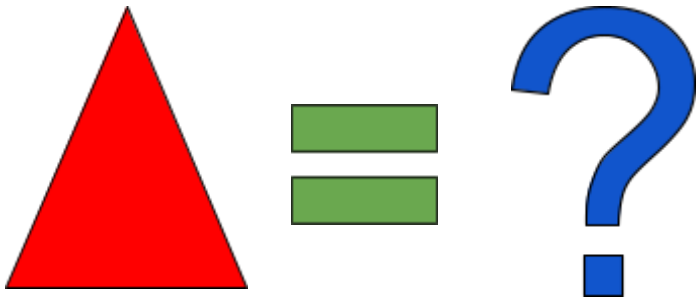
Based on investigations and data analyses it undertakes, the SAG dictates to State Parks the measures to be taken to meet the obligations of the SOA.

And State Parks foots the bill for the SAG's services.

In considering the SOA, the SAG first postulated that intensive OHV recreation in specific areas of the dunes creates "hot spots" of dust emission. But this idea was abandoned after a couple of years because identifying theoretical hot spots via measurements of dust emissivity on dune surfaces proved elusive.

They next turned to examining years' worth of dust emission data that had been collected in the dunes by one of the SAG members. Eventually, through statistical analysis that aggregated data collected from multiple years, they claimed there were two different dust emission values for the dunes—one for inside the OHV riding area, and one for outside the riding area. Per the SAG, that difference—or "delta"—indicated that the OHV riding area of the park had a higher saltation-generated dust emission potential than elsewhere in the dunes, at least when the data were aggregated. But discerning a dust-emission "delta" using any specific year of the dune emission data—well, that also proved elusive.

Nonetheless, the SAG felt they could move forward with what they had.



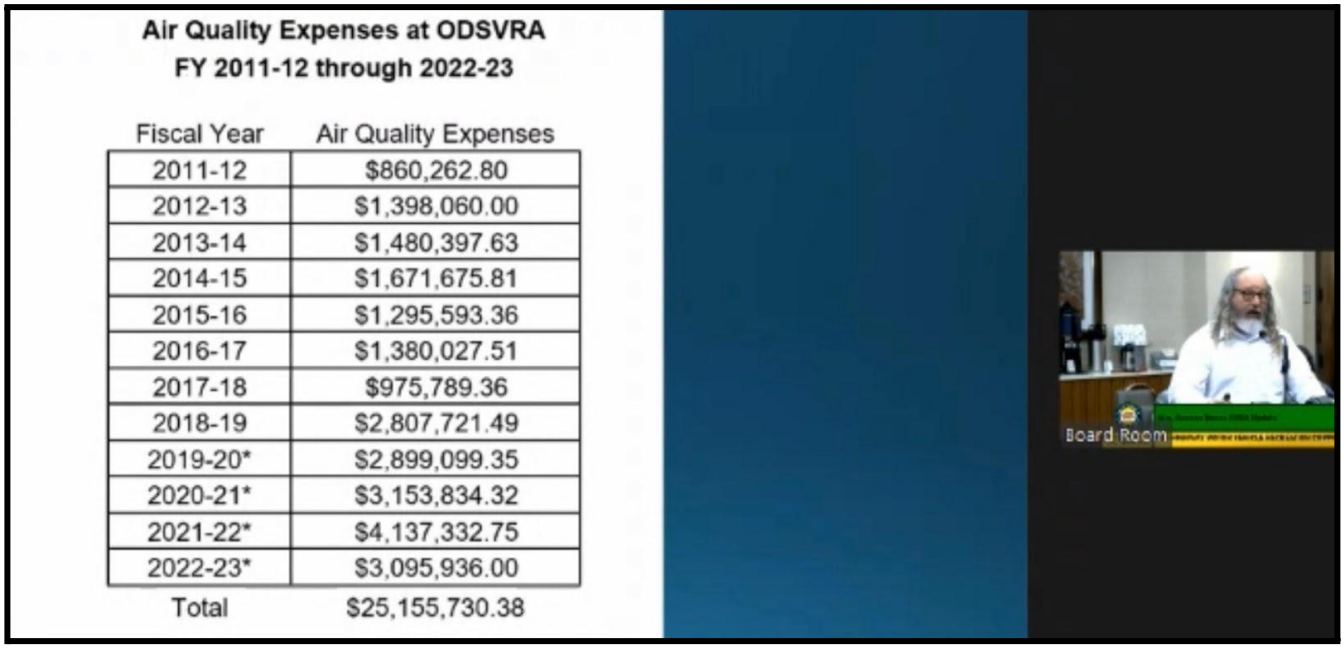
CHAPTER 6: *Of Computer Modeling, Plastic Fencing, Reductions in Park Acreage, and Cost*

The SAG plugged their “delta” data into custom computer models that are used to simulate PM10 dispersion from the dunes to the Mesa. This enables the SAG to quantify the amount of PM10 emitting from the riding and non-riding areas of the dunes to the Mesa, at least according to the models.

The computer modeling also estimates the PM10-reduction effectiveness of plastic fencing, hay bales, and vegetation plots placed in the riding area of the dunes to hamper the saltation process. These installations have been deemed necessary by the SAG to meet the obligations of the SOA.

The fencing, hay bale, and vegetation projects have thus far reduced the recreational area of the park to approximately 700 acres. Prior to the SOA, approximately 1,500 acres of the state park were open to riding and camping.

As of March 2023, State Parks has spent $25.2 million on SLOAPCD/SAG/SOA-related measures and services, including $3.1 million this past fiscal year. The expenditures are on-going.



State Parks’ SLOAPCD/SOA-Related Expenses as Reported March 24, 2023, OHMVR Commission Meeting Redding, CA

CHAPTER 7: *Continuing Violations of the PM10 Standard*

Despite the money spent and dune acreage covered to theoretically reduce PM10 on the Mesa, violations of the PM10 standard have only increased. In 2022, for the months April, May, and June, which are the windiest months in any given year, there were 40 violations of the PM10 standard on the Mesa.

That is more than any of the previous 8 years for the same three-month timeframe.

Springtime Violations of the State PM10 Standard by Month and Year at the CDF Air Monitoring Station on the Nipomo Mesa

Year	April	May	June	Spring Totals
2014	10	19	6	35
2015	12	5	5	22
2016	13	4	10	27
2017	14	10	9	33
2018	8	9	9	26
2019	6	6	2	14
2020	10	12	7	29
2021	6	7	6	19
2022	**14**	**16**	**10***	**40**

*For June 2022, data are only through June 20, 2022.
Note: The CDF station is approximately two miles downwind (east) of the Oceano Dunes SVRA.

Springtime Violations of the California PM10 Standard, SLOAPCD CDF Station on Nipomo Mesa. Data from: https://www.arb.ca.gov/aqmis2/display.php?param=PMBAM&units=001&year=2022&report=SITE1YR&statistic=DAVG&site=3762&ptype=aqd&std15=

CHAPTER 8: *Dust and PM10 are not Synonymous*

A key term that the SLOAPCD and the SAG have used synonymously with the Mesa PM10 is "dust." The measures to cover the dunes, the computer modeling, and the SLOAPCD's basic premise that the high PM10 on the Mesa is from the OHV riding area of the dunes, all assume that the PM10 on the Mesa is from dust generated by the saltation process in the dunes.

Saltation does indeed generate dust: As the wind pushes the sand, sand grains bounce along the dune surface, and in so doing they dislodge other grains, including finer grains that can be considered dust. The finer particles are lofted by the wind, sometimes settling out downwind, sometimes becoming entrained in the wind.

But PM10 and dust from sand saltation are not synonymous. PM10 is a generic term. As mentioned earlier, PM10 can be smoke, water vapor or other aerosols—even sea salt—as well as dust.

Sand Saltation in Process, Blurring the Near-Horizon, Oceano Dunes (photo: Will Harris).

CHAPTER 9: *Assuming but not Verifying*

Dust from the saltation of dune sand has the same mineral composition as the dune sand. That's because the dust particles are just smaller bits of that sand. The proportional amount of mineral dust in a sample of PM10 can be determined in a relatively straightforward, if precise, combined analytical process called gravimetry and speciation.

Gravimetry is the before-sampling and after-sampling weighing of a PM10 filter to determine the total mass of PM10 collected on the filter from a known volume of air drawn through the filter.

Speciation, broadly speaking, enables the determination of the proportional mass of crustal minerals in the PM10 sample. Note here, the term "crustal" refers to bits of rock and soil--aka, mineral dust.

If the mass of the mineral dust equals the total mass of the PM10 sample, then 100% of the PM10 sample consists of dust. And obviously, if the mass of dust is less than the mass of the PM10 sample, then one fraction of the PM10 sample is dust, and the remainder consists of other things, such as water vapor, other aerosols, and sea salt. Without this testing, claiming the PM10 is dust from the dunes is just an assumption.

Unfortunately, the SLOAPCD made this assumption but never verified if it was true. They never conducted the combined gravimetry-speciation analysis to actually determine how much of the PM10 was dust.

And of equal concern, the SAG also did not test the PM10 for dust content. That meant they never determined if the most fundamental assumption in their computer modeling—that the PM10 was 100% dust—was correct.

CHAPTER 10: *Scripps Collaboration with State Parks*

Early on, I knew the SLOAPCD's 100% dust assumption to be incorrect because I looked at the particulate under a microscope. Collecting a bulk sample of the stuff was simple: In the spring, the particulate gloms onto the seaward side of fences and just about everything else sticking up from the dune surface. It was just a matter of knocking the dried, glommed bits of the particulate into a plastic bag and then placing a bit of the collected material on a glass slide for microscopic viewing. What I saw were bits of plankton—evidence that the PM10 was not just dust from the dunes.

This was in 2014, and I shared what I discovered with the SLOAPCD. They were not intrigued, and so ignored the information. But State Parks was at least curious and allowed me to pursue an investigation. This led to my collaboration with the Scripps Institution of Oceanography at U.C. San Diego (Scripps).

Particulate Material at Oceano Dunes and Photomicrographs of Planktonic Pieces in the Material (collected and photographed by Will Harris).

My initial work was with marine microbiologist Dr. Brian Palenik, and we confirmed that phytoplankton were a contributing source to the PM10. With that success, we expanded the investigation in a simple way.

The SLOAPCD has said many times over that the PM10 is dust from Oceano Dunes and so the manager of the park, State Parks, is responsible. That meant for State Parks that determining the amounts of all of the ingredients that make up the PM10 was not necessary. We only needed to know the amount of just one ingredient--dust. So to determine the proportional amount of dust in the Mesa PM10, Dr. Lynn Russell, atmospheric chemistry professor at Scripps, joined our investigation.

Chapter 11: *Targeted Sampling of Mesa PM10 by Scripps*

As mentioned previously, the prevailing winds along this stretch of California coast are strongest in the spring and fall. And typically during these seasons, the winds rise to their greatest on-shore strength from late morning to early evening. This is also when the SLOAPCD's automated hourly measurements of PM10 on the Mesa are at their highest.

As part of her three-year investigation, which began in 2019, Dr. Lynn Russell targeted the high wind/high PM10 seasons of spring and fall, sampling the Mesa air for PM10 on consecutive days. On each day, sampling was from late morning to early evening. This ensured "worst-case scenario" conditions—when PM10 concentrations on the Mesa would be greatest, and presumably, when the amount of dust in the PM10 would also be greatest.

31 Day Summary for Hourly PM10 (BAM)
for Arroyo Grande-2391 Willow Road
Display Ends 05/31/2021
Micrograms/Cubic Meter (ug/m3)

Graphit

		Hours 00-07										Hours 08-15								Hours 16-23			
Date	Day's Max	00 - 01	01 - 02	02 - 03	03 - 04	04 - 05	05 - 06	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23	23 - 00
05/31	16.0	16.0	12.0	10.0	10.0	7.0	8.0	8.0	5.0	11.0	1.0			2.0	4.0	5.0	7.0	6.0	3.0	0.0	3.0	13.0	14.0	11.0	9.0
05/30	30.0	30.0	21.0	28.0	29.0	28.0	23.0	19.0	23.0	30.0	17.0	8.0	18.0	20.0	20.0	18.0	28.0	25.0	30.0	24.0	18.0	28.0	17.0	13.0	12.0
05/29	122.0	24.0	26.0	21.0	25.0	18.0	21.0	15.0	21.0	12.0	5.0	0.0	20.0	82.0	76.0	107.0	122.0	100.0	51.0	33.0	26.0	47.0	48.0	46.0	42.0
05/28	106.0	3.0	1.0	3.0	3.0	1.0	2.0	0.0	-1.0	0.0	2.0	14.0	74.0	77.0	106.0	92.0	106.0	85.0	86.0	47.0	31.0	45.0	46.0	40.0	29.0
05/27	102.0	27.0	19.0	20.0	16.0	19.0	19.0	18.0	20.0	17.0		16.0	18.0	16.0	53.0	74.0	102.0	80.0	54.0	28.0	22.0	38.0	35.0	12.0	7.0
05/26	54.0	22.0	23.0	20.0	26.0	30.0	16.0	19.0	27.0	26.0	34.0	17.0	21.0	25.0	22.0	23.0	27.0	27.0	28.0	23.0	25.0	54.0	41.0	27.0	22.0
05/25	305.0	28.0	31.0	36.0	32.0	37.0	53.0	50.0	48.0	31.0	50.0	111.0	198.0	223.0	305.0	201.0	152.0	115.0	51.0	35.0	37.0	37.0	38.0	35.0	27.0
05/24	142.0	13.0	9.0	4.0	4.0	7.0	9.0	10.0	22.0	24.0	8.0	36.0	56.0	142.0	100.0	44.0	42.0	41.0	46.0	34.0	22.0	42.0	35.0	37.0	32.0
05/23	151.0	26.0	35.0	20.0	20.0	24.0	12.0	24.0	21.0	24.0	12.0	15.0	16.0	33.0	56.0	151.0	143.0	96.0	51.0	20.0	17.0	28.0	29.0	17.0	15.0
05/22	59.0	42.0	28.0	25.0	21.0	24.0	29.0	37.0	31.0	31.0	10.0	14.0	11.0	30.0	36.0	36.0	38.0	45.0	59.0	38.0	34.0	43.0	43.0	37.0	33.0
05/21	84.0	24.0	35.0	22.0	20.0	25.0	35.0	46.0	44.0	36.0	15.0	24.0	41.0	70.0	67.0	64.0	84.0	63.0	57.0	34.0	31.0	48.0	52.0	49.0	44.0
05/20	375.0	25.0	24.0	26.0	30.0	39.0	46.0	38.0	27.0	36.0	45.0	165.0	286.0	314.0	375.0	336.0	316.0	244.0	148.0	102.0	57.0	57.0	52.0	47.0	37.0
05/19	314.0	31.0	23.0	20.0	16.0	30.0	24.0	41.0	49.0	48.0	74.0	163.0	251.0	257.0	288.0	314.0	278.0	204.0	119.0	84.0	52.0	59.0	48.0	38.0	30.0
05/18	171.0	11.0	18.0	6.0	6.0	8.0	10.0	15.0	20.0	14.0	8.0	43.0	159.0	171.0	162.0	165.0	125.0	149.0	109.0	64.0	44.0	69.0	50.0	44.0	29.0

31 Day Summary for Daily Average Resultant Wind
for Arroyo Grande-2391 Willow Road
Display Ends 05/31/2021
Miles Per Hour (mph)

Graphit

		Hours 00-07										Hours 08-15								Hours 16-23			
Date	Day's Max	00 - 01	01 - 02	02 - 03	03 - 04	04 - 05	05 - 06	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12	12 - 13	13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23	23 - 00
05/31	9.2	CALM	340/01.3	CALM	CALM	CALM	255/02.0	301/01.4	306/02.1	295/04.1	296/05.5	277/06.8	272/08.4	274/09.2	281/08.1	284/07.9	297/06.5	287/05.8	283/05.2	281/03.7	281/03.4	299/03.1	282/02.0	289/02.5	CALM
05/30	11.0	288/02.9	CALM	289/03.1	306/03.8	300/03.1	287/02.7	278/02.1	CALM	205/02.4	231/04.7	280/08.3	285/10.9	279/10.2	274/10.4	271/11.0	272/09.9	255/08.2	256/07.3	248/05.0	227/04.0	250/02.8	165/02.7	172/04.4	159/02.6
05/29	15.5	301/04.6	277/04.9	309/01.5	331/02.3	292/03.6	286/02.4	299/02.2	CALM	306/01.4	268/06.8	272/07.7	293/10.3	286/13.0	284/15.2	290/15.5	298/14.2	303/12.6	302/11.2	306/09.9	307/07.1	306/04.7	305/04.2	302/03.5	294/03.3
05/28	13.1	133/03.3	142/02.0	CALM	159/01.3	183/03.0	304/01.8	343/01.6	266/05.5	CALM	287/07.5	292/09.6	292/11.9	295/12.3	294/12.9	295/13.1	305/10.2	304/10.4	305/09.4	310/09.2	311/07.1	307/06.8	301/05.2	302/05.3	310/05.6
05/27	11.1	CALM	306/02.0	296/02.8	251/03.1	259/01.7	149/02.9	138/04.7	233/01.4	272/06.8	269/05.1	259/04.3	278/09.5	281/10.7	294/10.8	303/11.1	307/10.2	312/09.8	305/07.0	312/05.1	321/03.0	139/03.0	127/03.7	099/03.9	122/03.2
05/26	12.6	103/02.7	085/01.2	073/01.5	CALM	CALM	CALM	100/02.2	141/04.3	142/05.7	242/04.2	282/08.2	283/08.9	276/12.3	278/11.8	270/12.6	269/11.4	268/10.6	262/08.2	266/07.3	225/02.7	104/04.0	092/02.3	CALM	CALM
05/25	14.1	CALM	CALM	CALM	CALM	CALM	123/01.2	249/01.2	287/05.0	290/07.0	307/07.6	310/09.7	303/10.6	314/11.0	308/14.1	311/12.1	311/11.8	314/09.7	302/06.7	292/04.5	281/02.4	323/01.5	CALM	152/02.2	099/01.8
05/24	9.0	CALM	CALM	083/01.4	CALM	CALM	CALM	CALM	272/02.9	277/06.0	277/06.9	282/08.0	286/08.2	290/09.0	294/08.4	286/08.1	279/07.5	270/06.0	245/04.6	205/03.0	139/05.1	128/05.0	121/03.6	102/02.5	CALM
05/23	13.1	CALM	CALM	CALM	CALM	293/02.1	271/03.5	248/02.7	247/03.5	CALM	259/03.5	285/06.1	288/09.2	291/11.7	292/12.2	303/12.8	307/13.1	306/11.1	308/09.5	309/05.9	279/02.8	CALM	CALM	CALM	CALM
05/22	15.5	062/01.2	CALM	CALM	105/01.5	105/02.9	100/03.3	140/03.7	193/02.2	273/06.1	290/08.1	293/10.0	290/11.8	277/15.5	275/13.9	277/15.2	288/10.9	293/10.2	301/08.8	309/06.9	311/03.3	304/03.3	343/01.4	CALM	335/01.2
05/21	15.4	056/01.4	072/01.8	090/02.1	105/02.1	108/02.1	096/03.3	CALM	151/02.9	298/06.6	278/10.3	280/13.7	289/14.2	282/15.4	287/15.1	286/15.0	286/15.4	291/13.1	296/11.3	302/10.3	308/08.6	306/07.9	306/05.2	298/03.7	297/01.2
05/20	17.3	CALM	050/01.3	CALM	CALM	064/01.7	CALM	327/03.3	332/07.3	317/07.5	293/11.5	301/13.8	301/15.2	296/16.2	296/17.3	299/16.9	303/16.7	304/15.3	307/13.4	307/10.4	309/04.5	CALM	CALM	081/01.2	CALM
05/19	16.0	054/01.2	CALM	CALM	063/01.3	069/01.2	CALM	CALM	290/05.6	293/08.8	299/11.2	299/12.8	306/15.6	306/16.0	302/15.4	303/14.8	302/14.7	302/12.1	300/09.9	306/07.5	296/06.7	CALM	CALM	099/01.4	050/01.2
05/18	14.2	269/02.3	CALM	CALM	263/01.4	CALM	CALM	301/02.8	288/04.4	278/06.0	278/07.7	301/09.1	307/13.3	310/14.2	306/12.7	309/14.0	308/12.5	306/10.5	307/07.9	303/03.6	CALM	CALM	119/01.9	056/01.6	282/01.6

May 2021 Daily/Hourly PM10 and Wind data, CDF Monitoring Station, Nipomo Mesa. Hours when PM10 was 100 micrograms or higher (boxed in red) and northwesterly winds were 11 mph or stronger (boxed in blue) demonstrating temporal correlation. Source: https://www.arb.ca.gov/aqmis2/aqdselect.php

Chapter 12: *Scripps Findings and Implications*

Year to year, the results of Dr. Russell's investigation were remarkably consistent. When PM10 sampling was completed in the third year and the data analyzed, the conclusion was undeniable: The Mesa PM10 contained just 14% dust.

Additionally, because the Mesa is more than a mile downwind of Oceano Dunes, that meant that the amount of dust in the Mesa PM10 that could be attributed to Oceano Dunes is something less than 14%.

Dr. Russell's findings are significant. The implications include:

1. The SAG's computer modeling assumes that the Mesa PM10 is 100% dust. Findings of 14% dust in the PM10 invalidate the SAG's computer modeling.

2. The plastic fences, hay bales and vegetation placed within Oceano Dunes at SAG direction are designed to suppress saltation-generated dust. These projects were placed within hundreds of acres of public recreational lands, effectively extracting those acres from use. With dust from Oceano Dunes at something less than 14% of the overall Mesa PM10, the SAG-mandated measures to suppress dune saltation will do little to nothing to reduce Mesa PM10, This negates any given rationale for sacraficing the public recreational lands.

3. With dust contributing just 14% to the Mesa PM10, and Oceano Dunes contributing something less than that, it appears the SLOAPCD's long held premise that the PM10 is dust from Oceano Dunes has itself been invalidated.

4. State Parks has thus far spent **$25.2 million** on a slew of activities based on the SLOAPCD's premise. The Scripps findings prove that premise to be false, which means the public money spent by State Parks to appease the SLOAPCD has been for nothing.

CHAPTER 13: *Record of Reporting by Scripps and Publication of Investigation Results*

As stated, Dr. Russell began her three-year investigation in 2019. First season findings of the work were presented to State Parks in a report dated February 21, 2020. Dr. Russell presented second season findings to the state's Off Highway Motor Vehicle Recreation Commission (OHMVR Commission) on September 24, 2020, as well as in a written report to State Parks dated that same day. She submitted a report of third season findings to State Parks on November 8, 2021 and presented those findings to the OHMVR Commission on December 9, 2021. The final report of the Scripps investigation was submitted to State Parks on February 24, 2022.

Dr. Russell's work was also published in the February 1, 2023 printed issue of the scientific journal Atmospheric Environment. The peer-reviewed document can also be viewed online at https://www.sciencedirect.com/science/article/pii/S1352231022005805. The online version of Dr. Russell's published report was first available on November 24, 2022.

With increasing documented certainty, each report and presentation from Dr. Russell to State Parks and the OHMVR Commission indicated that dust was but a small fraction of the Mesa PM10. The peer-reviewed publication of her work further cemented those findings.