North Carolina Department of Environmental Quality

May 4, 2020

Title VI: Increasing Equity, Transparency, and Environmental Protection in the Permitting of Swine Operations in North Carolina

Attachment F: Final Duplin County Air Monitoring Study Report

NORTH CAROLINA
Department of Environmental Quality

NC Department of Environmental Quality
Division of Air Quality
Ambient Monitoring Section
Raleigh, North Carolina

Duplin County Air Monitoring Study (DCAMS)

Final Report

May 4, 2020

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Executive Summary

As part of a Settlement Agreement, the Department of Environmental Quality (DEQ) agreed to design and implement a temporary ambient air quality monitoring study in and around Duplin County, North Carolina. The Division of Air Quality (DAQ) was tasked with determining the degree of air pollution in the Duplin County area airshed of three pollutants of specific concern, particulate matter (PM2.5), hydrogen sulfide (H2S), and ammonia (NH3).

The study was conducted in two phases, the "continuity" phase and the 12-month phase. The continuity phase was performed to 1) "bridge" the PM2.5 data set from a previous PM2.5 regulatory site at Kenansville Elementary and a new site close by at the Cowan Museum, both of which were in Kenansville, NC, 2) to provide comparison to another rural site outside the study area, Candor, NC for all three pollutants, and 3) be a shakedown period for implementation of the H2S and NH3 instrumentation under the same conditions that they would be used under in the 12-month phase. The 12-month phase was performed to monitor concentrations in the Duplin County study area for the three pollutants and compare those to reference values to determine the degree of air pollution in the study area. Those reference values were:

Pollutant	Reference Value	Reference
Particulate matter (PM2.5)	35 ug/m^3	National Ambient Air Quality Standard NAAQS, 24-hr Avg
Hydrogen sulfide (H2S)	85.9 ppb	NC AAL (Acceptable Ambient Level) 24-hr Chronic Toxicant
Ammonia (NH3)	3868 ppb	NC AAL (Acceptable Ambient Level) 1-hr Acute Irritant

The results of the continuity phase were 1) the PM2.5 values at Cowan Museum and Kenansville Elementary were similar, 2) the three compound concentrations were similar at Candor and the Cowan during this time and 3) the instruments for H2S and NH3 performed well and were ready to deploy in the 12-month phase of the study.

The 12-month phase results showed that while there were several distinct events in the PM2.5 data sets and the NH3 data sets (which are discussed in the body of the report), and no distinct H2S events, the results of the study show that the reference values were only exceeded in two instances. Those two instances were for PM2.5 at the Williamsdale Farm site when the 24-hour average values for two days exceeded the NAAQS. These occurred on August 2, 2019 and August 4, 2019 with values of 36.0 ug/m3 and 36.5 ug/m3, respectively.

The H2S AAL was not exceeded and all of the 24-hr average values were 10 times lower that the AAL. Additionally, although there are 15-minute periods where the H2S concentrations were above a mean odor threshold, this does not constitute a level at which DAQ can take any regulatory actions based on the data.

The NH3 AAL was not exceeded at any time and there was a single period (February 14-16, 2019) when the 1-hr average NH3 values were between 0.5 ppm and 2.9 ppm (max value) in two distinct events.

Based on the analyses of these results relevant to the comparison values, the DAQ does not believe that they constitute a significant air quality issue in the study area for these pollutants; therefore DAQ does not intend to conduct additional air quality monitoring under the settlement agreement.

Acknowledgements

The Division of Air Quality (DAQ) would like to acknowledge the assistance of various community, local and state agencies and their staffs for their assistance in planning and execution of this study over the preceding 20 months. Those organizations include Rural Empowerment Association for Community Help (REACH), Duplin County Manager, Duplin County Commissioners, Duplin County Water Department, Williamsdale Farm Extension & Research Center, NC DAQ Wilmington Regional office, NC DAQ Monitoring Section and its Branch units, DAQ Administration and Budget Offices, Division of Water Resources, and DEQ Administration and Legal Offices.

1.0 Introduction

As part of a Settlement Agreement [(1)], the Department of Environmental Quality (DEQ) agreed to design and implement a temporary ambient air quality monitoring study in or around Duplin County, North Carolina. The Division of Air Quality (DAQ) was tasked with determining the degree of ambient air pollution in the Duplin County area airshed of three pollutants of specific concern, particulate matter (PM2.5), hydrogen sulfide (H2S), and ammonia (NH3). See Appendix A for the pertinent Air Quality sections of the Settlement. Additionally, as part of the settlement agreement, DAQ accepted public comments on this report and have addressed those comments in the final report that were found to be relevant to the report and the study goals.

With regular and periodic consultation, throughout the 17-month study period, with the community group, REACH (Rural Empowerment Association for Community Help), DAQ planned and conducted this study in two phases, the continuity phase (June 1 – August 31, 2018) and the 12-month phase (October 1, 2018 – October 31, 2019). The "continuity" phase was performed to 1) "bridge" the PM2.5 data set from a previous PM2.5 regulatory site at Kenansville Elementary and a new site close by at the Cowan Museum, both of which were in Kenansville, NC, 2) to provide comparison to another rural site outside the study area, Candor, NC for all three pollutants, and 3) be a shakedown period for implementation of the H2S and NH3 instrumentation under the same conditions that they would be used under in the 12-month phase. The 12-month phase was performed to monitor concentrations in the Duplin County study area for the three pollutants and compare those to reference values to determine the degree of air pollution in the study area. Figure 1.0 shows the locations of these 4 sites.

Figure 1.0 Site Locations

2.0 Sites and Instrumentation

2.1 Site Selection

The "continuity" phase sites were selected based on several criteria. The first being the need for a site that was comparable to the previous PM2.5 regulatory site located at the Kenansville Elementary School and was in the same general vicinity of Kenansville, NC. This was necessitated by the fact that the Kenansville Elementary School site was no longer available to conduct ambient monitoring. Another criterion was the need for a site that represented a similarly rural environment outside the study area. Selection of the two sites were also guided by the EPA's sighting criteria for PM2.5. The two continuity sites were located at the Cowan Museum and the Candor Urban Air Toxics Network (UATN) site and are shown in Figure 1.0 above.

The 12-month phase sites were selected in Duplin County guided by EPA's siting criteria for PM2.5[(2)], EPA Guidance for Network Design and Optimum Site Exposure for PM2.5 and PM10 [(3)] and specifically informed by the definitions of community-oriented monitoring and neighborhood scale monitoring (see below).

> **Community-oriented monitoring** sites are beyond the zone of influence of a single source, and should have neighborhood- to urban- scale zones of representation. The principal purpose of community-oriented monitoring sites is to approximate the short-term and long-term exposures of large numbers of people where they live, work, and play. A monitor placed at the fence line of an emissions source would not be considered to represent community exposures, even though there might be residences abutting that fence line. A monitor placed in the middle of an area adjacent to a source would, however, be deemed a community exposure monitor for that neighborhood provided that the location represented a zone of at least 0.5 km in diameter. The fence line monitor might still be operated because it provides information on how much the nearby source contributes to the community-oriented site. The data from the fence line monitor would not be used to determine annual NAAQS compliance, though it might be used to make comparisons to the 24-hour standard or to design control strategies to bring the area into compliance with the annual NAAQS.
>
> **Neighborhood Scale (500 m [0.3 miles] to 4 km [2.5 miles]):** Neighborhood-scale monitors do not show significant differences in particulate concentrations with spacing of a few kilometers. Sources affecting neighborhood-scale sites typically consist of small individual emitters, such as clean, paved, curbed roads, uncongested traffic flow without a significant fraction of heavy-duty vehicles, or neighborhood use of residential heating devices such as fireplaces and wood stoves.

The sites were also chosen to meet the neighborhood scale criterion that they "should generally be at least 1 km (0.6 miles) from very large, visibly identifiable source areas …" [(2)]. These sites were therefore, located such that they were 0.5 miles away from the predominant industrial sources in Duplin County, primarily Concentrated Animal Feeding Operations (CAFOs) but also still encompassing the range of the neighborhood scale at a 2.5-mile distance. Finding sites that met these criteria as well as the provisions for Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring found in the Federal Regulations [(2)], prevailing seasonal wind directions for this region of NC (predominantly from the southeast and northwest), and readily available sources of power for the instruments proved to be a considerable challenge but was accomplished. Over forty (40) potential sites were considered and the sites that were chosen were the ones that best met the criteria described above.

Figure 2.0 shows the Duplin county area with an overlay of permitted 2016-19 CAFO locations (yellow dots) and their associated activities such as land application areas including spray fields in Duplin and surrounding counties, the monitoring site locations, and circles representing the neighborhood scale boundaries (0.5 miles to 2.5 miles). Figures 2.1 – 2.3 show enlarged views of the areas near each study site. Note: In these figures, the orange dots are other animal operations' "barns" whose locations are readily discernable as such in the Google Earth view from July 9, 2018 and may be additional sources of the pollutants of concern.

Table 1.0 provides the site information; Name, Address, and Coordinates.

Table 1.0 Site Information

Continuity Sites		**12-month Study Sites**	
Cowan Museum 411 S Main St Kenansville, NC Lat: 34.9599° Long: - 77.9657°	Candor UAT site 112 Perry Dr Candor, NC Lat: 35.2632° Long: -79.8365°	Water Tower Sarecta Rd 2140 Sarecta Rd Beulaville, NC Lat: 34.9632 º Long: -77.7915 º	Williamsdale Farm 7624 South Hwy 41 Wallace, NC Lat: 34.7614 º Long: -78.0982 º

Figure 2.0 DCAMS Sites Map

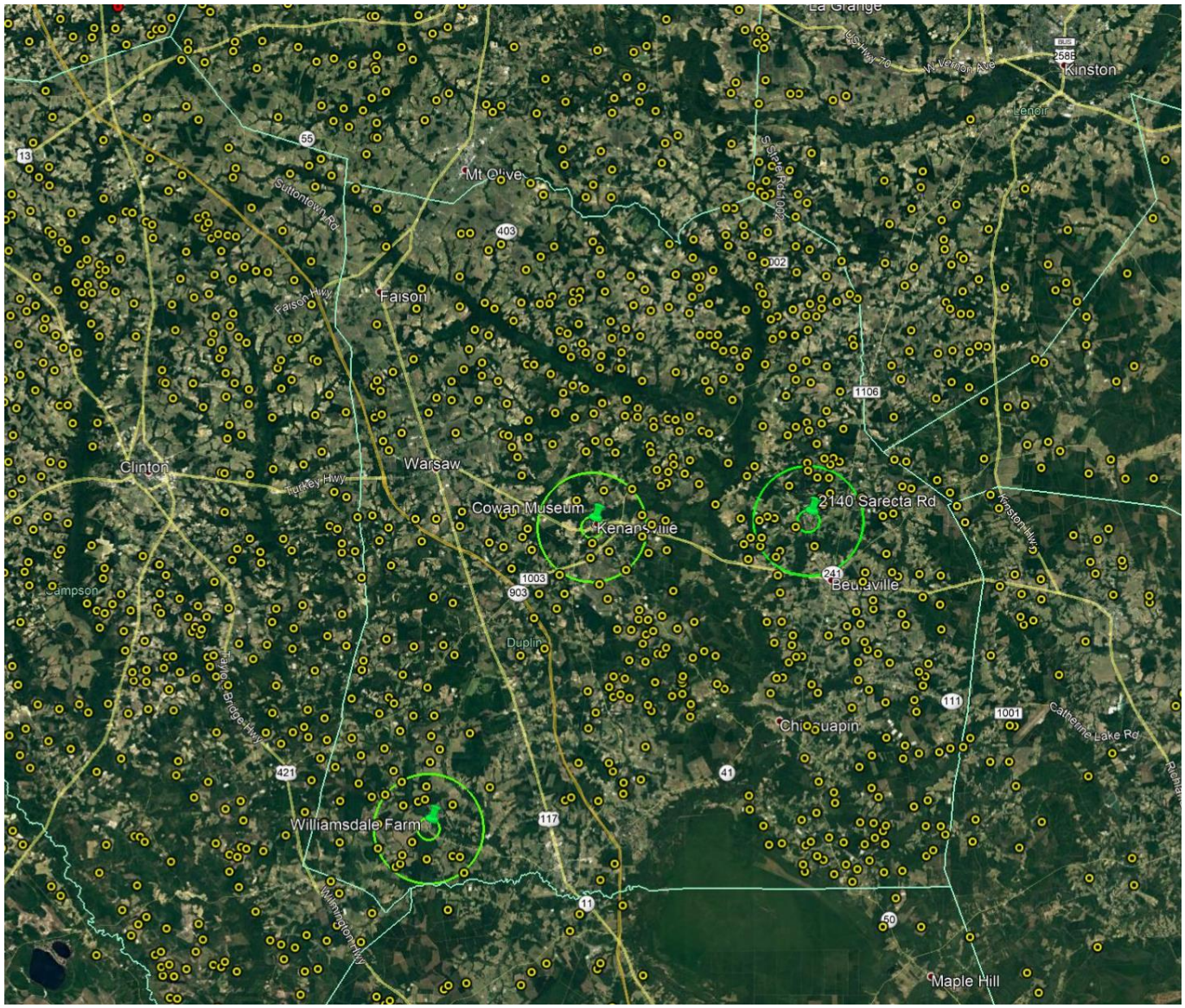


Figure 2.1 Cowan Museum Site Area
Inside 2.5-mile circle: 9 Permitted CAFO, 8 "barns"

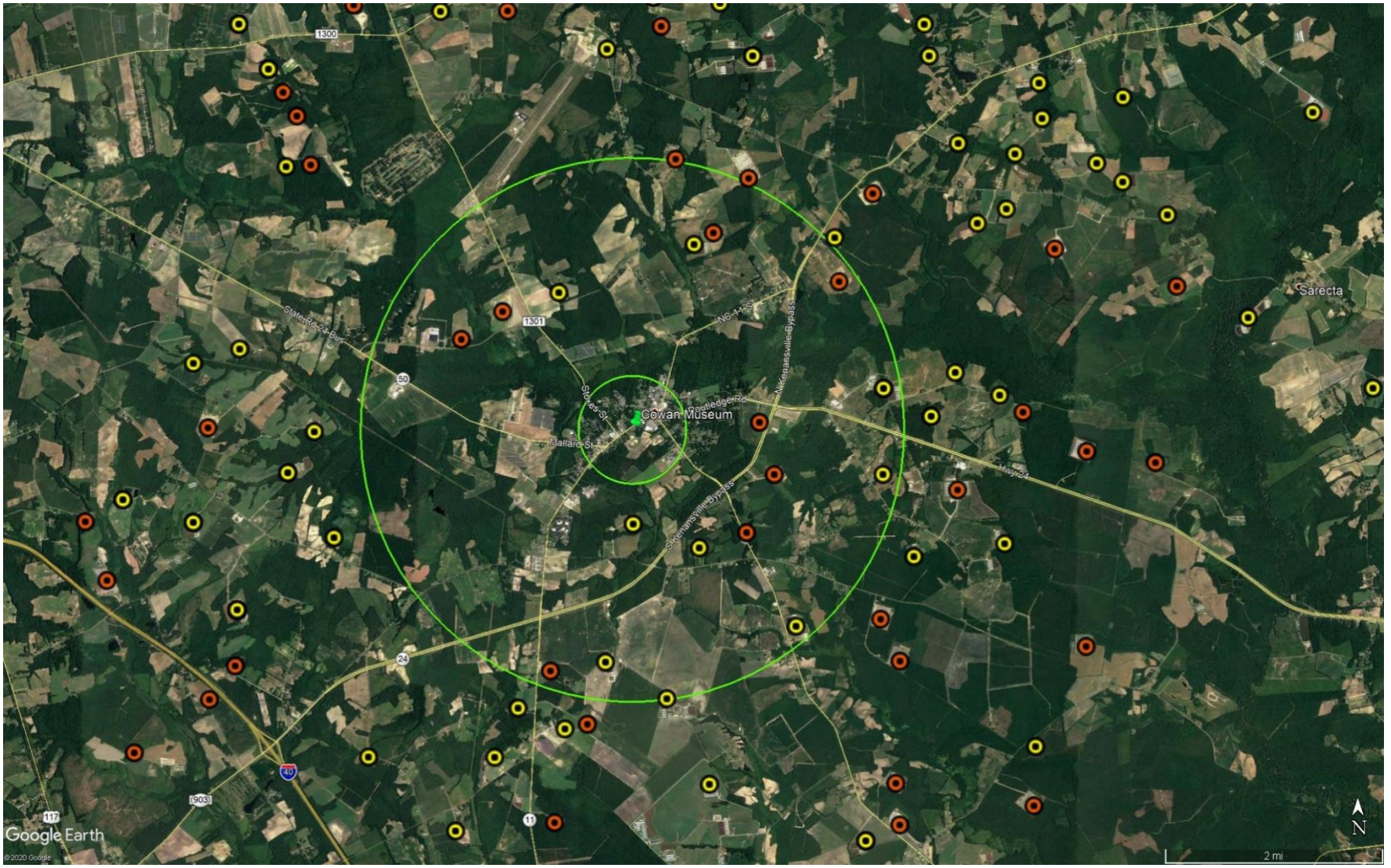


Figure 2.2 Sarecta Road Site Area
Inside 0.5-mile circle: 1 "barn"
Inside 2.5-mile circle: 17 Permitted CAFO, 17 "barns"

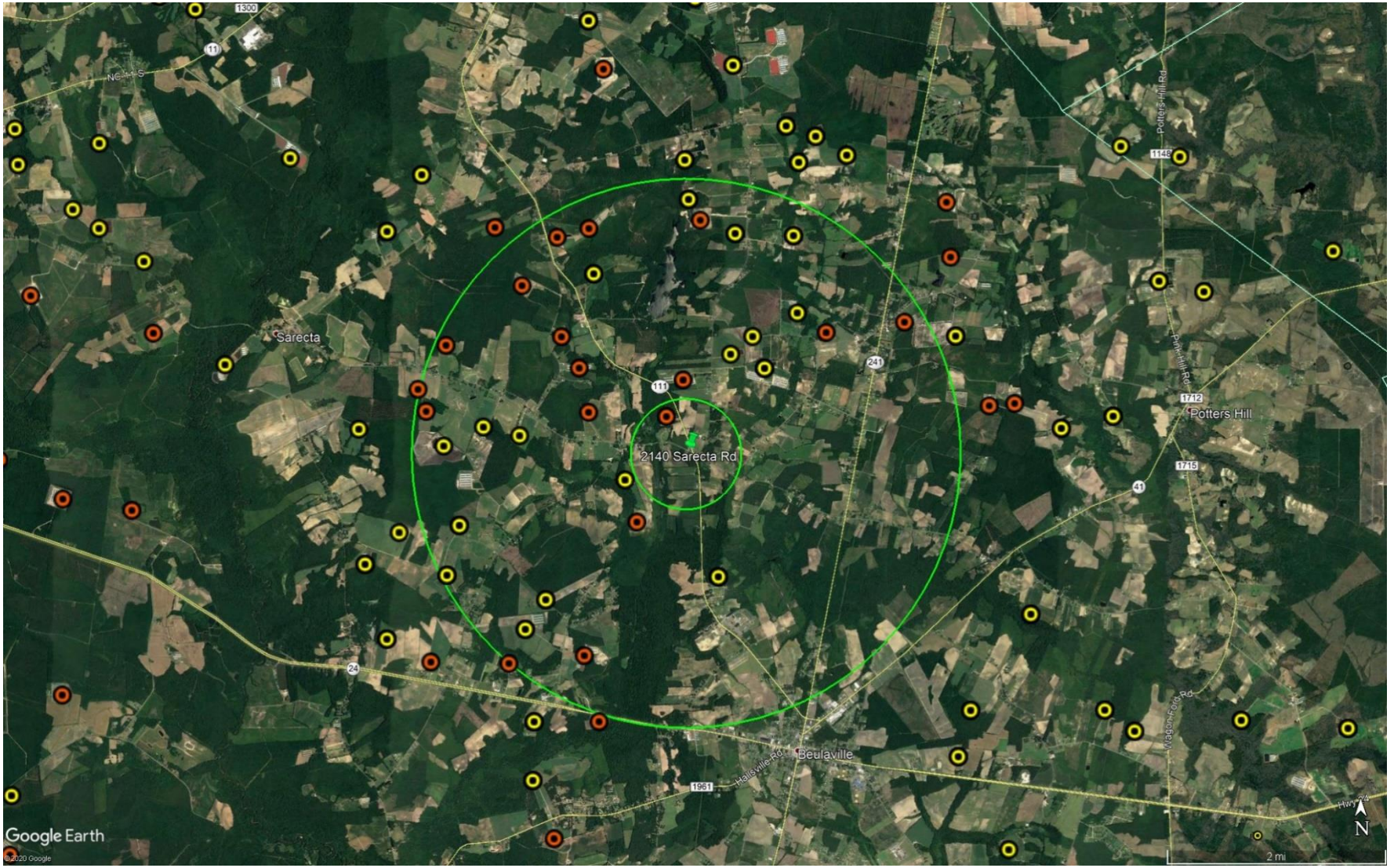
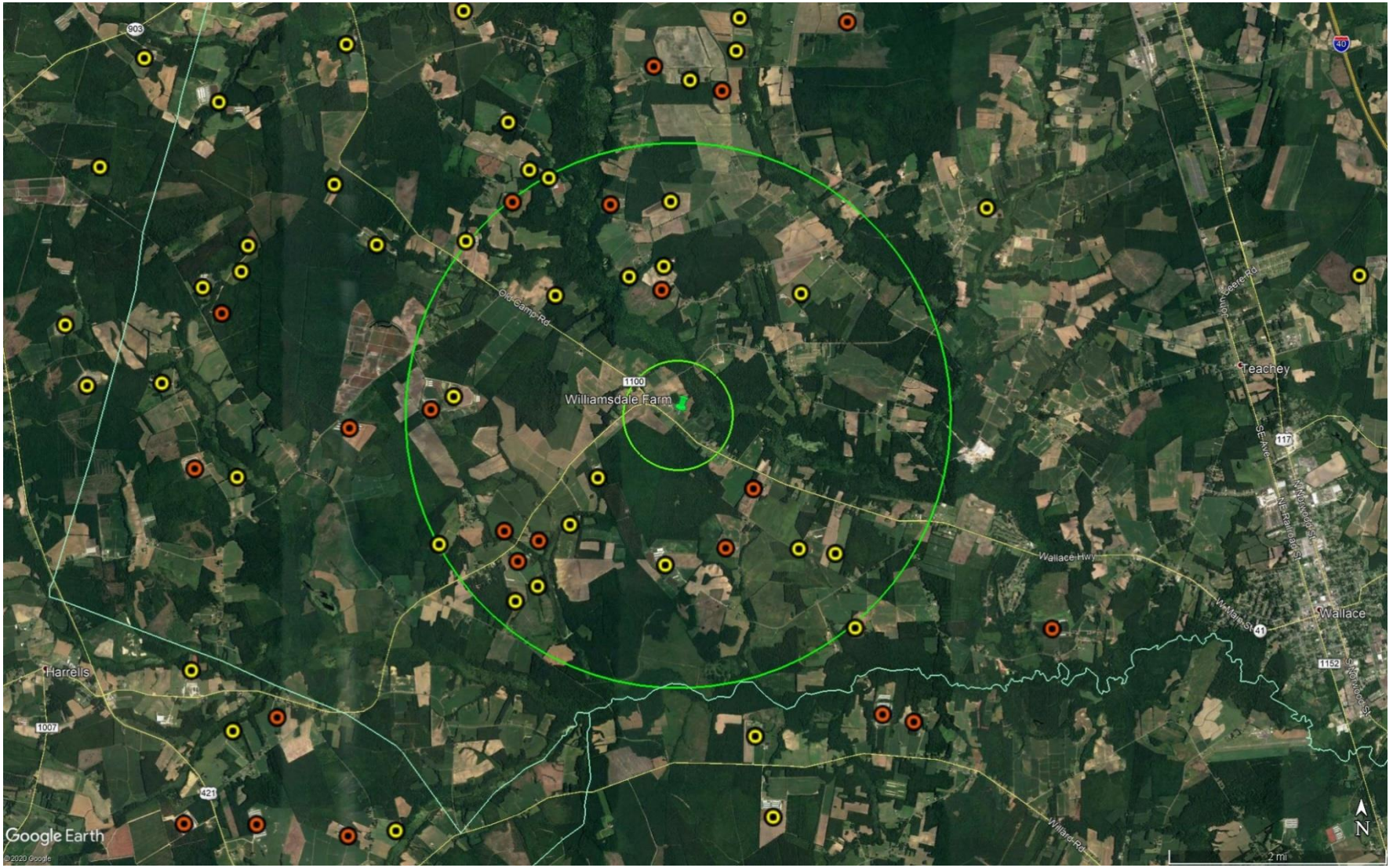


Figure 2.3 Williamsdale Farm Site Area
Inside 2.5-mile circle: 17 Permitted CAFO, 9 "barns"



2.2 Monitoring Instruments

Each site was equipped with instruments to monitor PM2.5, H2S, and NH3, as well as wind speed, wind direction, temperature, and relative humidity and were inside a secured fenced enclosure. See Figure 3.0.

Figure 3.0 Williamsdale Farm Site – Typical Site Installation

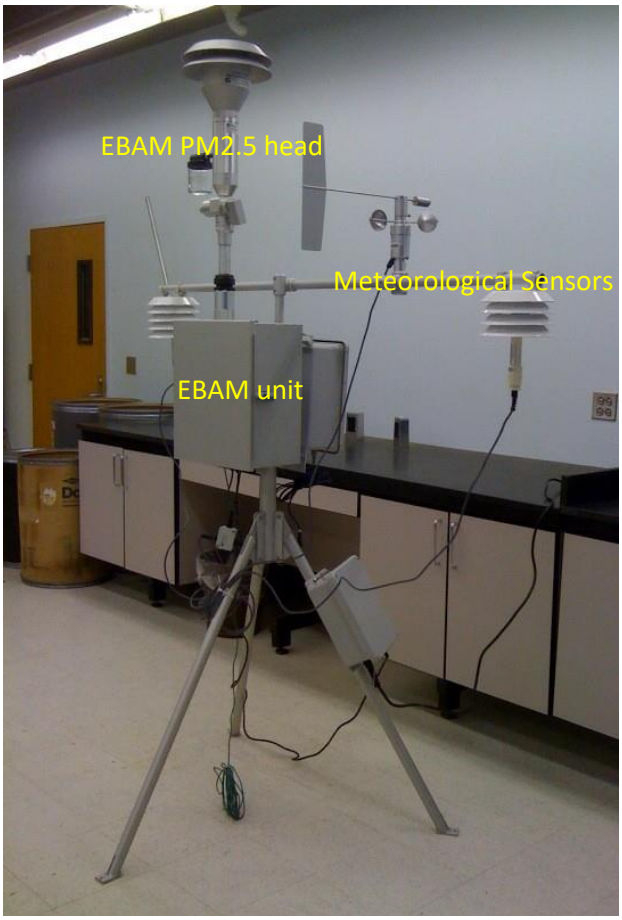
Table 2.0 below lists the instruments used for this study and the parameters that were used to collect the data as well as the reference values to which the data sets would be compared. Figure 4.0 shows each instrument. The Jerome Meter and the AreaRae were housed in a weather proof enclosure equipped with sampling lines (see Figure 3.0) to protect them from the weather. Data was collected from the instruments by DAQ staff on a 7-10 day schedule. Instruments were operated continuously over the entire study period from June 1, 2018 to October 31, 2019 except for shutdowns caused by equipment malfunctions, instrument calibrations and QA checks, power outages, and/or hurricanes. Instrumentation was also exchanged as necessary with backup instruments when available when malfunctions or other operational issues arose. Those exchanges were documented and the accompanying quality assurance measures were taken to ensure that the quality of the data set was not compromised.

Table 2.0 – Instrumentation and Sampling Parameters

Instrument	Pollutant	Detection Range	Resolution	Averaging Period	Reference Value	Reference
EBAM (Environmental Beta Attenuation Monitor) equipped with meteorological station						
	Particulate matter (PM2.5)	0-1000 μg /m^3	0.1 μg /m^3	1 hr	35 μg/m^3	NAAQS
Meteorology (model 034B)	Wind Speed	0-167mph	0.25 mph	1 hr	--	--
	Wind Direction	0-360	<0.5º	1 hr	--	--
	Temperature	-50 °C to 70 °C	± 0.2 °C	1 hr	--	--
	Relative Humidity	0-100%	0.1%	1 hr	--	--
Jerome meter Model 631X						
	Hydrogen sulfide	0-50 ppb	1 ppb	15 min	85.9 ppb (0.12 mg/m^3)	NC AAL 24-hr Chronic Toxicant
AreaRae						
	Ammonia	0-50 ppm	0.1 ppm	1 hr	3868 ppb (2.7 mg/m^3)	NC AAL 1-hr Acute Irritant

Figure 4.0 Monitoring Instrumentation

Environmental Beta Attenuation Monitor (EBAM)



Jerome H2S Meter Model 631X

AreaRae NH3 monitor

3.0 Sample Data Collection and Quality Assurance

Electronic sampling data were collected on a periodic basis, typically every 7 days and returned to the DAQ laboratory and uploaded to a central data storage drive or web-based cloud server. From there the data was quality assured and then posted on the DAQ web site on a semi-monthly basis. All of the data presented in this report have been quality assured according to the Quality Assurance Guidance Document (QAGD).
(https://files.nc.gov/ncdeq/Air%20Quality/monitor/specialstudies/duplin-county/Duplin-County-Air-Monitoring-Study-QAGD-and-SOPs.pdf)

There is a data set gap between the "continuity" and the 12-month phases which was due to two hurricanes and their aftermath (Florence September, 2018 and Michael October 2018). This resulted in the study being extended for an additional month to October 31, 2019. A subsequent gap from September 3 to 12, 2019 was due to Hurricane Dorian.

Table 3.0 provides a monitoring timeline for the "continuity" and 12-month phases of the study.

Table 3.0 Monitoring Timeline

	"Continuity" Phase						
	Candor			Cowan Museum			
Instrument	Installed	Data Set Start	Data Set End	Installed	Data Set Start	Data Set End	Comments
BAM	network	06/01/18	08/31/18				NC DAQ network instrument
EBAM				06/01/18	06/07/18	08/31/18	Provided continuity PM data
Jerome Meter	07/01/18	07/09/18	08/31/18	07/01/18	07/18/18	08/31/18	Provided a shakedown period
AreaRae	07/01/18	08/07/18	08/31/18	07/01/18	07/11/18	08/31/18	Provided a shakedown period
	12-Month Phase						
	Water Tower Sarecta Rd			Williamsdale Farm			
Instrument	Installed*	Data Set Start	Data Set End	Installed	Data Set Start	Data Set End	Comments
EBAM	10/01/18	10/18/18	10/31/19	10/01/18	10/04/18	10/31/19	
Jerome Meter	10/25/18	11/01/18	10/31/19	10/01/18	10/04/18	10/31/19	
AreaRae	10/01/18	11/01/18	10/31/19	10/01/18	10/25/18	10/31/19	
* Installations were delayed by Hurricanes Florence and Michael and their aftermath							

Table 4.0 Provides the data completeness overview of the study. Data completeness is the percentage of possible data points collected divided by the total number of valid quality assured data points. The Data Quality Objective (DQO) listed in the QAGD for completeness are listed. The data quality objectives for the "continuity" phase was exceeded for the PM2.5 monitoring. As anticipated for a "shake down" phase, the H2S and NH3 monitors did experience some issues that led to not meeting the DQO for H2S at Candor and NH3 at Cowan although they were nearly met; however, during the 12-month phase, the DQOs were exceeded for each compound at both sites.

Table 4.0 Data Completeness

	Candor	Cowan	Sarecta*	Williamsdale*
PM2.5 1-hr Avg Data Completeness (Data Completeness objective ≥ 75%)				
# possible data points	2207	2064	9096	9432
# valid data points **	2185	1757	8602	8769
% completeness	98.9%	85.1%	94.5%	92.9%
H2S 15-min Avg Data Completeness (Data Completeness objective ≥ 75%)				
# possible data points	4416	4320	35040	37728
# valid data points **	3206	4175	32526	33066
% completeness	72.6%	96.6%	92.8%	87.6%
NH3 1-hr Avg Data Completeness (Data Completeness objective ≥ 75%)				
# possible data points	600	1248	8760	8928
# valid data points **	495	886	8242	7390
% completeness	82.5%	71.0%	94.1%	82.8%
* Does include Hurricane Dorian Shutdown period ** Possible data points minus QA data points				

A Quality Assurance Guidance Document (QAGD) and Standard Operating Procedures (SOPs) were devised and implemented to ensure the production of a high quality data set. These documents pertain to the instrument operations, calibrations/checks, and maintenance, and data collection, and the parameters for quality assuring the data sets. These documents are available on the DAQ website at https://deq.nc.gov/about/divisions/air-quality/air-quality-data/special-studies.

4.0 Results and Discussion

This section will present the results of the study for the three pollutants of interest, PM2.5, H2S, and NH3. Each subsection will present the data set for the two phases of the study and discuss conclusions reached from those data. Wind roses and pollutant roses were generated in some instances to provide a visual depiction of the wind speed and direction and the pollutant concentration with respect to the wind direction, respectively in order to better inform the discussion of the results. Descriptions of wind and pollutant roses can be found in Appendix B. Study data sets and data handling descriptions are located at https://deq.nc.gov/about/divisions/air-quality/air-quality-data/special-studies/duplin-county.

4.1 Particulate Matter (PM2.5)

The particulate and meteorological data were collected using a MetOne EBAM equipped with a meteorological station. Data were collected as shown in Table 2.0 above. The reference point for the PM2.5 data was the National Ambient Air Quality Standard (NAAQS) which is an average value of 35 $\mu g/m^3$ for a 24-hour period from midnight to midnight.

The following Figures 5.0 - 5.5 depict the 1 hr average PM2.5 data points for the "continuity" and 12-month phases of the study at each of the four sites as well as the 2014-2015 Kenansville Elementary PM2.5 BAM site data. This Kenansville Elementary site data is the last set of data from this site before it was decommissioned. This data was included for comparison and is the data to which the "continuity" phase was to "bridge". It also allows for some comparison of past data in the study area to the 12-month phase.

The following Figures 6.0 - 6.5 depict the 24-hr average data points that were calculated from the Figure 5.0 data set and are the values that are compared to the 24 hr average based PM2.5 NAAQS. Again the Kenansville Elementary site data are included for comparison to the NAAQS and to the other sites in the two study phases. These figures show that the NAAQS was not exceeded during the study at any site with the exception of two days at the Williamsdale Farm site. Those two days are discussed later in Section 4.1.1. Also of note was a period between June 27-29, 2019 at Williamsdale and Sarecta Rd that is also be discussed in Section 4.1.1 although they did not result in NAAQS exceedance.

As can be seen in both figures, the PM2.5 concentrations at the continuity sites, Cowan Museum and Candor are comparable to each other as well as to the Kenansville Elementary site. The figures also show that the PM2.5 concentrations at the 12-month study sites, Williamsdale Farm and Sarecta Rd are comparable to the Cowan Museum and Kenansville Elementary sites with a bit more variability in the concentrations. This may be attributable to the difference in the land uses between these two sets of sites and/or differences between the operational parameters of the EBAM and BAM units.

Figure 5.0 1-hr Avg PM2.5 Concentrations June 1, 2018 thru October 31, 2019

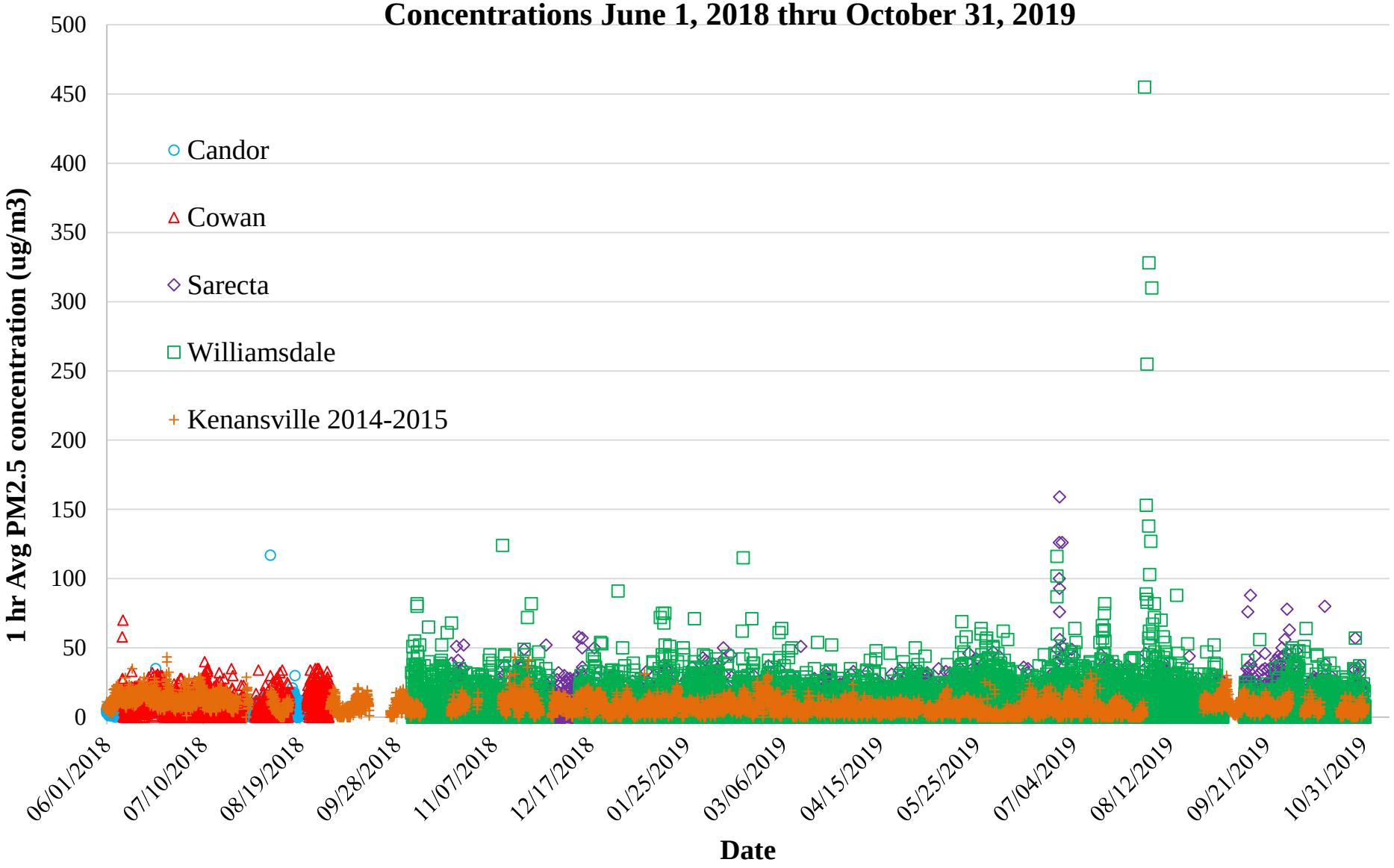


Figure 5.1 Kenansville Elementary 1-hr Avg PM2.5 Concentrations
June 1, 2014 thru October 31, 2015

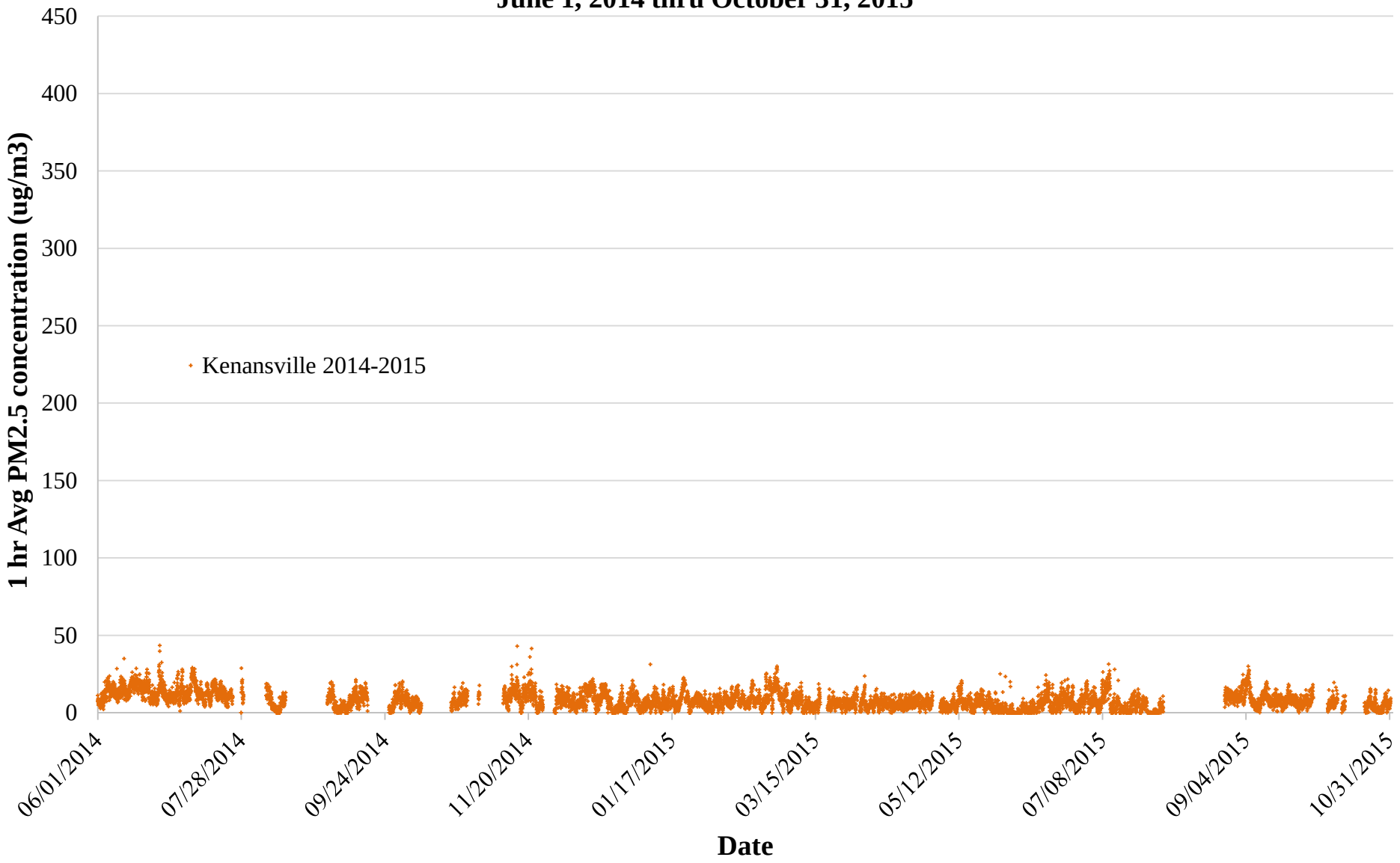


Figure 5.2 Candor 1-hr Avg PM2.5 Concentrations
June 1, 2018 thru August 31, 2018

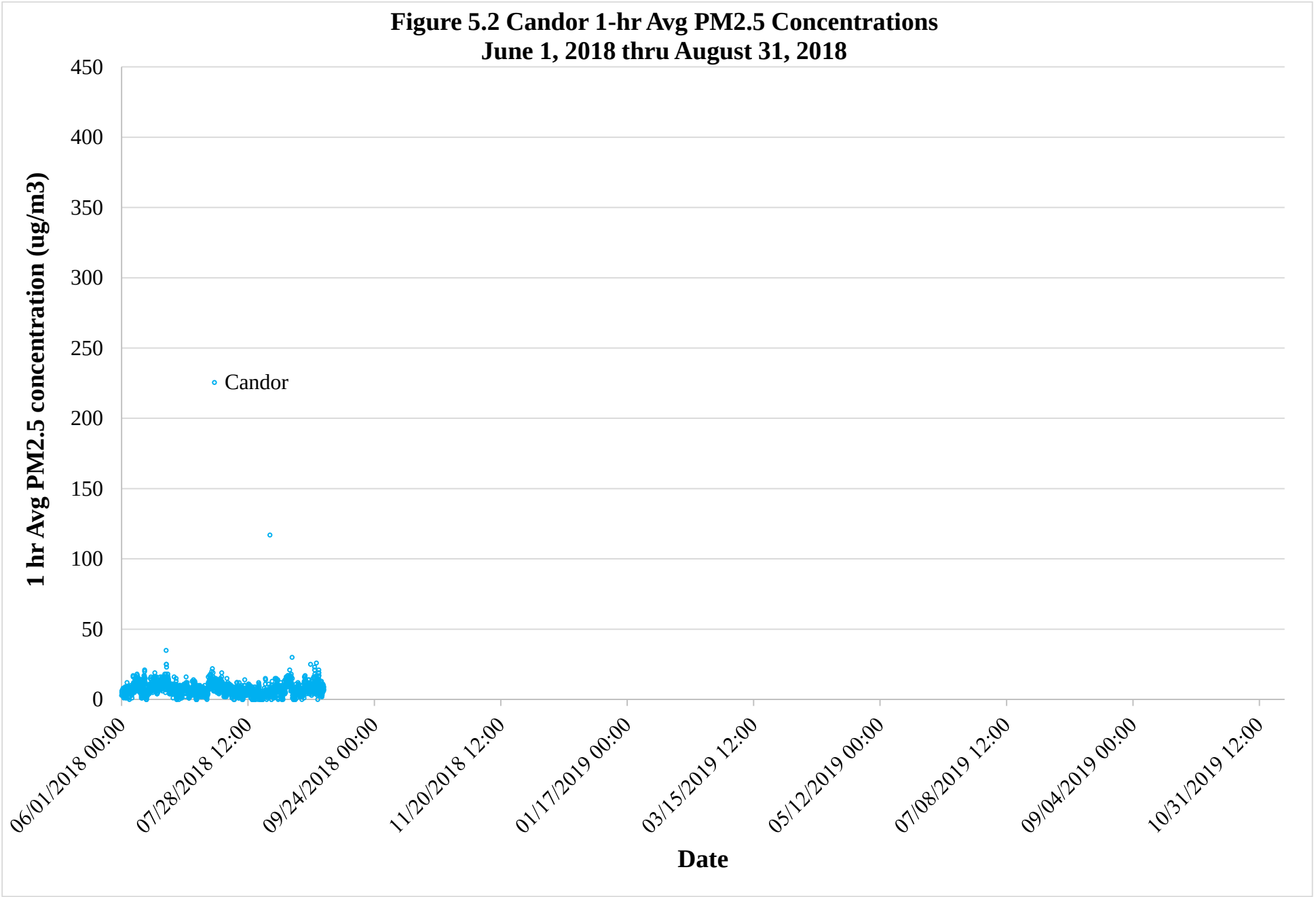


Figure 5.3 Cowan Museum 1-hr Avg PM2.5 Concentrations
June 1, 2018 thru August 31, 2018

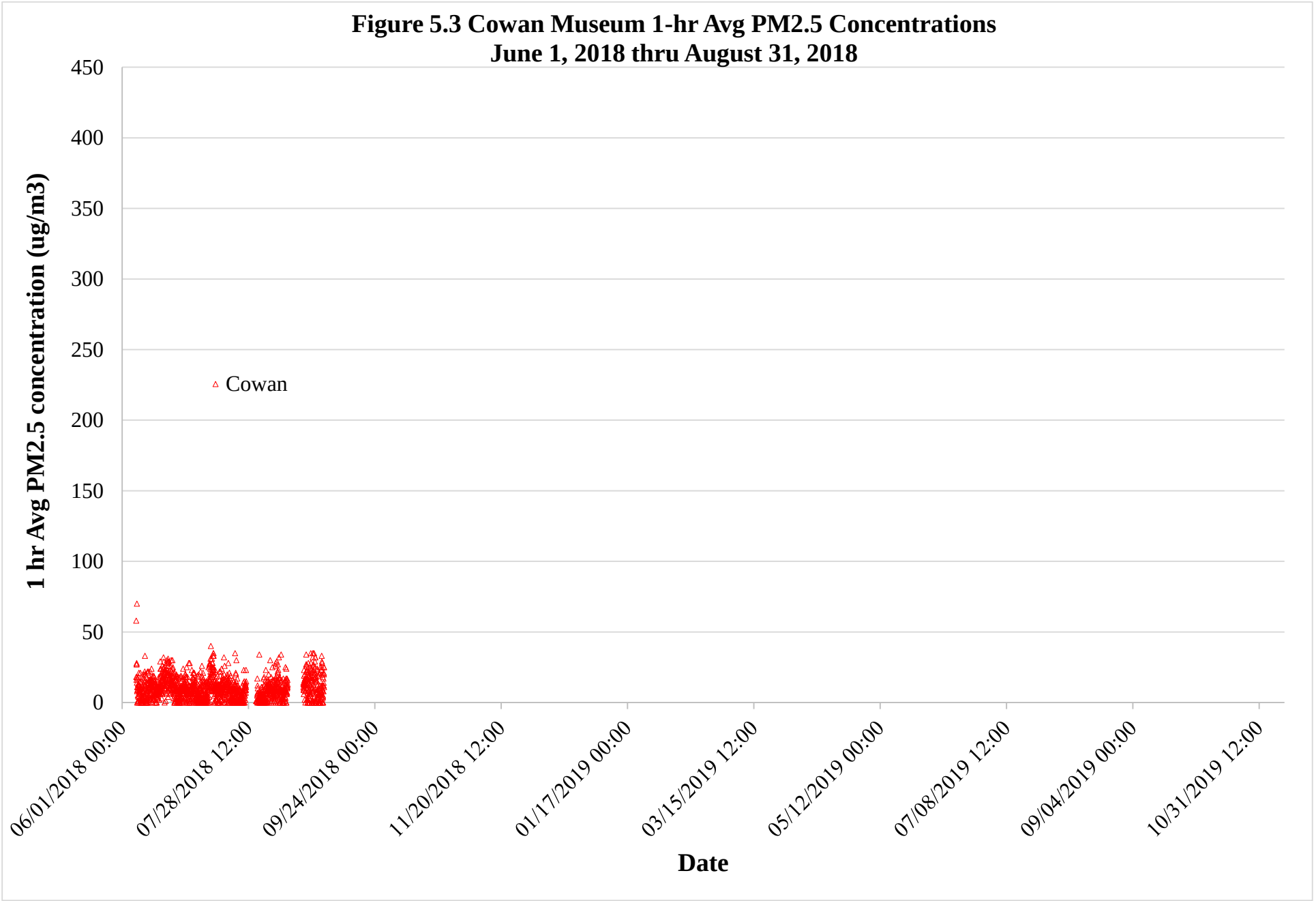


Figure 5.4 Sarecta Rd 1-hr Avg PM2.5 Concentrations
October 18, 2018 thru October 31, 2019

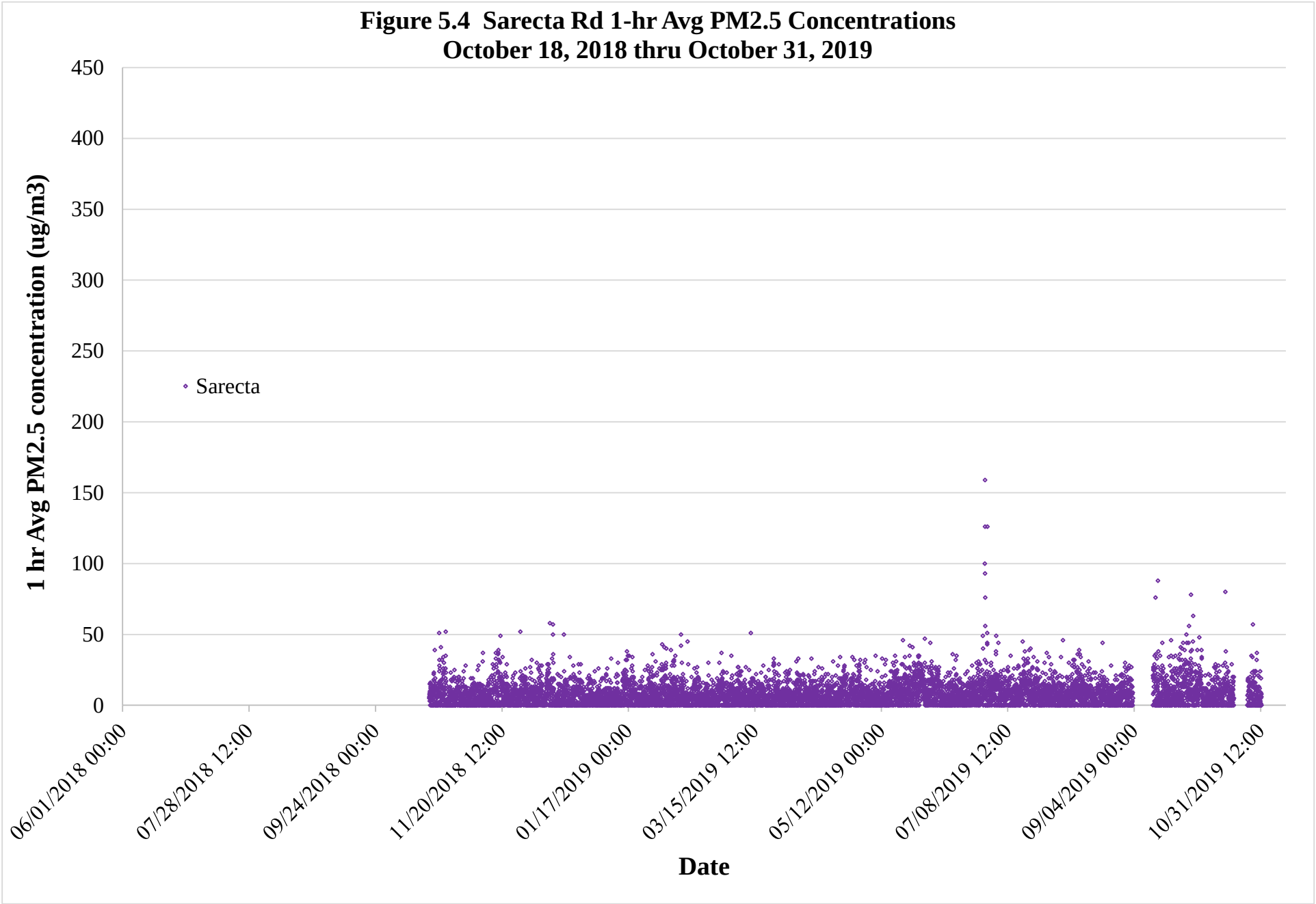
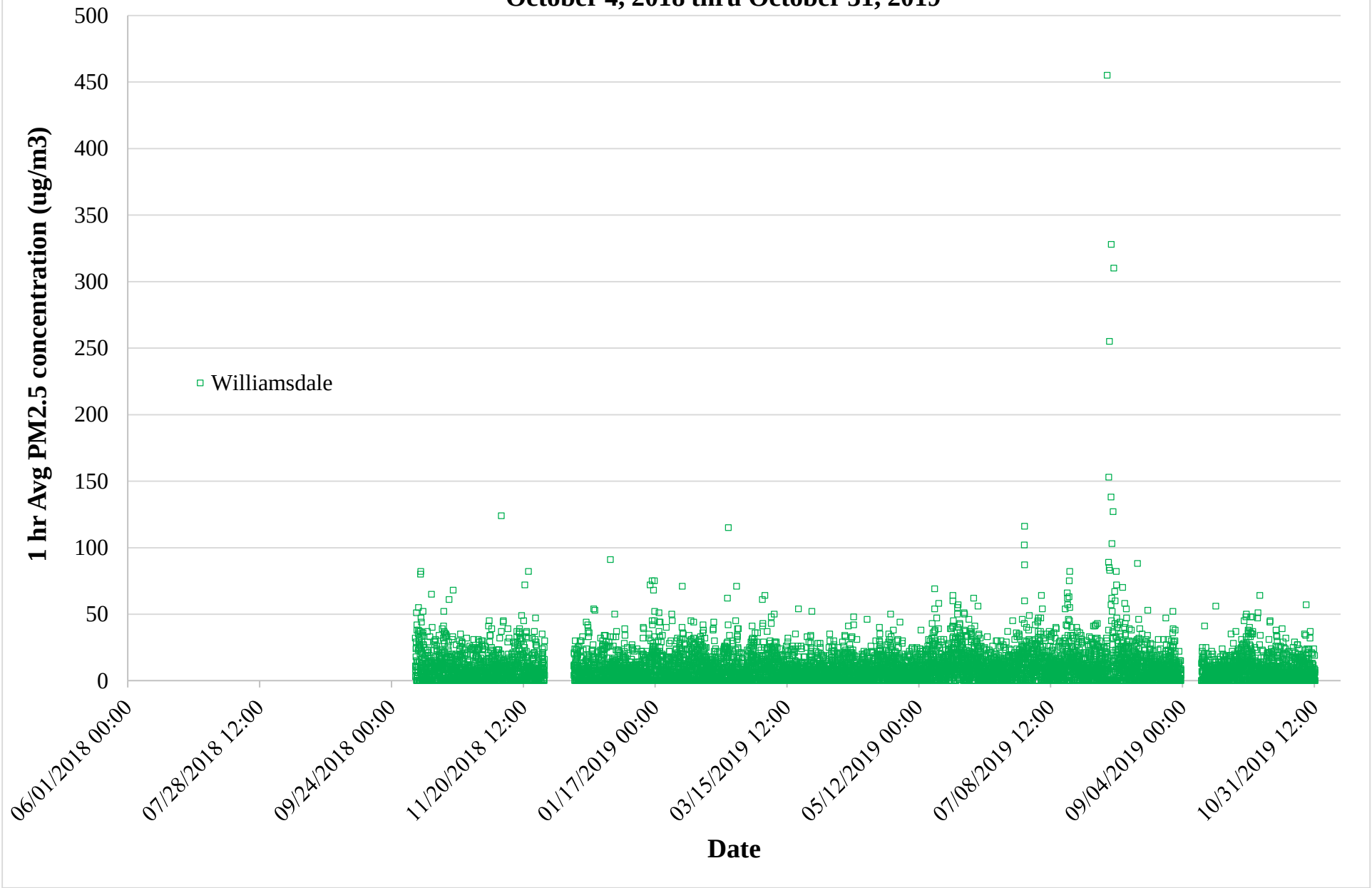


Figure 5.5 Williamsdale Farm 1-hr Avg PM2.5 Concentrations
October 4, 2018 thru October 31, 2019



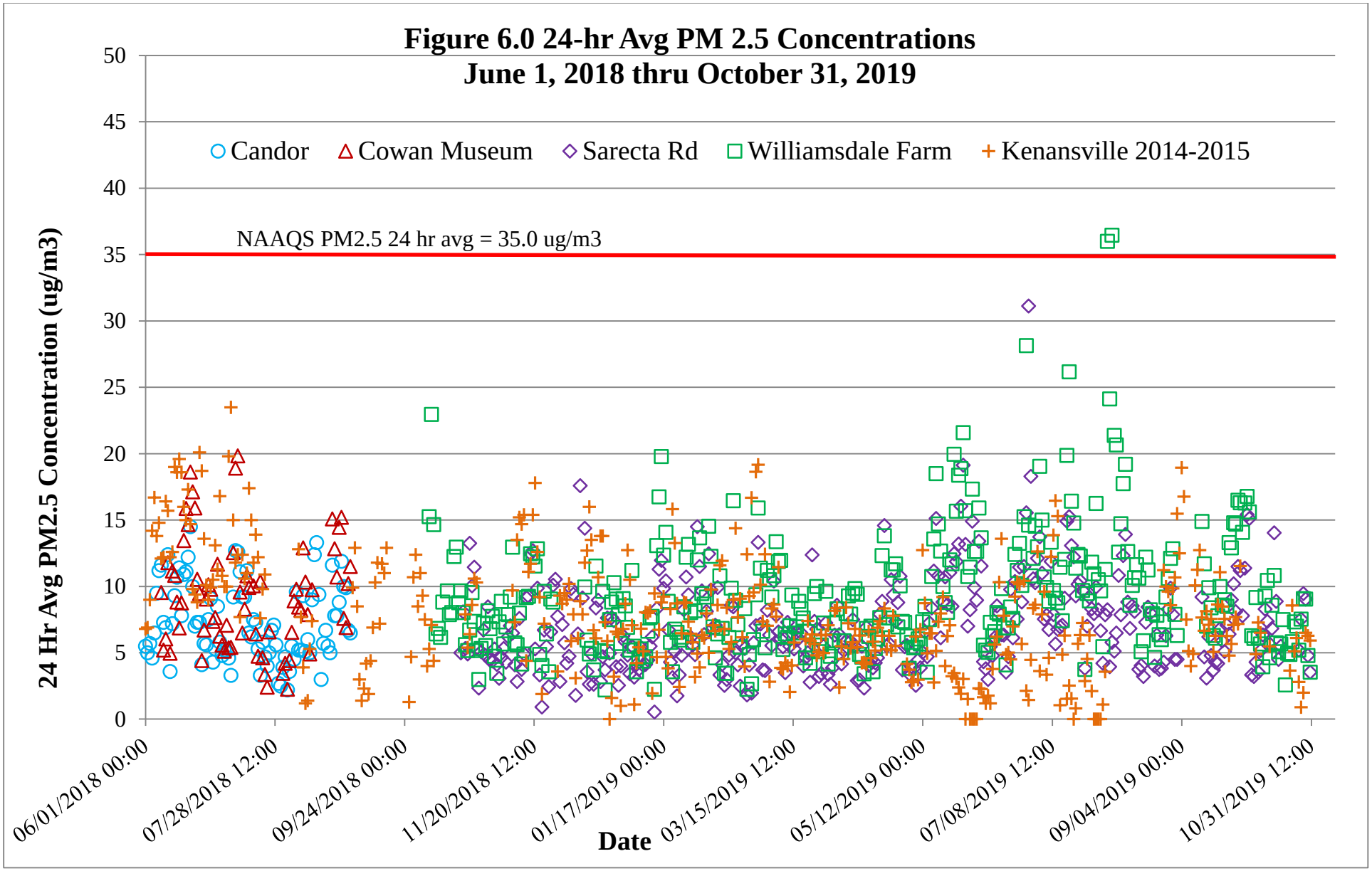


Figure 6.0 24-hr Avg PM 2.5 Concentrations
June 1, 2018 thru October 31, 2019
Candor
Cowan Museum
Sarecta Rd
Williamsdale Farm
Kenansville 2014-2015
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
24 Hr Avg PM2.5 Concentration (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
06/01/2018 00:00
07/28/2018 12:00
09/24/2018 00:00
11/20/2018 12:00
01/17/2019 00:00
03/15/2019 12:00
05/12/2019 00:00
07/08/2019 12:00
09/04/2019 00:00
10/31/2019 12:00
Date

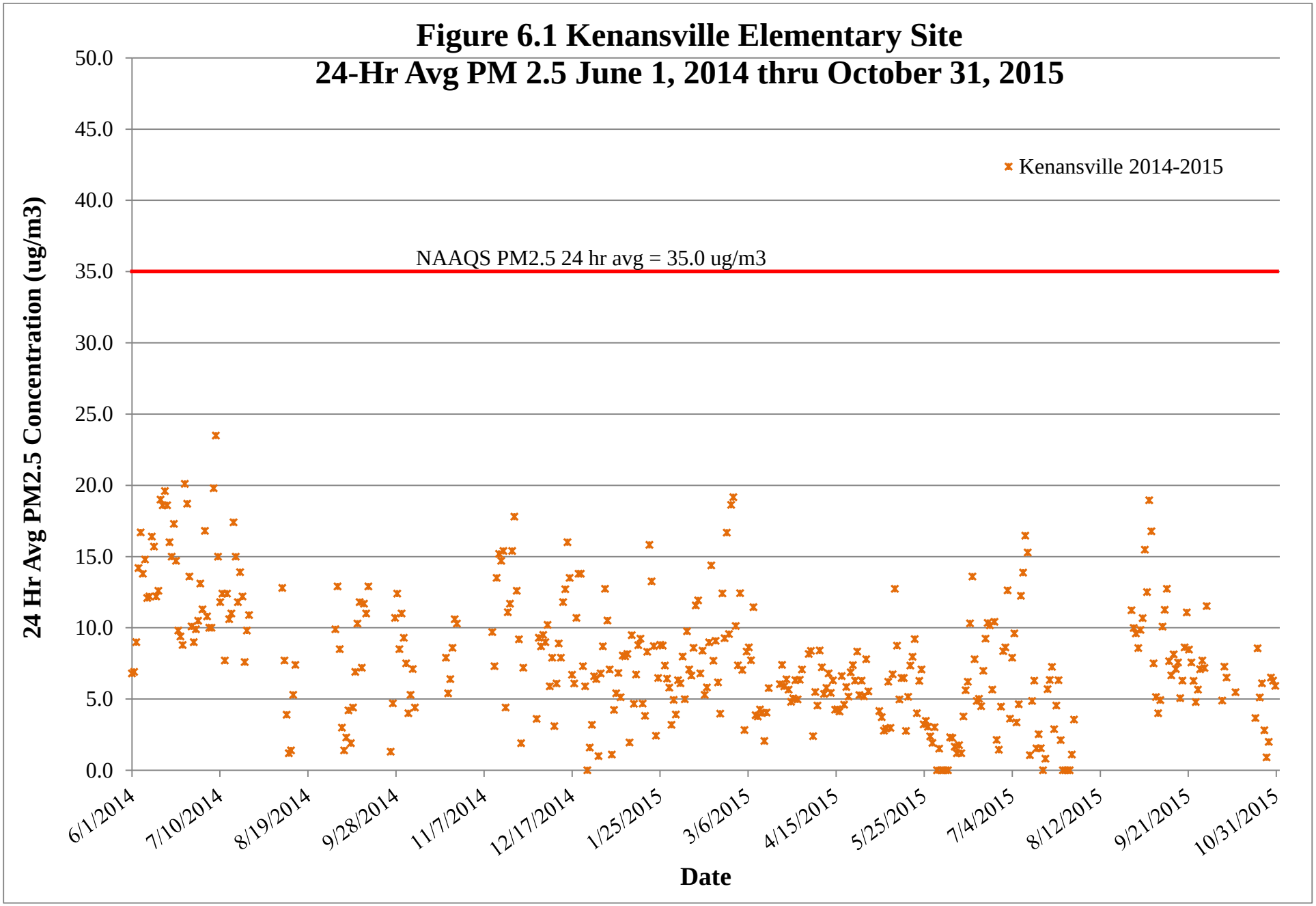


Figure 6.1 Kenansville Elementary Site
24-Hr Avg PM 2.5 June 1, 2014 thru October 31, 2015
24 Hr Avg PM2.5 Concentration (ug/m3)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Kenansville 2014-2015
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
6/1/2014
7/10/2014
8/19/2014
9/28/2014
11/7/2014
12/17/2014
1/25/2015
3/6/2015
4/15/2015
5/25/2015
7/4/2015
8/12/2015
9/21/2015
10/31/2015
Date

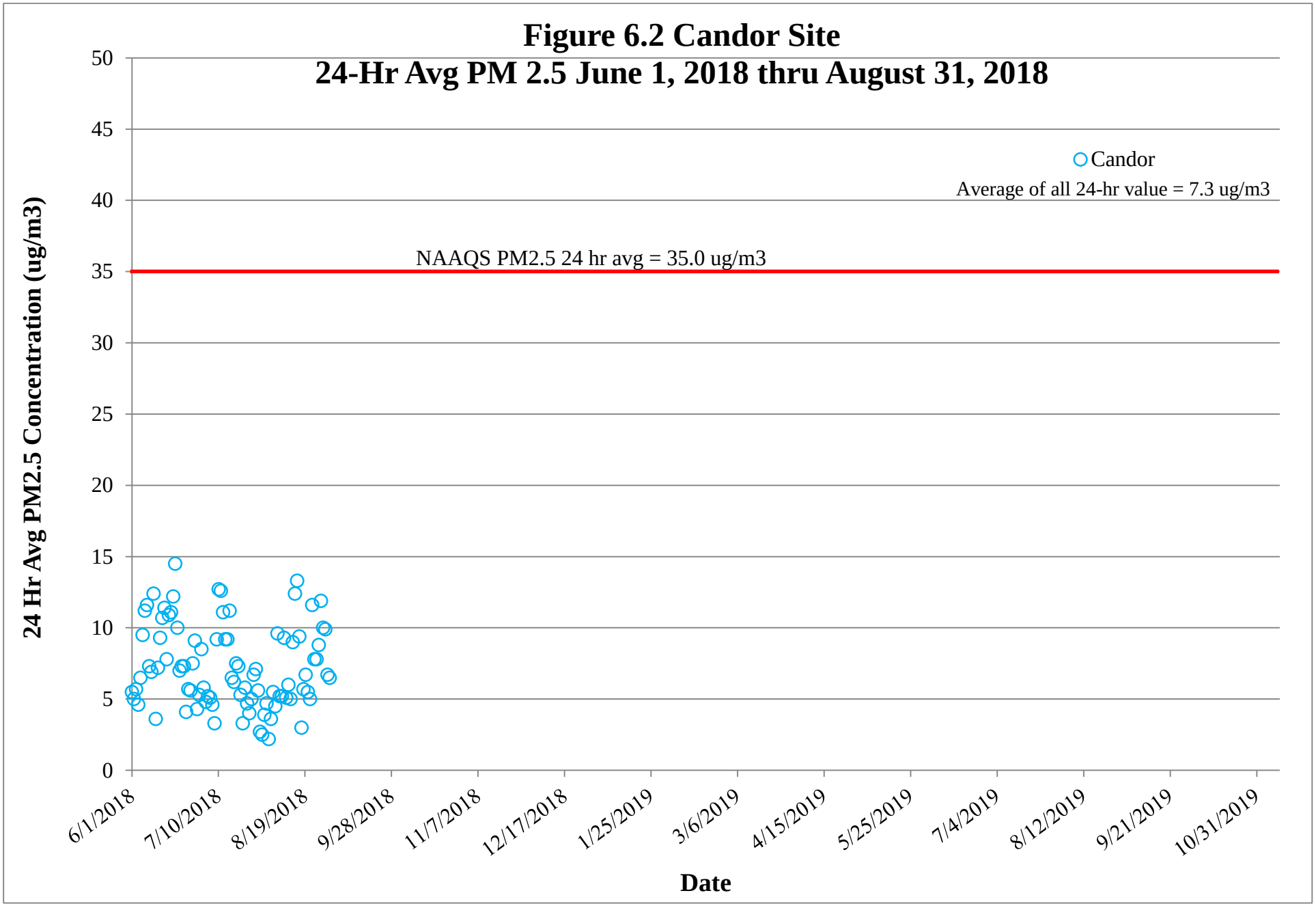


Figure 6.2 Candor Site
24-Hr Avg PM 2.5 June 1, 2018 thru August 31, 2018
24 Hr Avg PM2.5 Concentration (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
Candor
Average of all 24-hr value = 7.3 ug/m3
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
6/1/2018
7/10/2018
8/19/2018
9/28/2018
11/7/2018
12/17/2018
1/25/2019
3/6/2019
4/15/2019
5/25/2019
7/4/2019
8/12/2019
9/21/2019
10/31/2019
Date

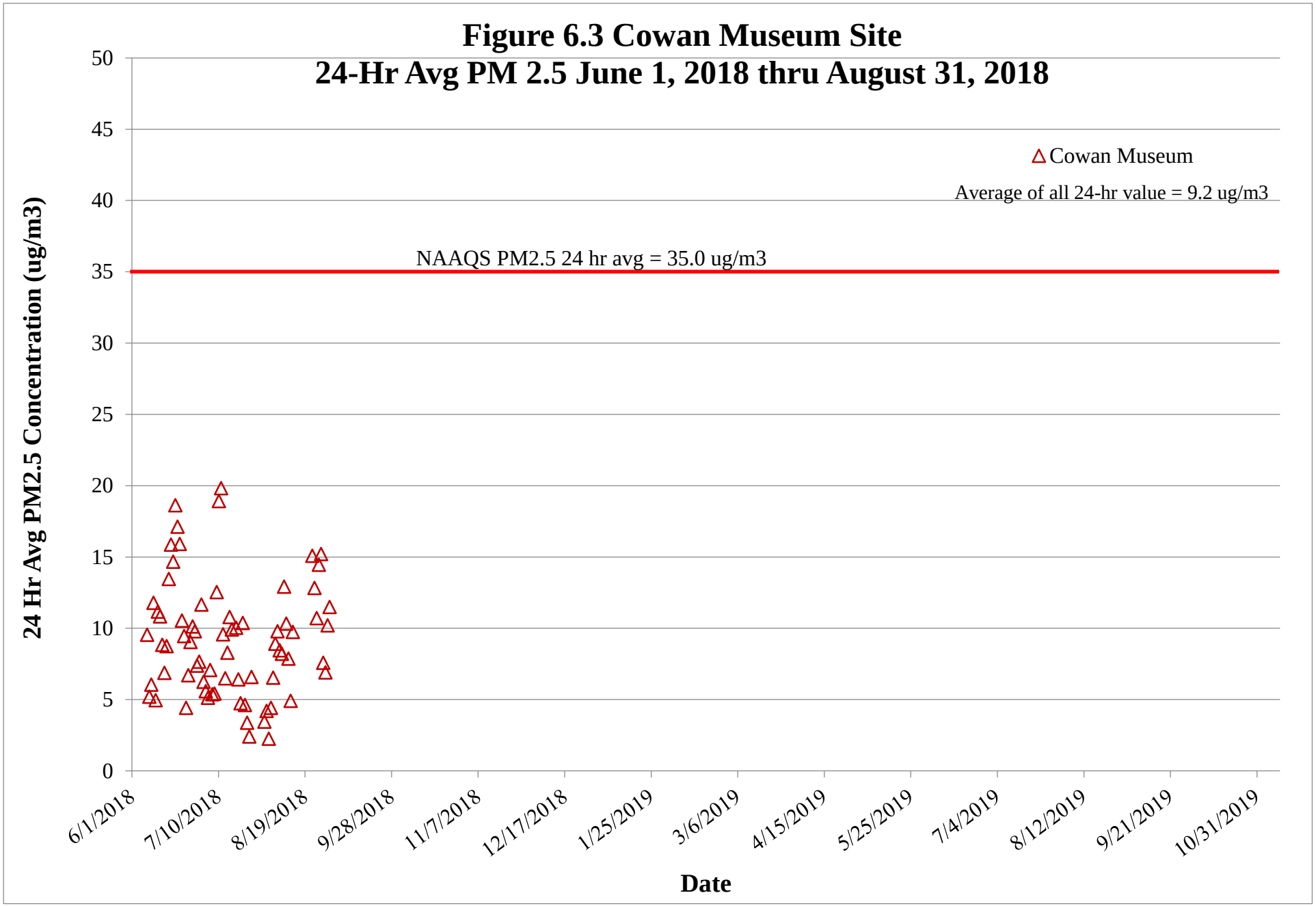


Figure 6.3 Cowan Museum Site
24-Hr Avg PM 2.5 June 1, 2018 thru August 31, 2018
24 Hr Avg PM2.5 Concentration (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
Cowan Museum
Average of all 24-hr value = 9.2 ug/m3
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
6/1/2018
7/10/2018
8/19/2018
9/28/2018
11/7/2018
12/17/2018
1/25/2019
3/6/2019
4/15/2019
5/25/2019
7/4/2019
8/12/2019
9/21/2019
10/31/2019
Date

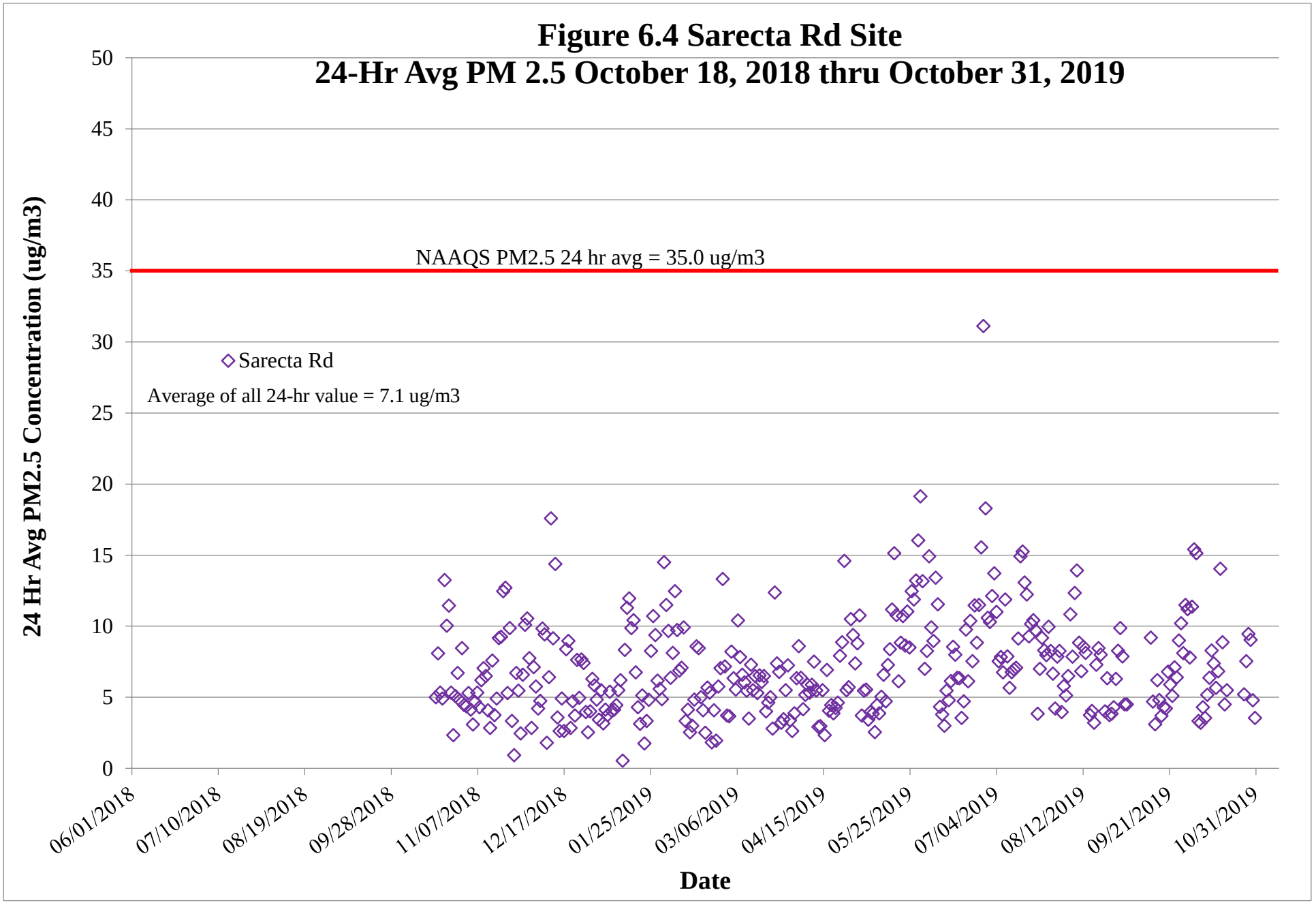


Figure 6.4 Sarecta Rd Site
24-Hr Avg PM 2.5 October 18, 2018 thru October 31, 2019
24 Hr Avg PM2.5 Concentration (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
Sarecta Rd
Average of all 24-hr value = 7.1 ug/m3
06/01/2018
07/10/2018
08/19/2018
09/28/2018
11/07/2018
12/17/2018
01/25/2019
03/06/2019
04/15/2019
05/25/2019
07/04/2019
08/12/2019
09/21/2019
10/31/2019
Date

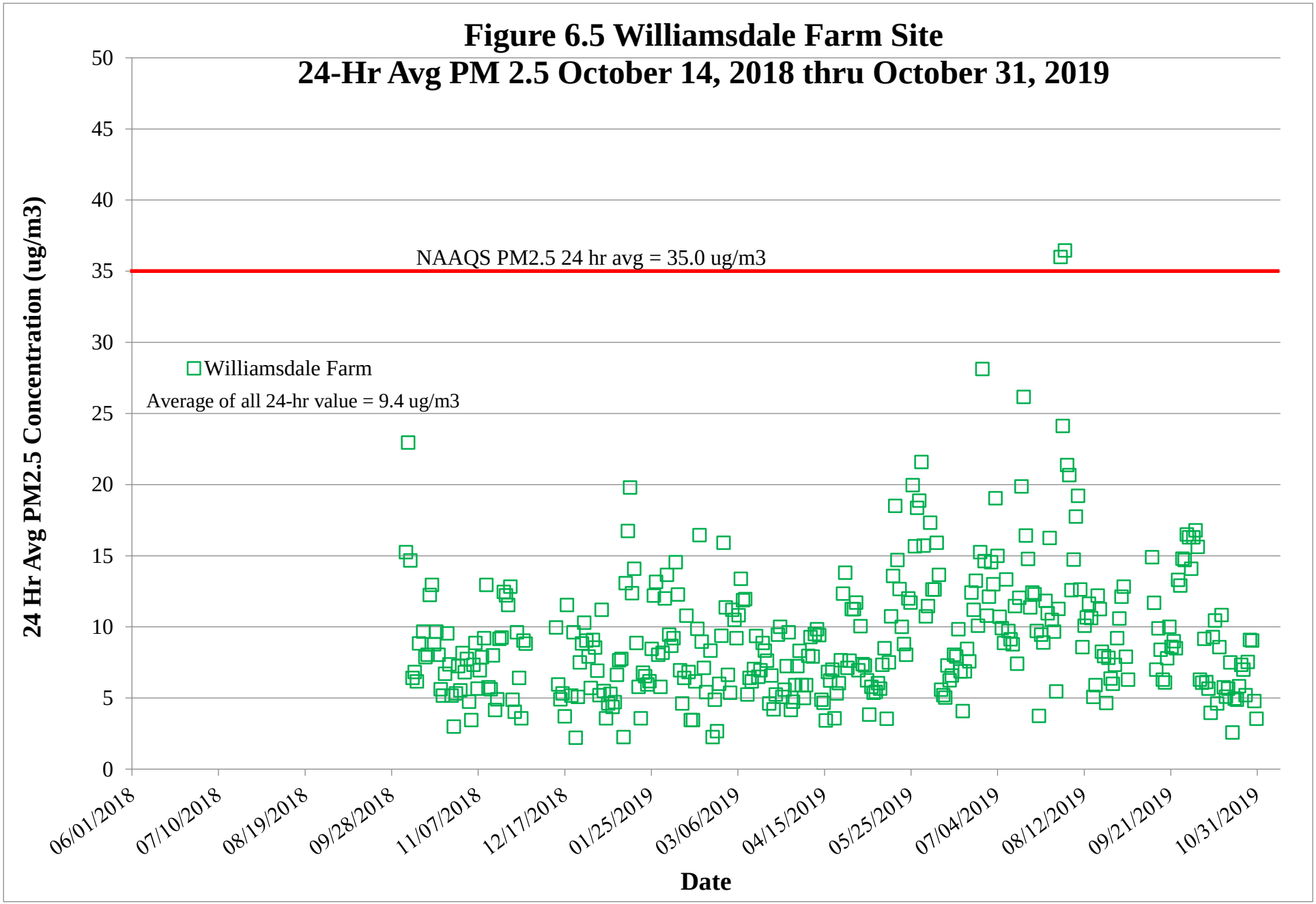


Figure 6.5 Williamsdale Farm Site
24-Hr Avg PM 2.5 October 14, 2018 thru October 31, 2019
24 Hr Avg PM2.5 Concentration (ug/m3)
50
45
40
35
30
25
20
15
10
5
0
NAAQS PM2.5 24 hr avg = 35.0 ug/m3
Williamsdale Farm
Average of all 24-hr value = 9.4 ug/m3
06/01/2018
07/10/2018
08/19/2018
09/28/2018
11/07/2018
12/17/2018
01/25/2019
03/06/2019
04/15/2019
05/25/2019
07/04/2019
08/12/2019
09/21/2019
10/31/2019
Date

4.1.1 Discussion of PM2.5 events.

4.1.1.1 Williamsdale June 27-29, 2019

Figure 7.0 shows the period of June 27-29, 2019 at the Williamsdale Farm site for the PM2.5 concentrations and the wind direction and speed during the elevated PM2.5 readings. The graph shows that during the event, the winds were very calm (0.3 m/s or 0.7 mph) and variable. And as the wind speed increased and changed direction, the PM2.5 concentration decreased significantly. Then as the wind direction returned to the earlier direction, the concentration increased slightly. This behavior is indicative of a transient plume being blown first across the site then back after being diluted.

Figure 8.0 shows the concentrations of all three pollutants during the same time period. It should be noted that the PM2.5 concentrations are independently changing with respect to the other two pollutants on the peak day of June 27 which indicates that they are most likely not from the same source. In this case the most likely cause is a transient smoke plume.

Figure 7.0 Williamsdale 1-hr Avg PM2.5 Concentrations, Wind Direction, Wind Speed

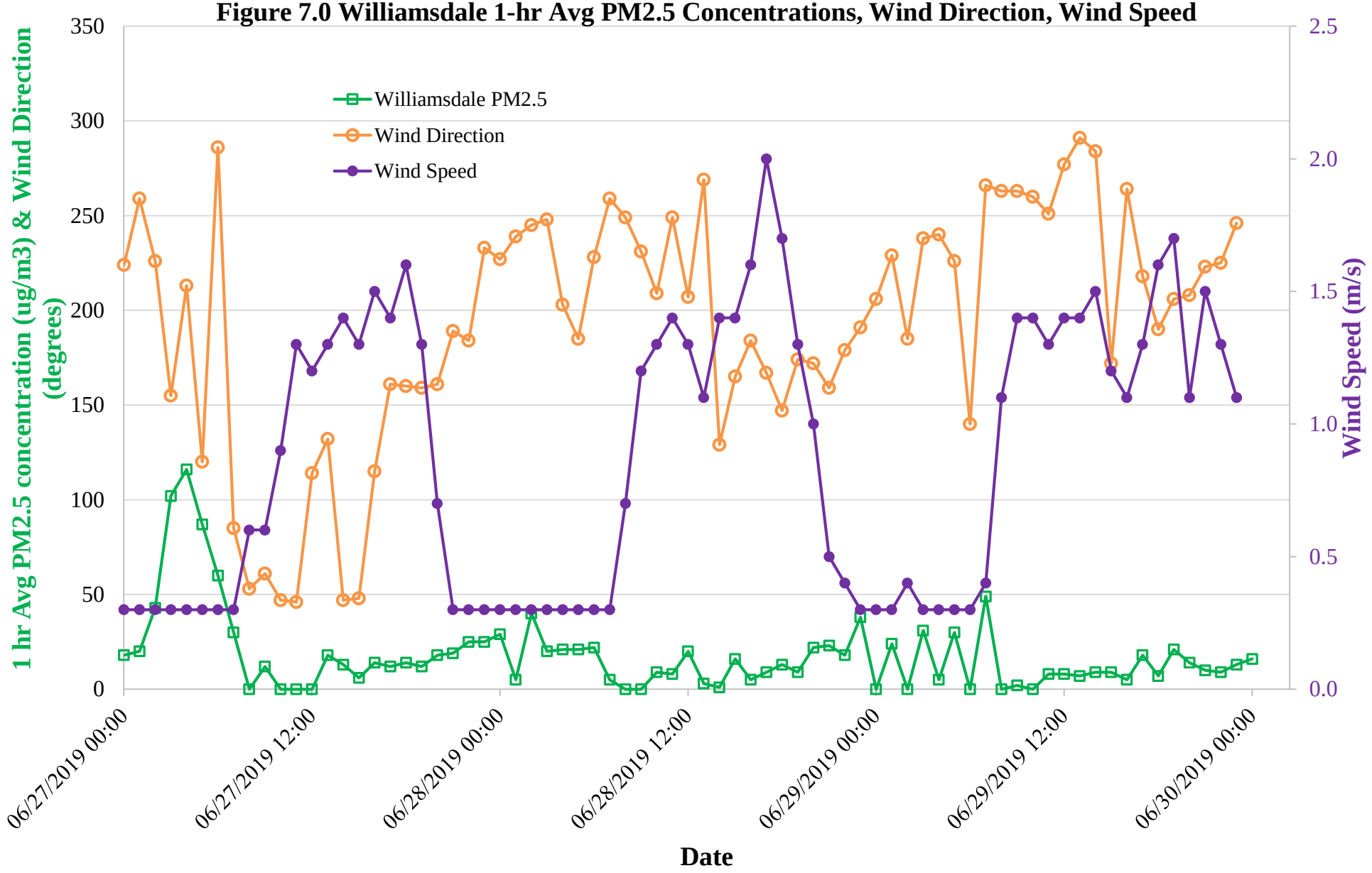
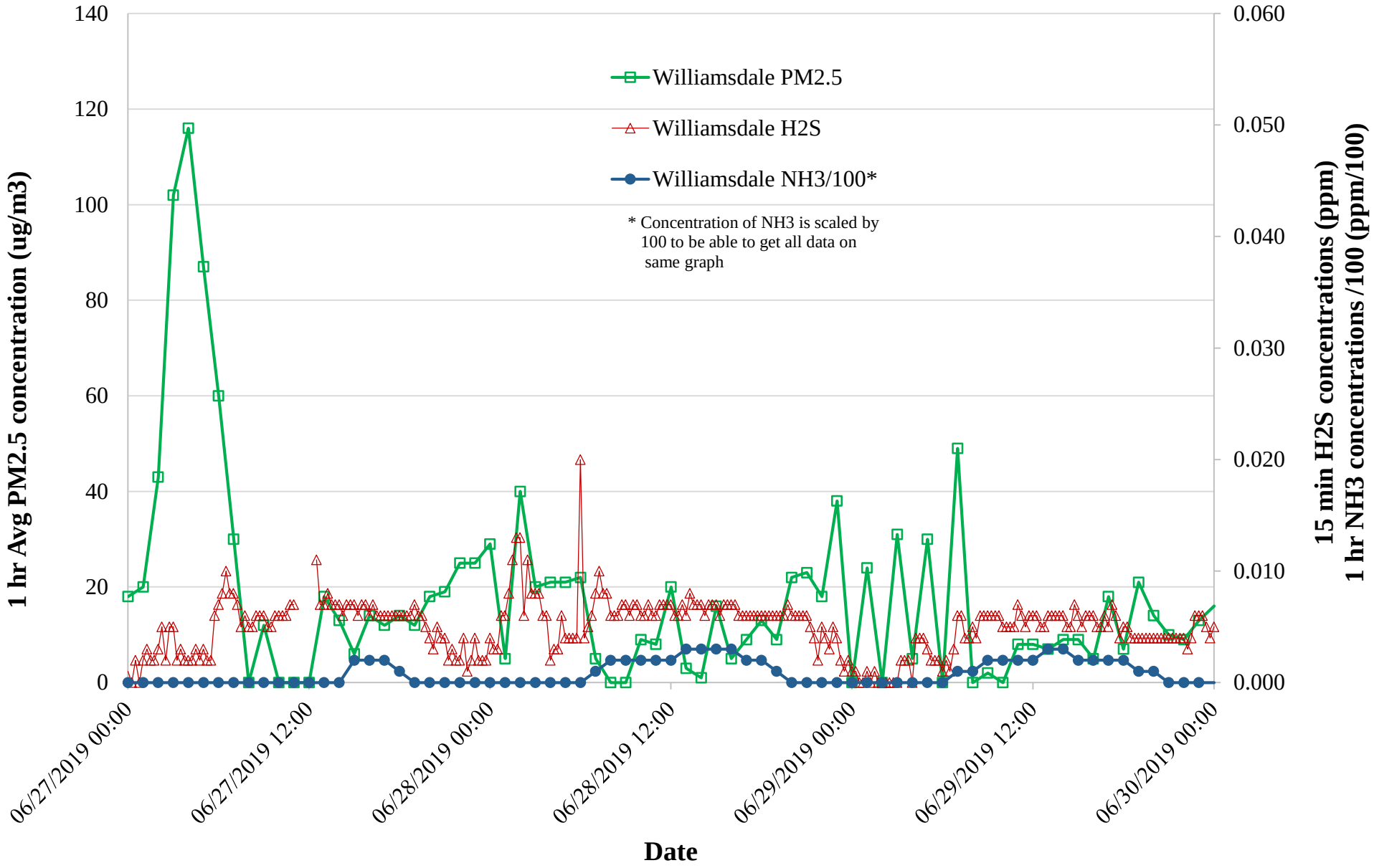


Figure 8.0 Williamsdale PM2.5, H2S, & NH3 Concentrations June 27-29, 2019



4.1.1.2 Sarecta Rd June 27-29, 2019

Figures 9.0 and 10.0 show the period of June 27-29, 2019 at the Sarecta Rd site for the PM2.5 concentrations, wind speed and wind direction. The Figure 9.0 shows that during the peaks, the winds were very calm (0.3 m/s or 0.7 mph) and directionally variable. And as the wind speed increased, the PM2.5 concentration decreased significantly. Also, it appears that the peaks were observed when the wind direction was predominantly from the southeast quadrant (90^{o}-180^{o}). Taking into account the low wind speeds and the predominant wind direction over this time period, the most likely explanation for the observations is a localized and temporal PM (e.g. smoke) source. Additionally, all of these peaks were observed in the early to mid-morning hours between 3am and 9am when any particulate matter (e.g. smoke) would typically held near the ground before being dispersed as the day warmed up.

Additional support for this being a localized smoke event is shown by Figure 11.0. Figure 11.0 shows all three pollutants of interest during the same time period. It should be noted that the PM2.5 concentrations are independently changing with respect to the other two pollutants on June 27-29 which indicates that they are most likely not from the same source. Note: The gaps in the H2S data are due to monitoring malfunctions, which unfortunately occurred during two of the three peaks.

One additional point to note is that looking at Figure 2.0, there are few, if any, close proximity sources for all three pollutants in the southeast quadrant from the Sarecta Rd site. Lack of sources lends itself to this situation being a localized transient source, such as open burning.

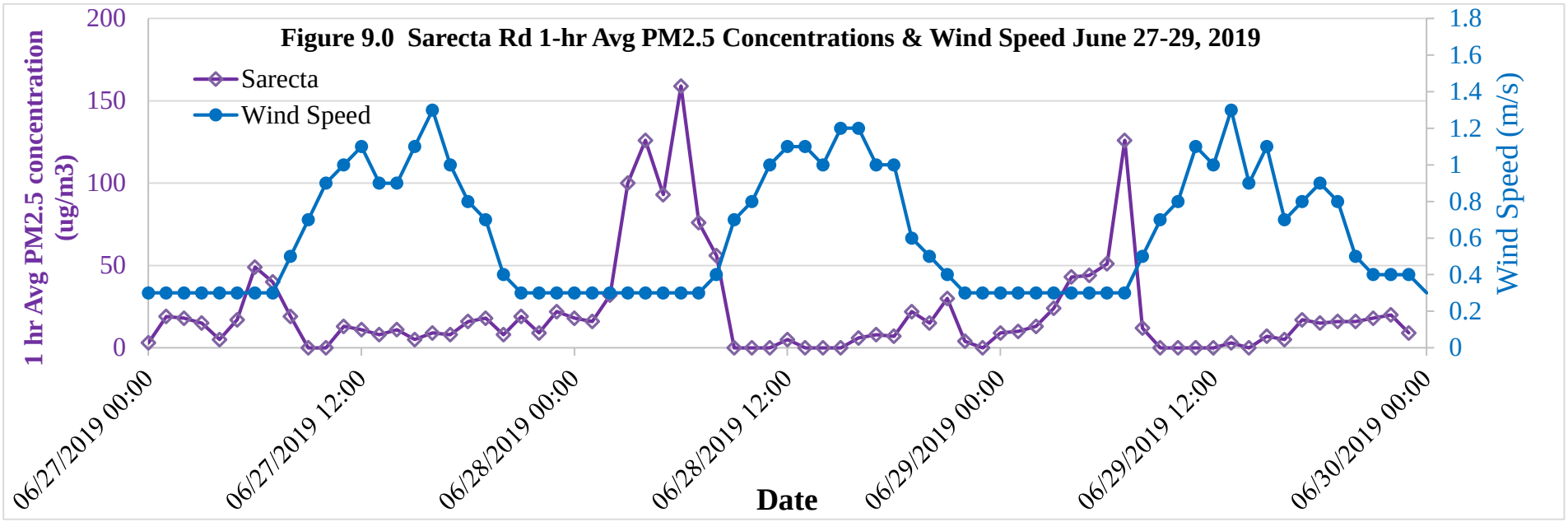


Figure 9.0 Saricta Rd 1-hr Avg PM2.5 Concentrations & Wind Speed June 27-29, 2019
Saricta
Wind Speed
1 hr Avg PM2.5 concentration (ug/m3)
Wind Speed (m/s)
200
150
100
50
0
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
06/27/2019 00:00
06/27/2019 12:00
06/28/2019 00:00
06/28/2019 12:00
06/29/2019 00:00
06/29/2019 12:00
06/30/2019 00:00
Date

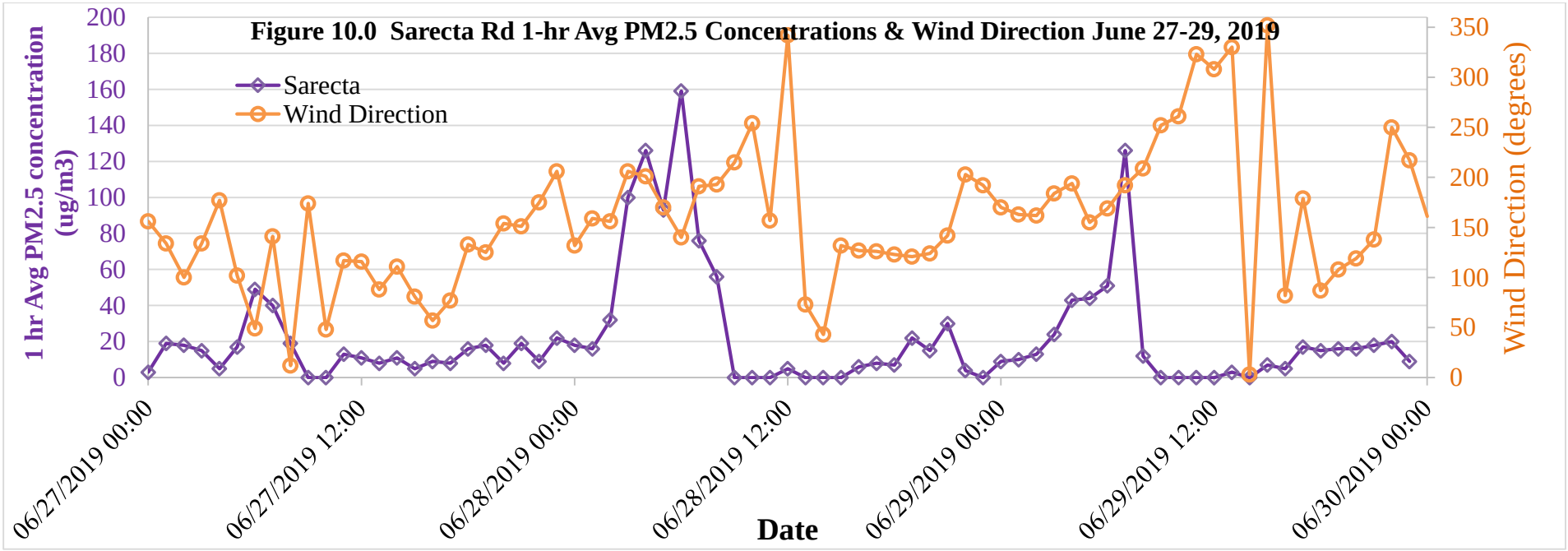
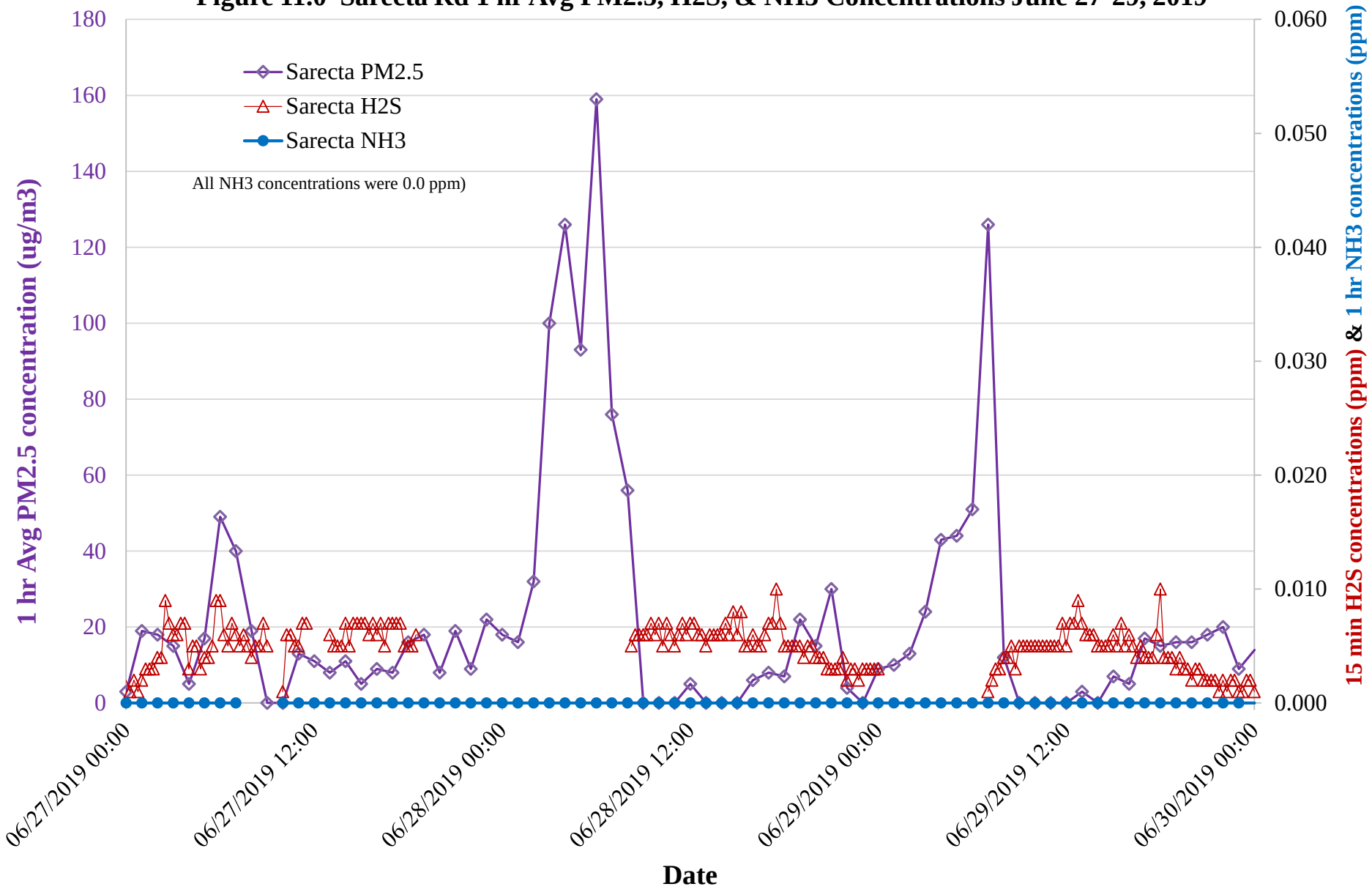


Figure 10.0 Saricta Rd 1-hr Avg PM2.5 Concentrations & Wind Direction June 27-29, 2019
Saricta
Wind Direction
1 hr Avg PM2.5 concentration (ug/m3)
Wind Direction (degrees)
200
180
160
140
120
100
80
60
40
20
0
350
300
250
200
150
100
50
0
06/27/2019 00:00
06/27/2019 12:00
06/28/2019 00:00
06/28/2019 12:00
06/29/2019 00:00
06/29/2019 12:00
06/30/2019 00:00
Date

Figure 11.0 Saracta Rd 1 hr Avg PM2.5, H2S, & NH3 Concentrations June 27-29, 2019



4.1.1.3 Williamsdale August 1-8, 2019

Figure 12.0 shows hourly PM2.5 values at the Williamsdale Farm site during the period of August 1-8, 2019 which resulted in two 24 hr average PM2.5 NAAQS exceedances on two days (August 2 and 4, 2019). To assist with providing a reasonable explanation for these values, several figures were constructed from the meteorological and PM2.5 data.

Figures 13.0-14.0 show the wind rose with wind speed and direction and the PM2.5 rose with the PM2.5 concentration and wind direction, respectively for August 2-6, 2019. Comparing these two figures generally shows that the winds over this period were very light and variable (more than 72% of the detected wind speed values were below 1.0 m/s and from multiple directions) and the highest PM2.5 values were distributed similarly to the wind directions. This latter observation indicates that there was not one prevailing direction for the higher readings. Also, given these two observations and the wide variation between the hourly values, i.e. high for a one 1- hr measurement then zero or very low the next hour, would indicate that the higher PM2.5 concentrations are due to a transitory event.

To support these observations, Figures 15.0 and 16.0 were constructed which show the hour by hour comparison of wind speed and direction, respectively, and the PM2.5 concentrations. Again comparing Figures 15.0 and 16.0, shows that during the period of August 2-6, 2019 that the winds were definitely very light and variable. These conditions and the measurements are consistent with what would be observed if a smoke plume(s) were to drift into the area and over the course of these few days and then was moved around by the very low wind speeds and in various directions. Because once the winds pick up and the direction begins coming consistently from the south(180^{o}) and southwest quadrant, the PM2.5 concentrations return to values at or below 40 ug/m^3.

To further support that this is most likely a smoke event, Figure 17.0 shows all three pollutants' hourly concentrations (PM2.5, H2S, and NH3). The observations show that there are no concomitantly high concentrations of those pollutants at the same time that the PM2.5 concentrations are elevated.; thus indicating that the sources are not the same for each pollutant.

Figure 12.0 Williamsdale PM2.5 Concentrations August 1-8, 2019

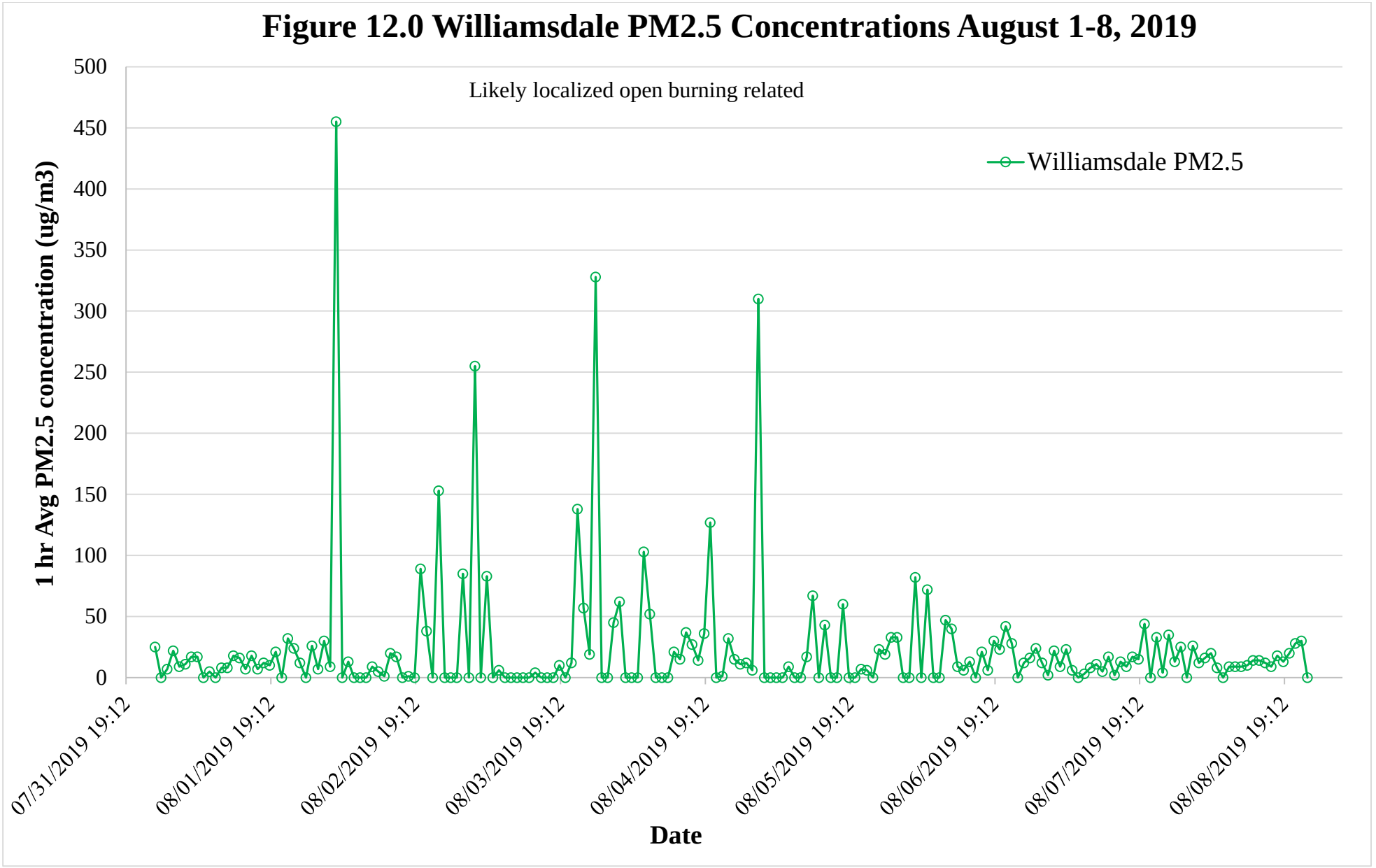


Figure 13.0 Wind Rose Williamsdale Site Aug 2-6, 2019

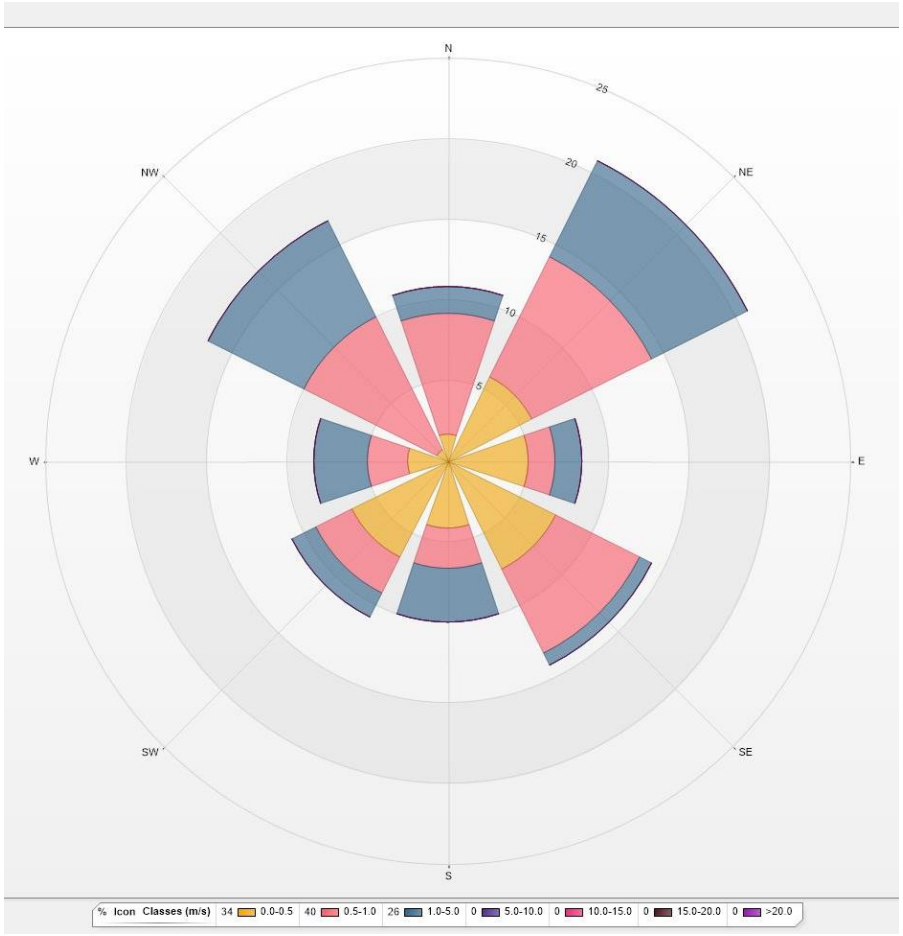
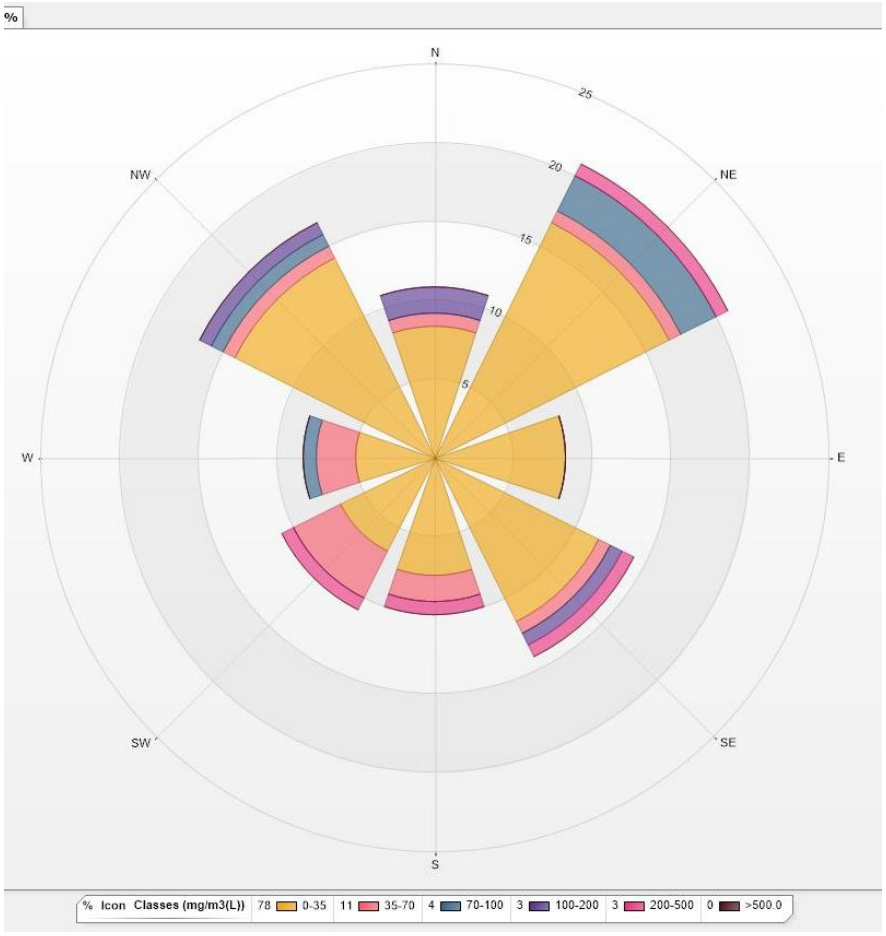


Figure 14.0 PM2.5 Rose Williamsdale Site Aug 2-6, 2019



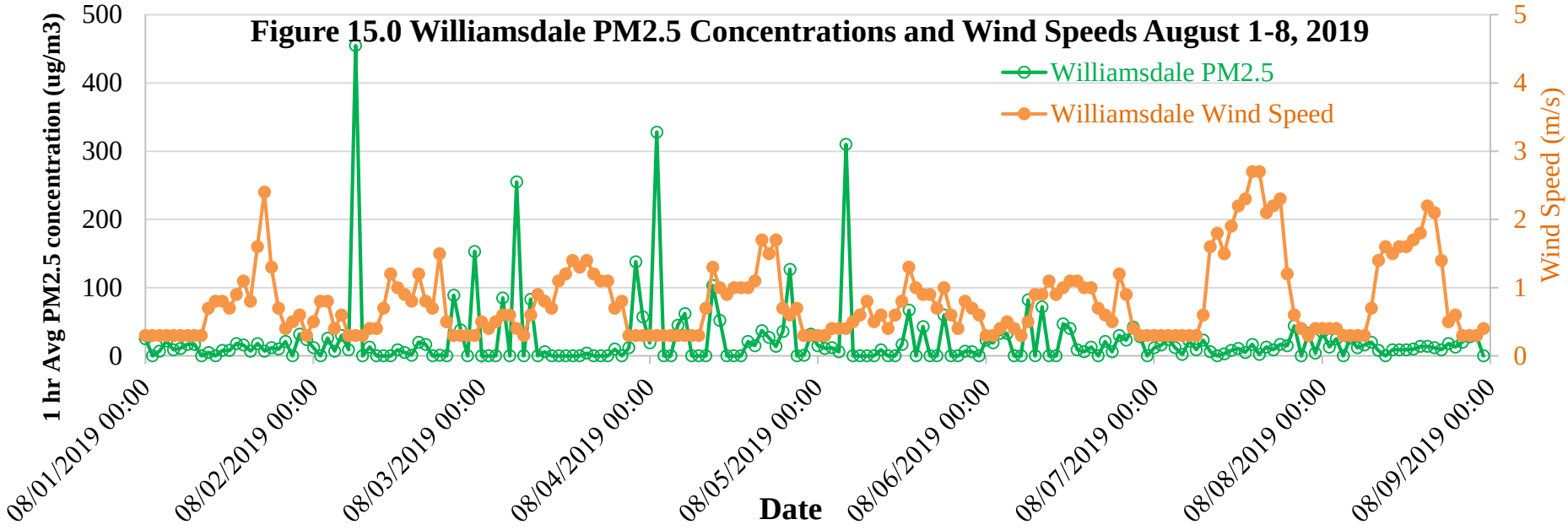


Figure 15.0 Williamsdale PM2.5 Concentrations and Wind Speeds August 1-8, 2019
Williamsdale PM2.5
Williamsdale Wind Speed
1 hr Avg PM2.5 concentration (ug/m3)
Wind Speed (m/s)
Date
08/01/2019 00:00
08/02/2019 00:00
08/03/2019 00:00
08/04/2019 00:00
08/05/2019 00:00
08/06/2019 00:00
08/07/2019 00:00
08/08/2019 00:00
08/09/2019 00:00

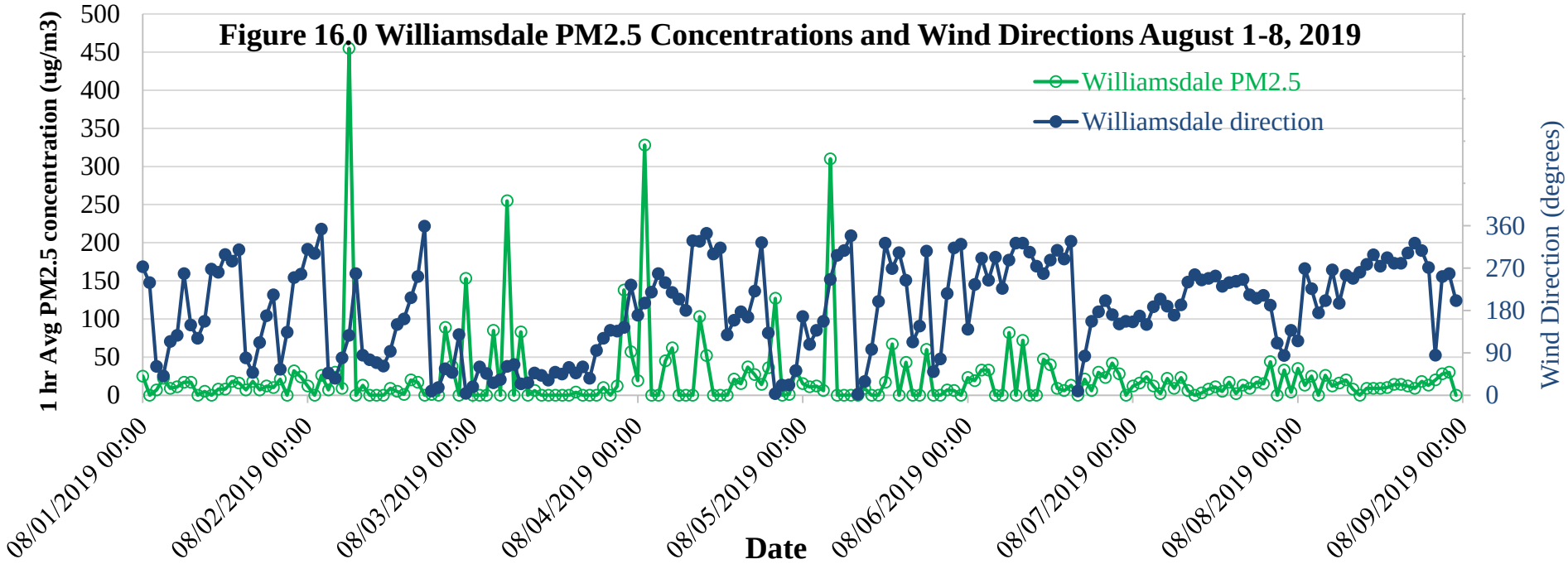
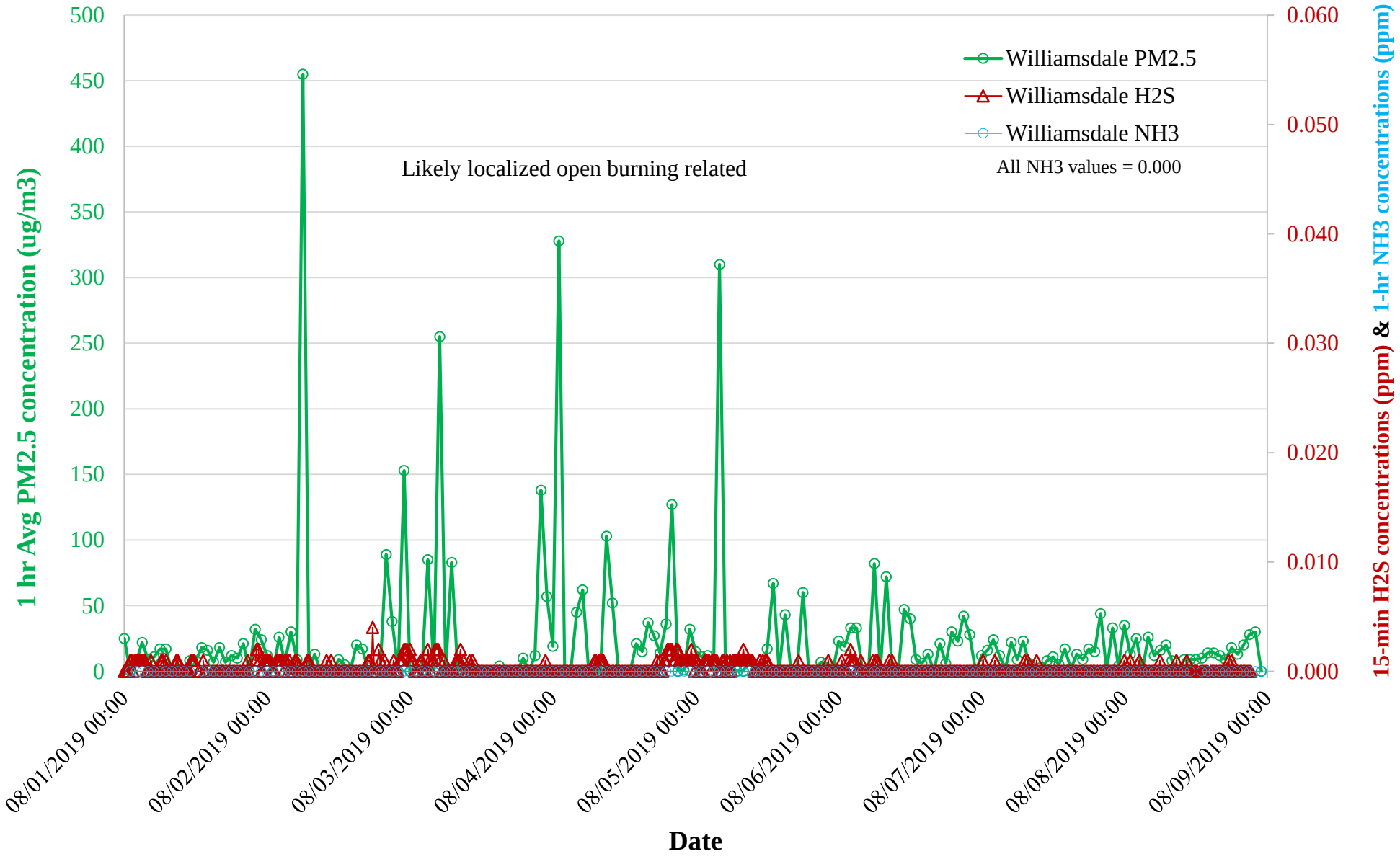


Figure 16.0 Williamsdale PM2.5 Concentrations and Wind Directions August 1-8, 2019
Williamsdale PM2.5
Williamsdale direction
1 hr Avg PM2.5 concentration (ug/m3)
Wind Direction (degrees)
Date
08/01/2019 00:00
08/02/2019 00:00
08/03/2019 00:00
08/04/2019 00:00
08/05/2019 00:00
08/06/2019 00:00
08/07/2019 00:00
08/08/2019 00:00
08/09/2019 00:00

Figure 17.0 Williamsdale PM2.5, H2S, & NH3 Concentrations August 1-8, 2019



4.2 Hydrogen Sulfide (H2S)

The hydrogen sulfide (H2S) data were collected using a Jerome H2S monitor, Model 631X. Data were collected as shown in Table 2.0 above. The reference point for the H2S data was the North Carolina Division of Air Quality Acceptable Ambient Level (AAL) for a 24-hr chronic toxicant of 0.086 ppm (85.9 ppb). This value is a modeling increment and IS NOT directly comparable to the monitored concentrations; however, DAQ frequently uses this value as a bench mark to determine if further investigation of a situation may be warranted. An additional reference point is a mean odor threshold value published by the World Health Organization [3] of 0.008 ppm (8 ppb). *Note that an odor threshold is typically defined as the concentration at which the distinct odor of a compound is first noticeable by sensitive individuals*. In addition to this odor threshold value, the Occupational Safety and Health Administration (OSHA) has an odor threshold range of 0.01-1.5 ppm (10-1500 ppb) with a notation that odor becoming more offensive at 3-5 ppm.[4]

The following Figures 18.0 – 18.4 depict the 15-min average data points for the continuity and 12-month phases of the study. Additionally, as mentioned earlier, since there is no historical data for H2S for the study area, the continuity phase of the study at Candor and Cowan was primarily as a "shake down" phase to determine how well the instruments would perform in this configuration and operational duration.

Also shown in the figures is the time period when the Jerome instrument was exchanged with an identical loaner instrument from the manufacturer. This replacement was necessitated when routine instrument quality assurance (QA) field checks were conducted and it was found that the instrument was beginning to have a slight positive bias although within the QAGD parameters. The appropriate QA checks were made with each instrument when they were exchanged both in July and October to make sure that the data collected were within QA parameters. Those checks were passed indicating that the data collected were accurate. Thus meaning that the lower and less variable H2S values detected at the Williamsdale Farm site were accurate. These same QA field checks were performed at the Sarecta Road site meaning that those more variable concentrations were also accurate.

Of note are the differences between the concentrations at the continuity sites and the 12-month sites. Specifically, the greater "spread" (variability) in the concentrations at the Williamsdale Farm and Sarecta Road sites. This is most likely due to the difference in land use and sources at the four sites. Also there seems to be a seasonal contribution to the H2S contribution as evidenced by the rise and fall of concentrations at both sites over the course of the 12-month study. This is most clearly seen in Figure 19.0. Additionally, although there are 15-minute periods where the concentrations were above the mean odor threshold, this does not constitute a level at which DAQ can take any regulatory actions based on the data.

In Figure 19.0, one can see that the H2S AAL reference point was never exceeded and the 24-hour average H2S concentrations were consistently 10 times lower than the 24-hour AAL at both sites throughout the study.

Figure 18.0 H_2S 15 Min Avg Concentrations
June 9, 2018 thru October 31, 2019

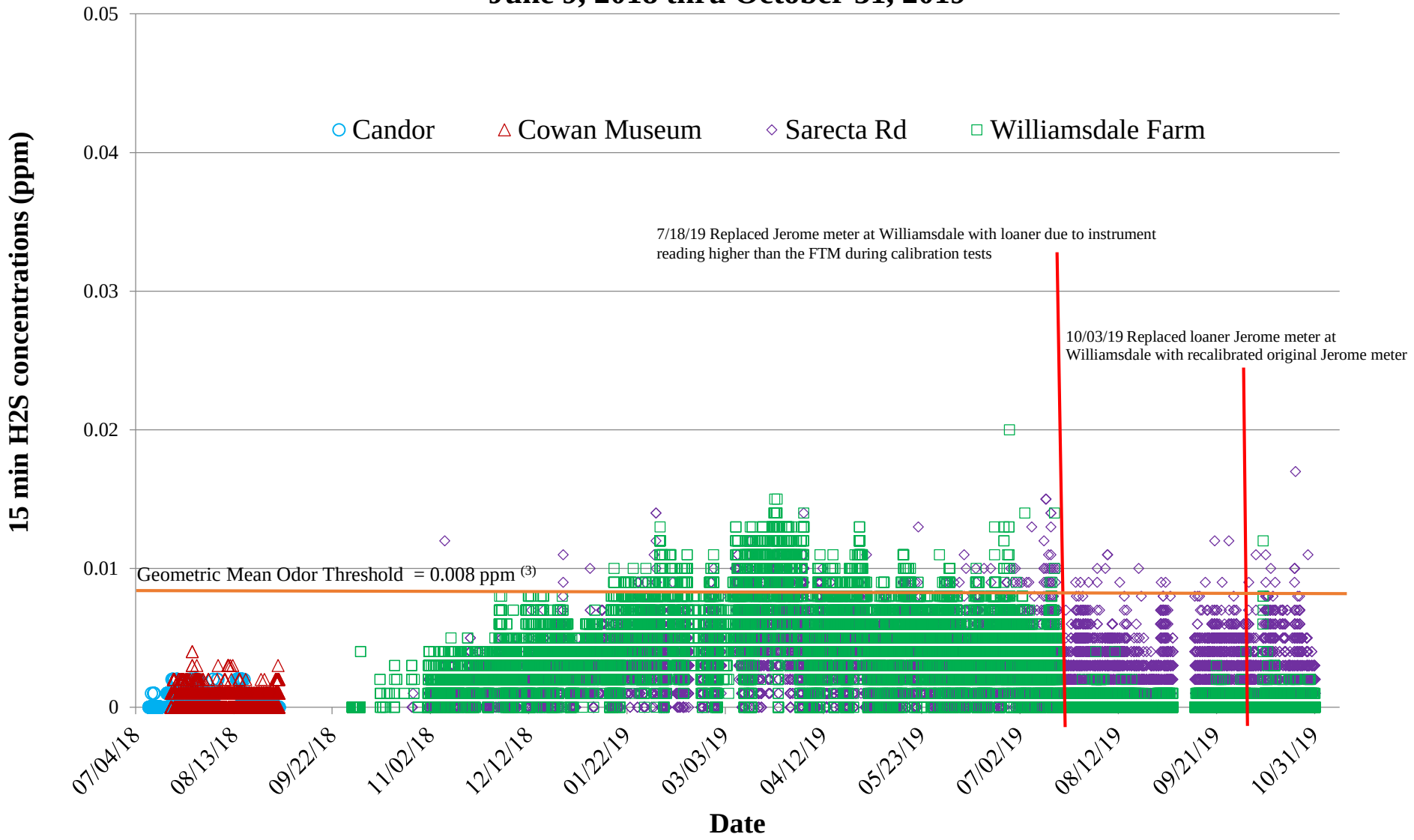
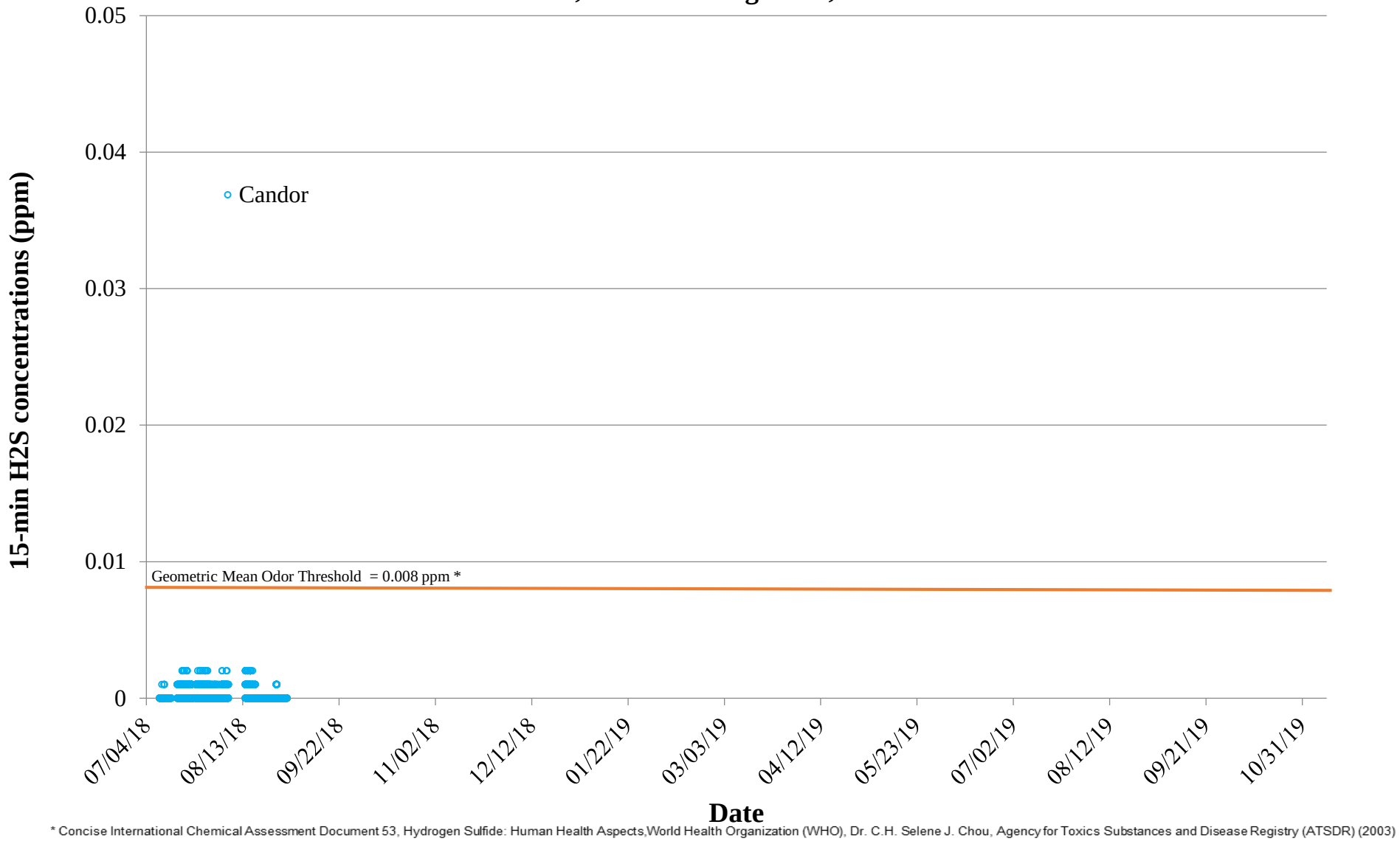
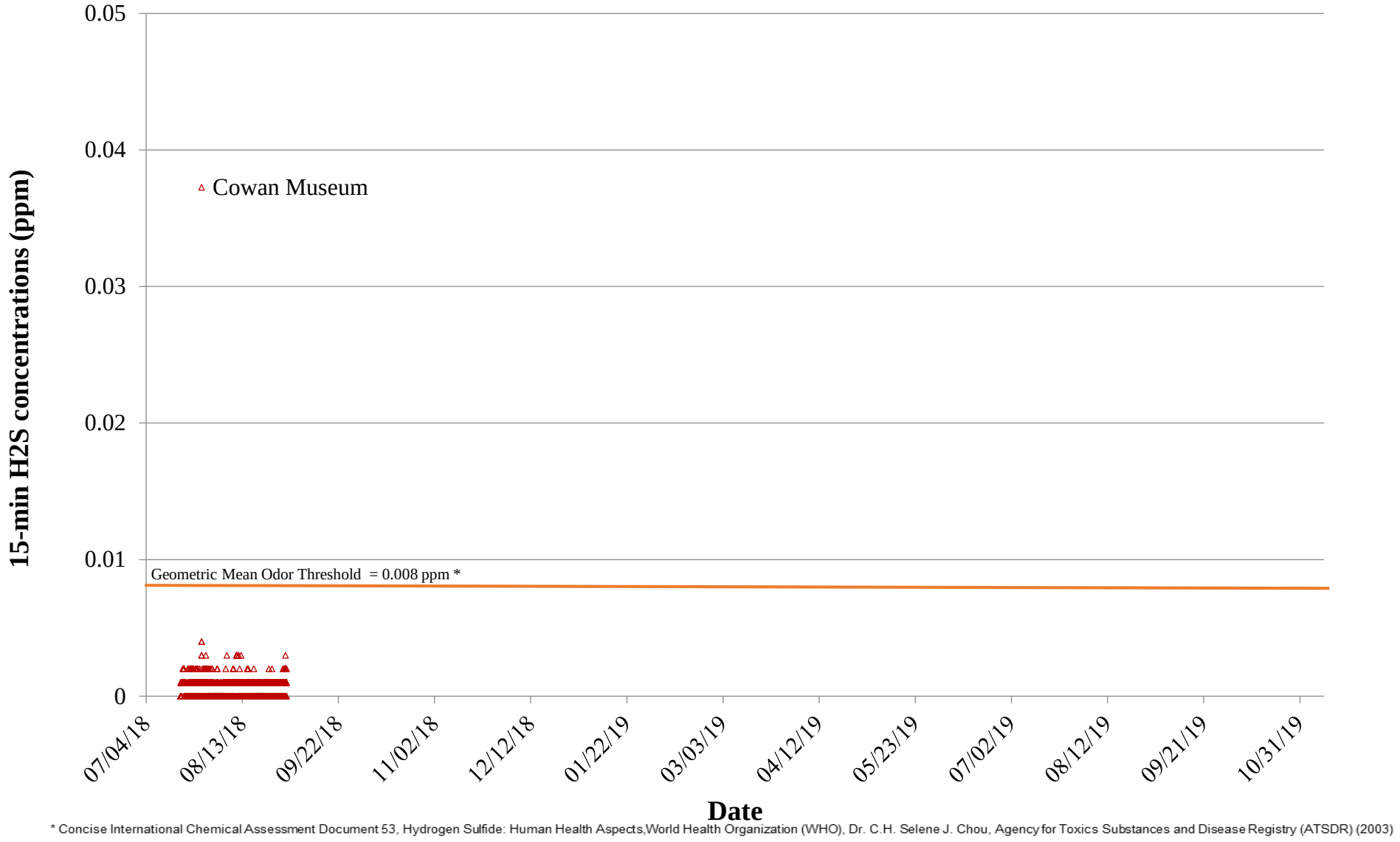


Figure 18.1 Candor H_2S 15-Min Avg Concentrations
June 9, 2018 thru August 31, 2018



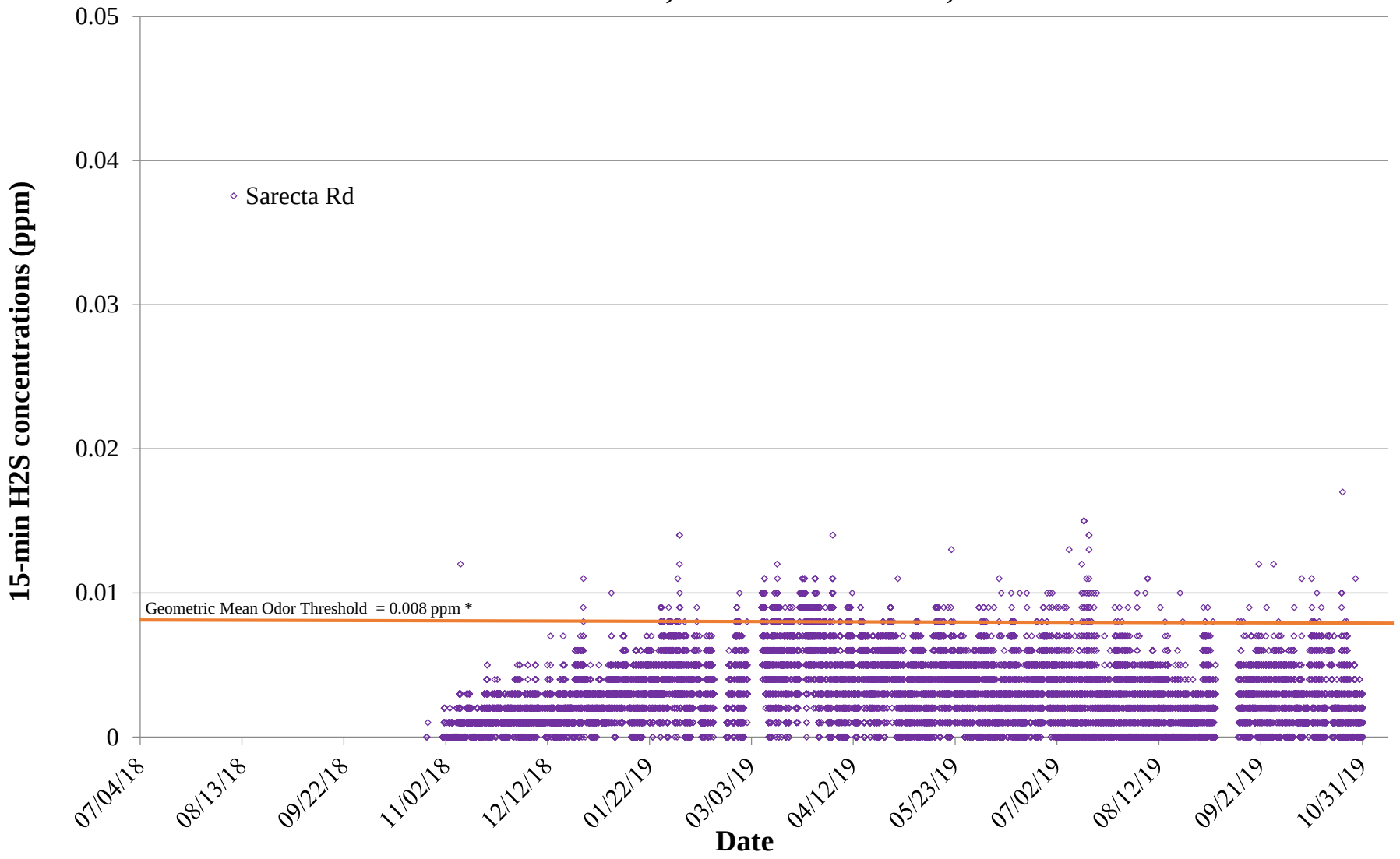
* Concise International Chemical Assessment Document 53, Hydrogen Sulfide: Human Health Aspects,World Health Organization (WHO), Dr. C.H. Selene J. Chou, Agency for Toxics Substances and Disease Registry (ATSDR) (2003)

Figure 18.2 Cowan Museum H_2S 15-Min Avg Concentrations
June 18, 2018 thru August 31, 2018



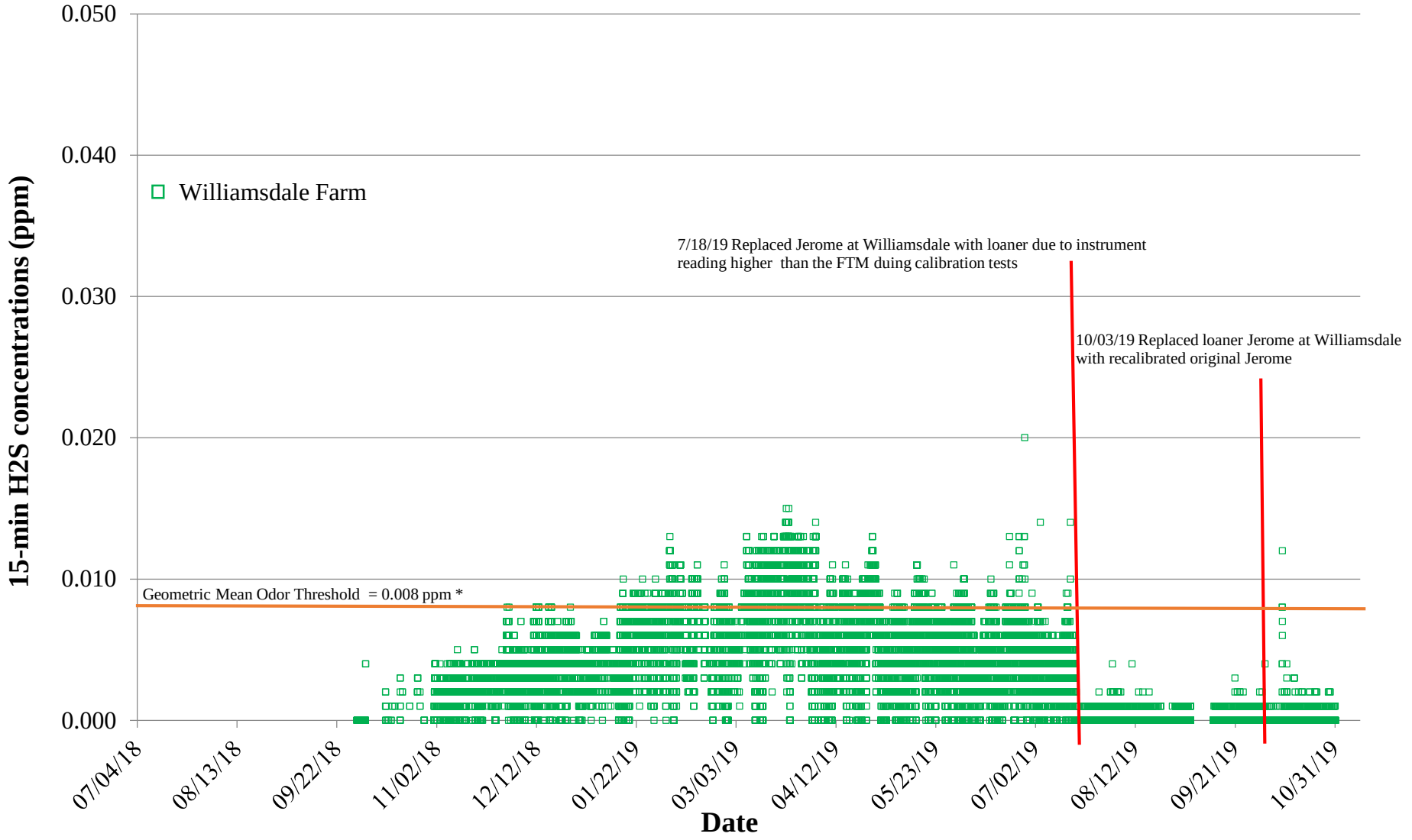
* Concise International Chemical Assessment Document 53, Hydrogen Sulfide: Human Health Aspects,World Health Organization (WHO), Dr. C.H. Selene J. Chou, Agency for Toxics Substances and Disease Registry (ATSDR) (2003)

Figure 18.3 Saracta Road H_2S 15-Min Avg Concentrations
November 1, 2018 thru October 31, 2019



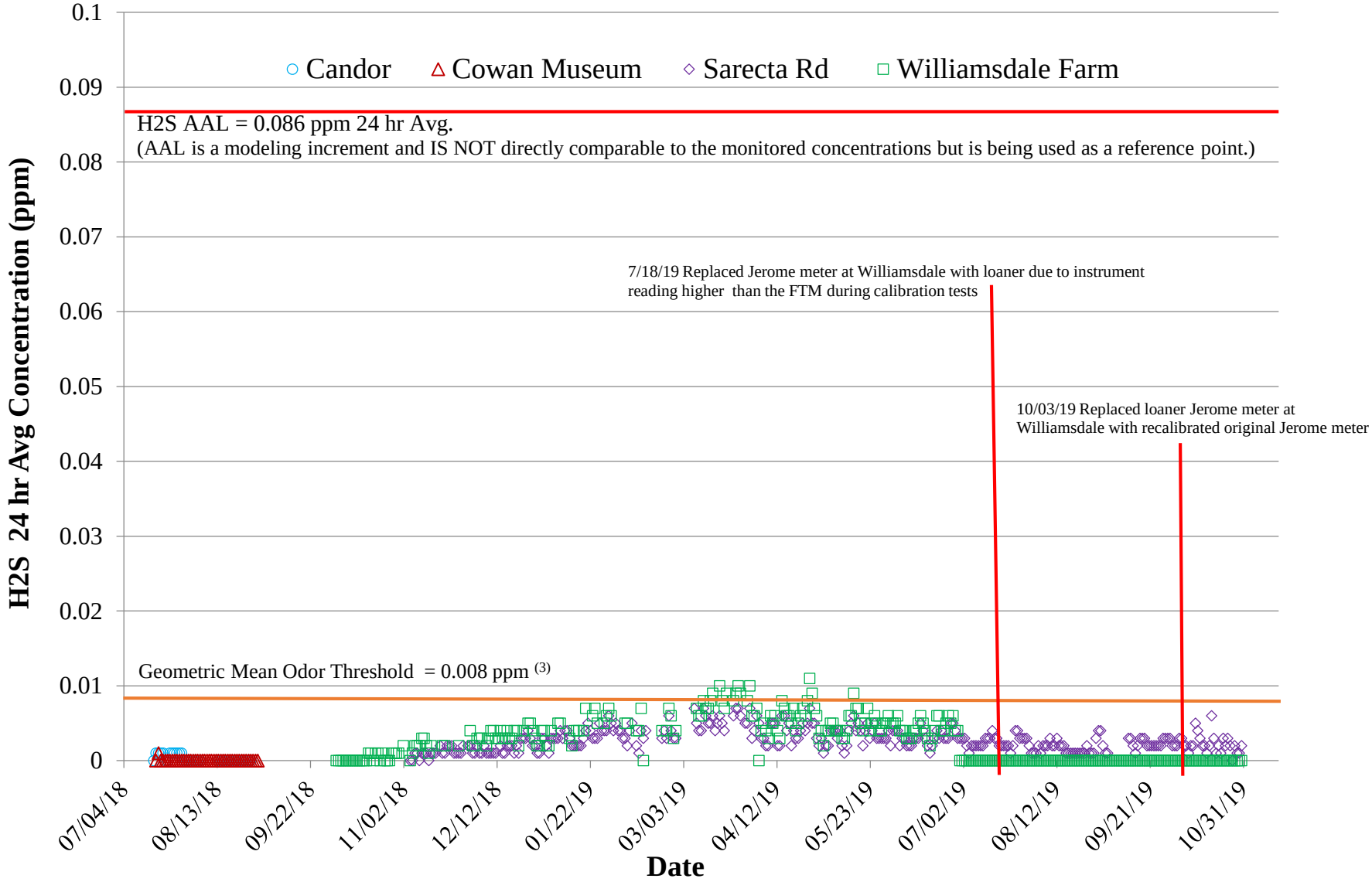
* Concise International Chemical Assessment Document 53, Hydrogen Sulfide: Human Health Aspects,World Health Organization (WHO), Dr. C.H. Selene J. Chou, Agency for Toxics Substances and Disease Registry (ATSDR) (2003)

Figure 18.4 Williamsdale Farm H_2S 15-Min Avg Concentrations October 4, 2018 thru October 31, 2019



* Concise International Chemical Assessment Document 53, Hydrogen Sulfide: Human Health Aspects,World Health Organization (WHO), Dr. C.H. Selene J. Chou, Agency for Toxics Substances and Disease Registry (ATSDR) (2003)

Figure 19.0 H_2S 24 hr Avg Concentrations July 9, 2018 thru October 31, 2019



4.3 Ammonia (NH3)

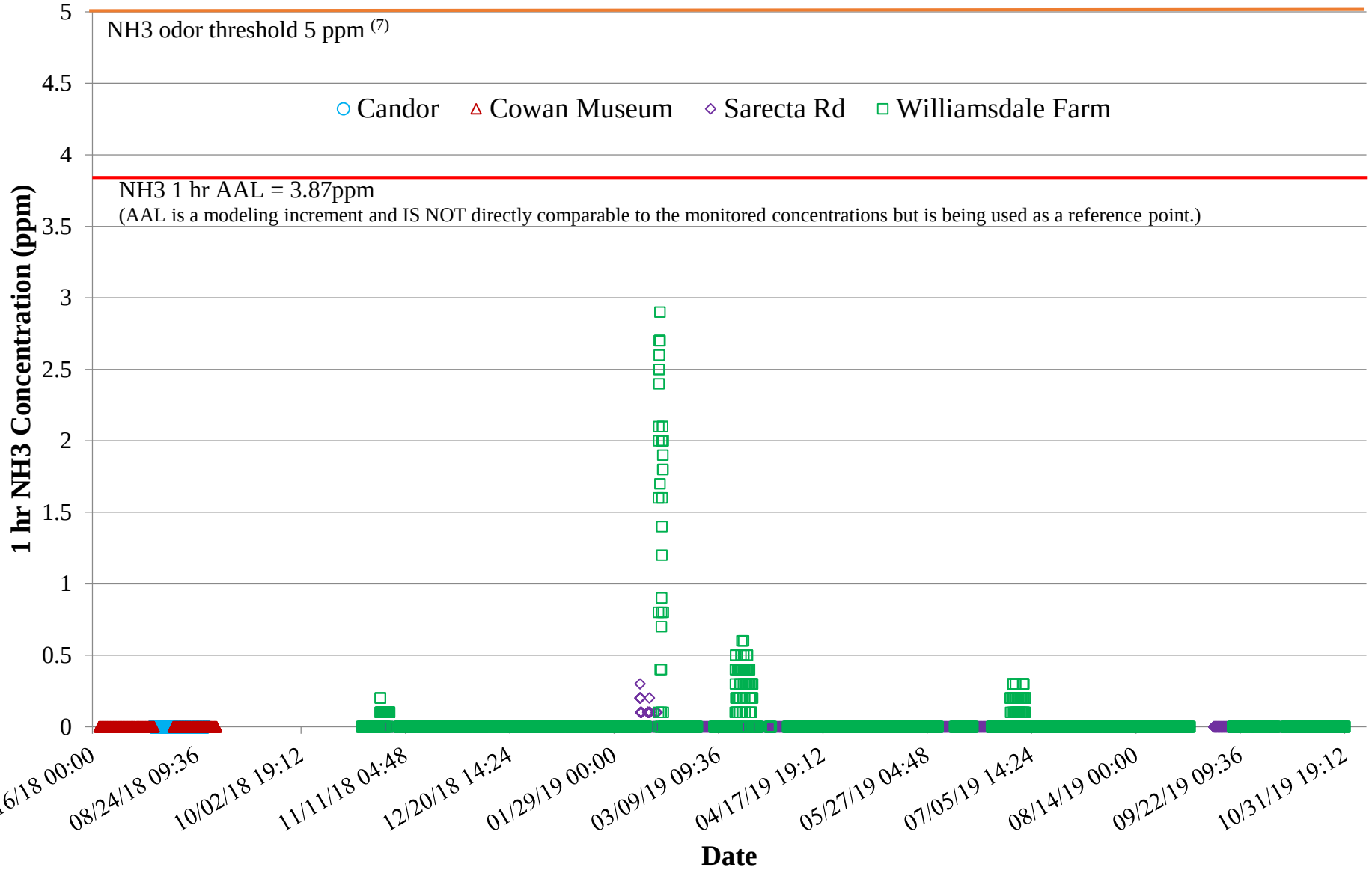
The ammonia (NH3) data were collected using a Rae systems AreaRae monitor equipped with an ammonia electrochemical sensor. Data were collected as shown in Table 2.0 above. The reference point for the NH3 data was the North Carolina Division of Air Quality Acceptable Ambient Level (AAL) for a 1-hr acute irritant of 3.87 ppm (3870 ppb). This value is a modeling increment and IS NOT directly comparable to the monitored concentrations; however, DAQ frequently uses this value as a bench mark to determine if further investigation of a situation may be warranted. Additional reference points are odor threshold values published by OSHA for a range of 5-50 ppm (5000-50,000 ppb)[(5)] and ATSDR at 5 ppm[(6)] Note that an odor threshold is typically defined as the concentration at which the distinct odor of a compound is first noticeable by sensitive individuals.

The following Figure 20.0 depicts the 1-hr average data points for the continuity and 12-month phases of the study. It also shows the reference point value of the NH3 1-hr AAL as well as the ATSDR odor threshold. As noted in other sections, the gap between the continuity and the 12-month phases was due to two hurricanes and their aftermath (Florence, September 2019 and Michael, October 2019). This resulted in the study being extended for an additional month to October 31, 2019. The September 3-12, 2019 gap was due to Hurricane Dorian. Additionally, as mentioned earlier, since there is no historical data for NH3 for the study area, the continuity phase of the study at Candor and Cowan was primarily as a "shake down" phase to determine how well the instruments would perform in this configuration and operational duration.

The following Figure 20.0 shows that for most of the study the NH3 concentrations were non-detects with 5 "events" with measurable NH3 concentrations; 1 at Sarecta Road and 4 at Williamsdale Farm. Only one event reached a level that approached the AAL reference point for a short period at the Williamsdale Farm site during the period of February 14-16, 2019 with a maximum 1-hr average concentration of 2.9 ppm. This event will be discussed later in section 4.3.1. The other events were relatively minor excursions with maxima less than 0.7 ppm.

In Figure 20.0, one can see that the NH3 AAL reference point was never exceeded This indicates that NH3 is not expected to be a significant singular contributor to poor air quality in the study area.

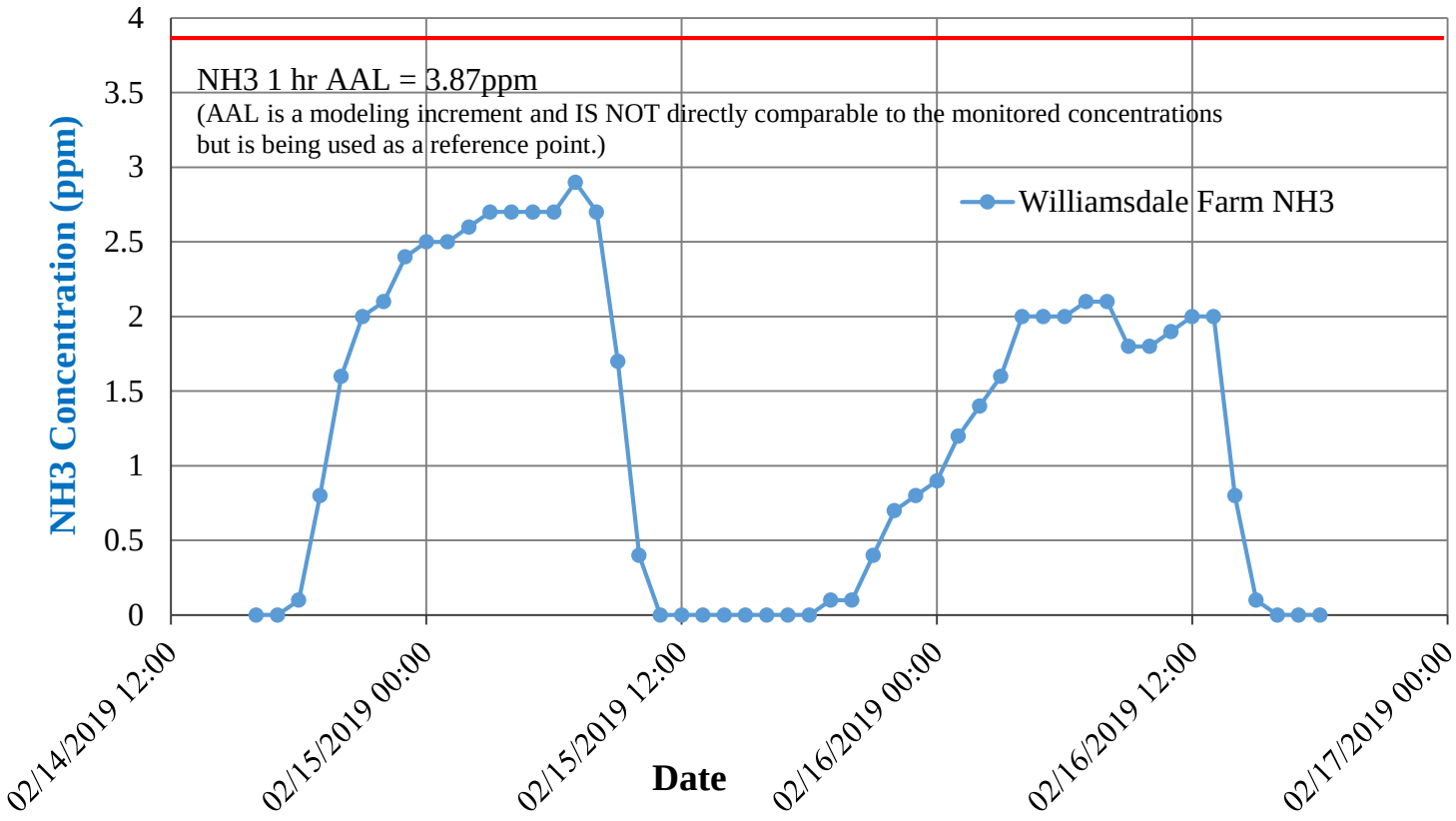
Figure 20.0 1 Hr NH3 Concentrations (ppm) July 16, 2018 thru October 31, 2019



4.3.1 Williamsdale February 14-16, 2019

The one event that approached the NH3 AAL value was at the Williamsdale Farm site on February 14-16, 2019. That event is shown in more detail in Figure 21.0.

Figure 21.0 Williamsdale NH3 Concentration and Wind Speed & Direction February 14-16, 2019



Figures 22.0-24.0 show the NH3 roses for each of the three days and the concentration relationship to the wind direction towards the monitoring site. These three figures show that the highest NH3 concentrations appears to be coming towards the site from the southwest and southeast quadrants during this event.

Figures 25.0 provides insight of the effect of the wind speed on the NH3 concentration. In general, it shows that the increases and decreases in NH3 concentrations are inversely related to the wind speeds more so than to the wind direction.

Figure 22.0 NH3 Rose February 14, 2019

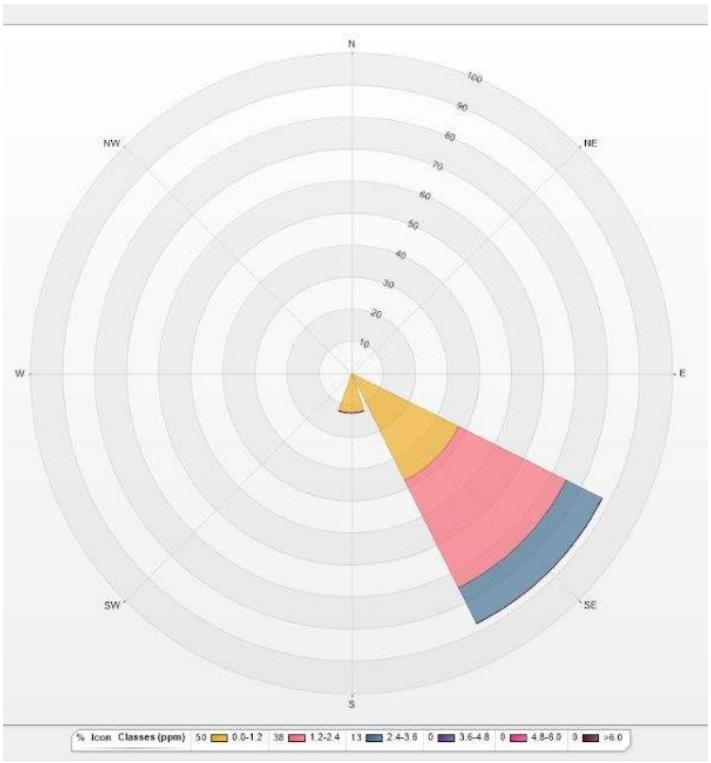


Figure 23.0 NH3 Rose February 15, 2019

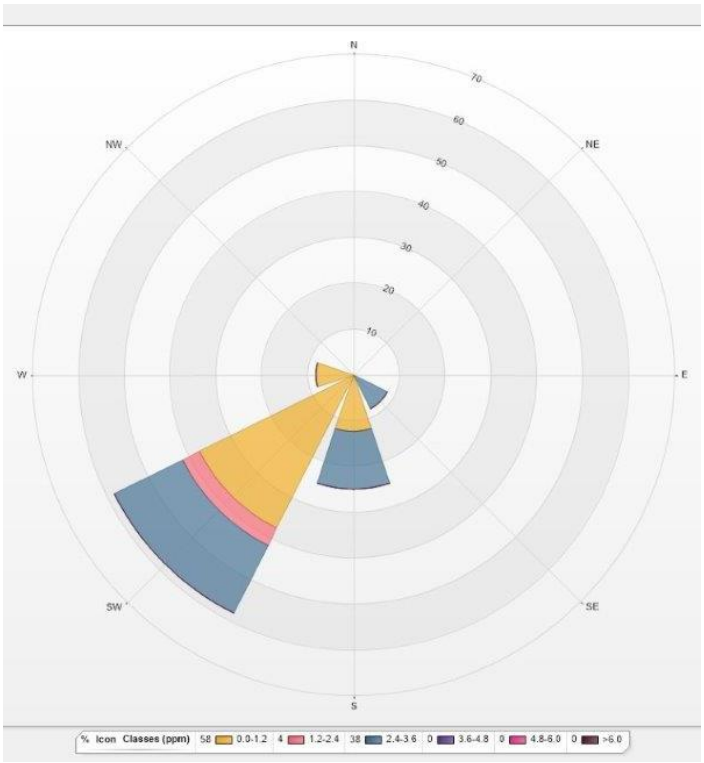


Figure 24.0 NH3 Rose February 16, 2019

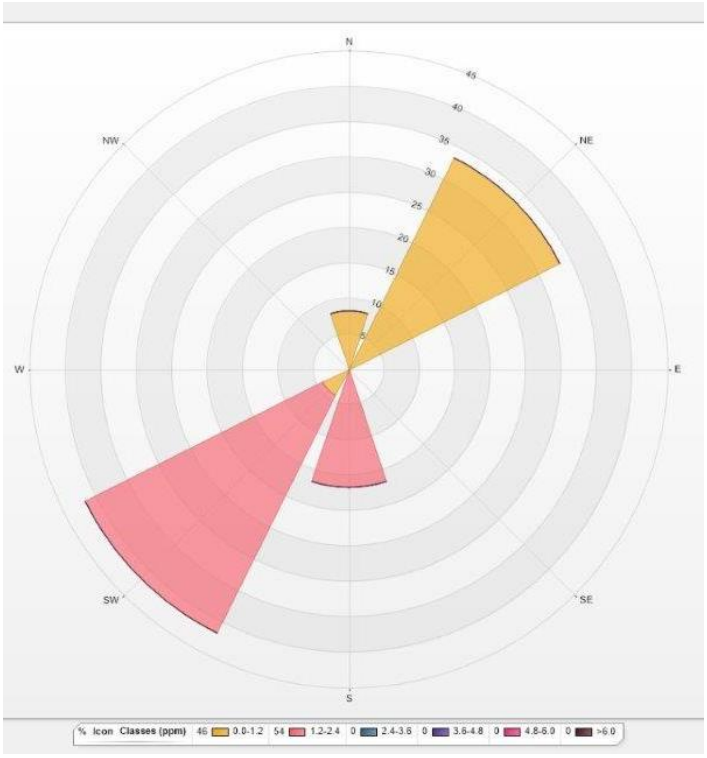


Figure 25.0 Williamsdale NH3 Concentration and Wind Speed & Direction February 14-16, 2019

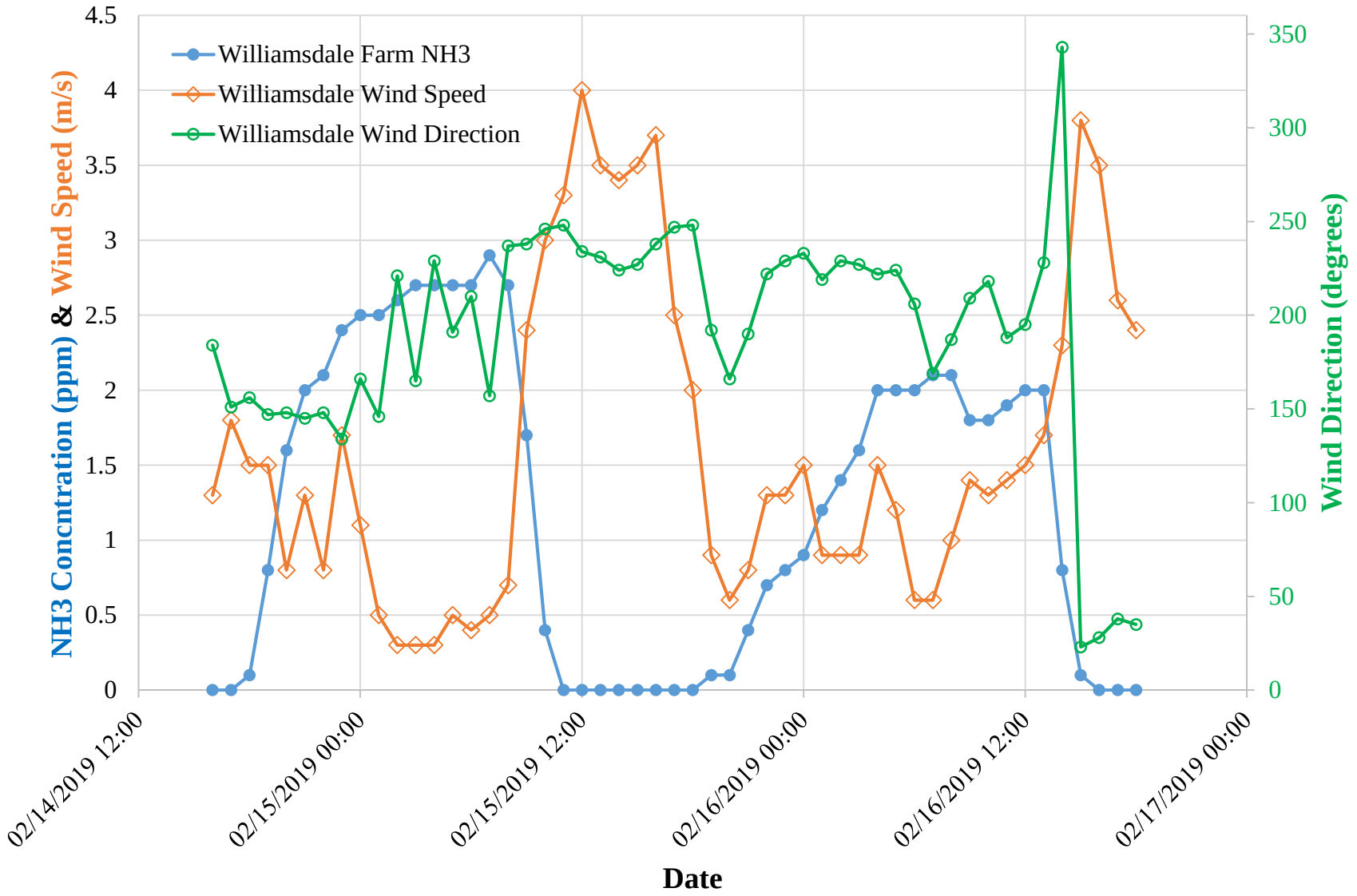
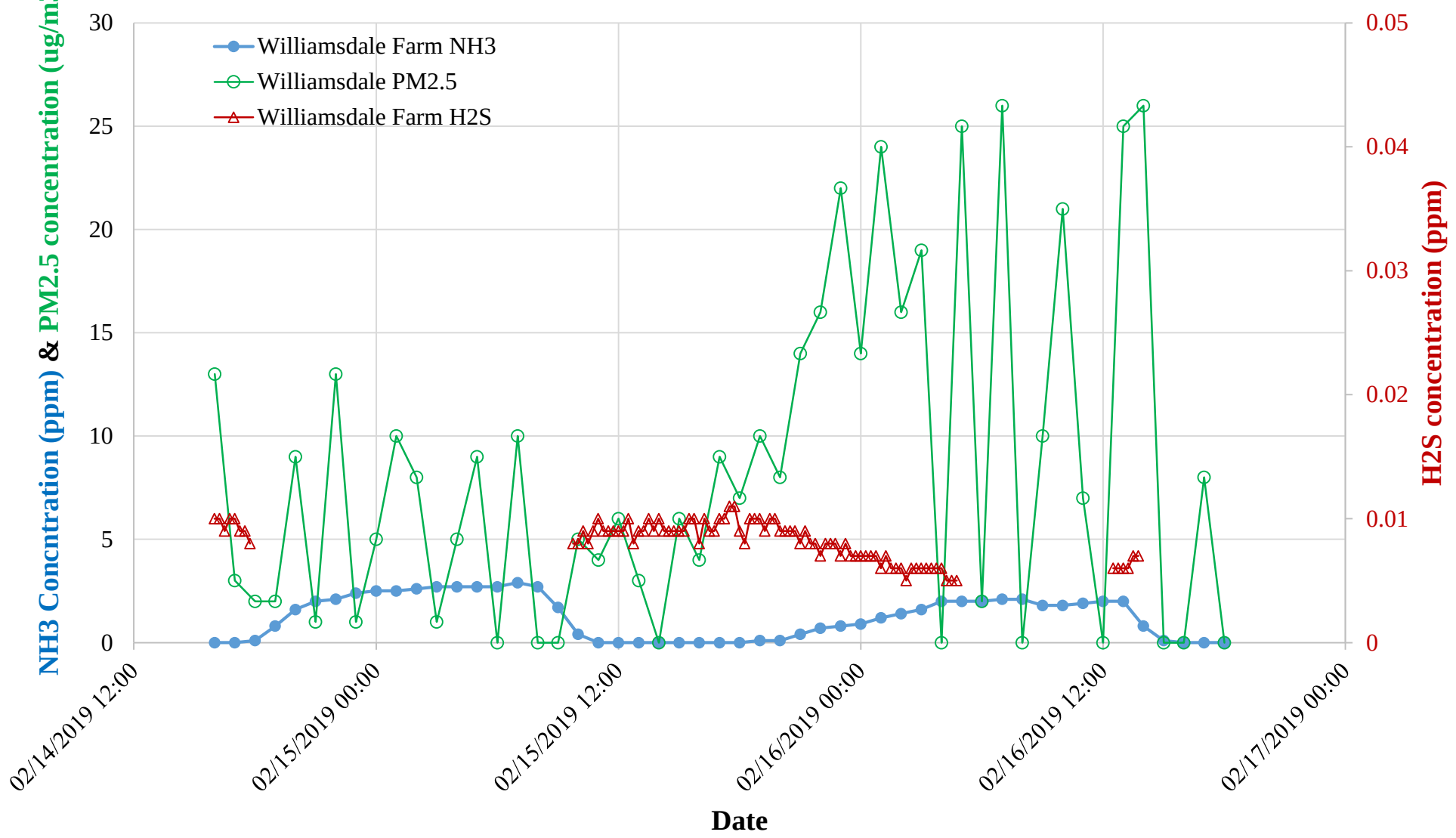


Figure 26.0 supports the supposition that this event is related to a source that has NH3 as its primary constituent such as agricultural activity related rather than a source that would contain all three pollutants. The figure shows that the increases and decreases in each pollutant is not mirrored in the same way by the other pollutants; thus indicating that the sources are not the same for each pollutant. And although H2S data are not complete during the entire event, this behavior is borne out where there are comparative values.

Figure 26.0 Williamsdale NH3, PM2.5 and H2S Concentrations February 14-16, 2019



5.0 Conclusion

After careful review of 15 months of data collected at neighborhood scale and comparison of the data to reference point values for the three pollutants of interest (PM2.5, H2S, and NH3), the Division of Air Quality finds that concentrations of these pollutants do not surpass those reference point values. While there were sporadic events as noted and discussed in this report, the results, in total, do not constitute a significant air quality issue in the study area for these pollutants. Therefore, DAQ does not intend to conduct additional air quality monitoring under the settlement agreement.

6.0 References

1. Title VI Settlement agreement (2018) https://files.nc.gov/ncdeq/documents/files/Final%20Settlement%20Agreement_attachments%20and%20sig.pdf

2. Title 40 - Protection of Environment, Chapter I - EPA Subchapter C – Air Programs, Part 58 – Ambient Air Quality Surveillance, Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

3. EPA Guidance for Network Design and Optimum Site Exposure for PM2.5 and PM10, EPA-454/R-99-022, December 1997.

4. Concise International Chemical Assessment Document 53, Hydrogen Sulfide: Human Health Aspects, World Health Organization (WHO), Dr. C.H. Selene J. Chou, Agency for Toxics Substances and Disease Registry (ATSDR) (2003)

5. OSHA H2S https://www.osha.gov/SLTC/hydrogensulfide/hazards.html

6. OSHA NH3 https://www.osha.gov/sites/default/files/2019-03/fs5-howsmelly.pdf

7. ATSDR Toxicological Profile for Ammonia, TP126 (2002)

7.0 Appendices

Appendix A Pertinent Air Quality Sections of the Settlement Agreement

Section IV: Air Monitoring

To determine the degree of air contamination and air pollution in and around Duplin County, North Carolina, and to ensure that residents have access to reliable information about air quality, DEQ agrees to design and implement a temporary ambient air quality study in partnership with REACH. DEQ and the Complainants agree to undertake the air monitoring activities outlined in the Air Quality Monitoring Agreement, attached as Exhibit B. At the conclusion of the 12-month study period, DEQ will determine on the basis of the data collected whether the study should be extended for an additional agreed upon time period. Additionally, at the conclusion of the 12-month study period, a draft report will be compiled by DAQ staff and provided to the interested parties for comment. A final version of the report will be posted to the DAQ website.

Exhibit B: Air Quality Monitoring Agreement

To determine the degree of air contamination and air pollution in and around Duplin County, North Carolina, and to ensure that local residents have access to reliable information about air quality, the North Carolina Department of Environmental Quality (DEQ) agrees to design and implement a temporary ambient air quality study in partnership with the Rural Empowerment Association for Community Help ("REACH"), according to the conditions set out below. In consultation with REACH, DEQ's Division of Air Quality ("DAQ") will conduct an ambient air quality study to evaluate whether ambient concentrations of particulate matter (PM2.5), hydrogen sulfide (H2S), and/or ammonia (NH3) may exceed relevant regulatory limits, published odor thresholds, or levels at the control site at the non-source oriented sites in and around Duplin County. In preparation for this study, DAQ in consultation with REACH and taking into account EPA siting criteria will determine the placement of a temporary fixed air monitoring site in or near Kenansville, North Carolina by May 15, 2018. This site will be within 1-2 miles of the previous Kenansville PM2.5 monitoring site. This is to provide continuity of data from the historical data to the current time period. This site will be equipped with instruments to monitor PM2.5, H2S, and NH3, as well as wind speed, wind direction, temperature, and relative humidity (the "Monitoring Equipment"). DAQ will begin to operate this monitoring equipment on or around June 1, 2018. The Monitoring Equipment will collect data 24 hours/day for at least 3 continuous months. DAQ will also establish a comparison site at the existing DAQ ambient monitoring site located in Candor, North Carolina. The comparison site will have instrumentation identical to the Monitoring Equipment and will collect data 24 hours/day during the same 3 continuous months as the Kenansville site. By June 30, 2018, DAQ and REACH will agree on at least 3 additional temporary fixed air monitoring sites in or near Duplin County, North Carolina. At least one of these sites will be operated on a continuous 12-month cycle to gather one year's data to account for seasonal variations in air quality and other factors. During this same 12-month period, monitoring at the remaining two sites will either occur at one site for the entire period or will be moved from one to the other to complete

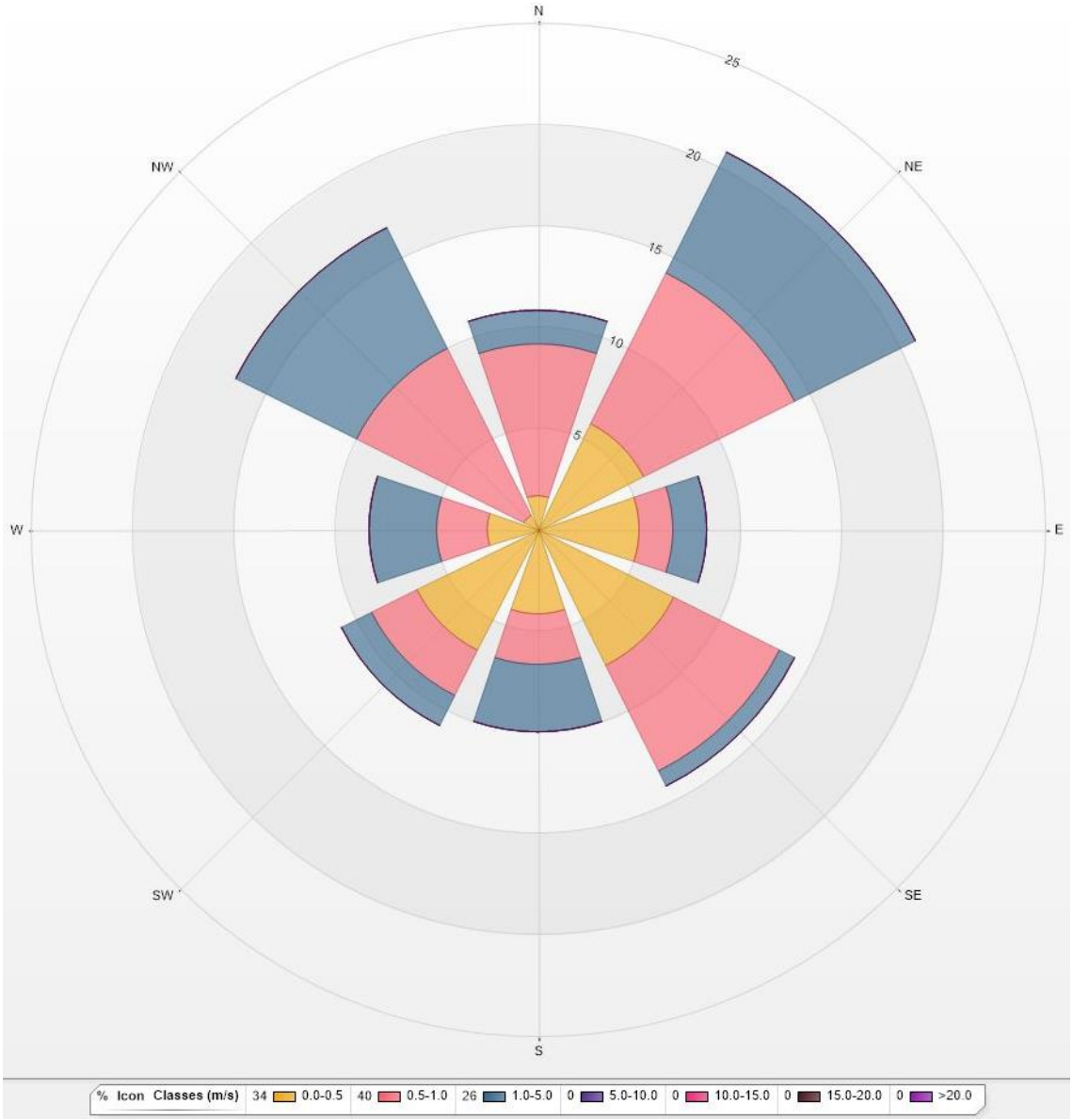
the balance of the 12-month monitoring period. Monitoring at these sites will begin by September 1, 2018. Note: There will be only two active monitoring sites during any period during the study given availability of equipment. DAQ and REACH will agree on a decision about whether to move the Monitoring Equipment based on the collected data DAQ reserves the option to remove instrumentation from any site if it is needed for another State air quality emergency such as a wildfire or chemical releases. In the event of such an emergency, DAQ will reestablish the Monitoring Equipment at the site from which it was removed within 2 weeks of the cessation of emergency monitoring requiring the use of the study instrumentation. The sites would be reestablished to complete the remaining time period for that site. Example: if an EBAM were removed from a site(s) for 4 weeks, upon returning it to operation at that site, it would remain for an additional 4 weeks from the original planned end date. Subject to the availability of DAQ resources, operation and logistics will be conducted by state personnel in accordance with established protocols. REACH will have access to each temporary fixed air monitoring site and the authority to conduct independent air monitoring, using REACH's equipment, at those sites. DAQ will provide REACH with written permission indicating this access and authority at least two weeks prior to beginning monitoring at these temporary fixed air monitoring sites. DAQ will make all data accessible to REACH and its partners and available to the public on the DAQ website. The schedule for data sharing will be dependent on the operational parameters of the instruments and the staffing required to collect the data. A tentative schedule will be determined in agreement with REACH prior to the beginning of monitoring. By October 15, 2019, DAQ will determine on the basis of the data collected whether the study should be extended for an additional agreed upon time period. By November 1, 2019, DAQ will release a draft report summarizing data from this study for public comment. A final report will be posted to the DAQ website by February 1, 2020. Provided that REACH's independent monitoring adheres to conditions to be established by DAQ and made available to REACH prior to REACH beginning data collection during the 12-month fixed air monitoring site study, DAQ will post REACH's independent community monitoring results report on the DAQ website after DAQ has the opportunity to review and comment.

Appendix B Wind Rose and Pollution Rose Descriptions

Wind Roses

In the wind rose below the circular format of the wind rose shows the direction the winds blew from and the length of each "sector" around the circle shows how often the wind blew from that direction. For example, the wind rose below shows that during this particular sampling period the wind blew from the northeast about 21% of the time, and from the northwest about 17% of the time. The different colors of each sector provide details on the speed (m/s) of the wind from each direction. Using the example below, the longest spoke shows the wind blew from the northeast at speeds between 0-0.5 m/s (yellow) about 6% of the time, 0.5-1.0 m/s (pink) about 8% of the time and 1-5 m/s (blue) about 7% of the time with the total being 21% as described above. The legend at the bottom shows the percentage of time that the wind speeds were at those speeds from all directions. In this example, the wind speed was 0-0.5m/s 34% of the time for the sampling period.

Figure 13.0 Wind Rose Williamsdale Site Aug 2-6, 2019



Pollutant Roses

In the pollutant rose below the circular format shows the direction the winds blew from and the length of each "sector" around the circle shows how often the pollutant came from that direction. For example, the PM2.5 rose below shows that during this particular sampling period the PM2.5 came from the northeast about 21% of the time, and from the northwest about 17% of the time. The different colors of each sector provide details on the concentration (ug/m3) of the pollutant from each direction. Using the example below, the longest spoke shows the PM2.5 came from the northeast at concentrations between 0-35 ug/m3 about 17% of the time, 35-70 ug/m3 (pink) about 1% of the time, 70-100 (blue) about 2% of the time, and 200-500 ug/m3 (dark pink) about 1% off the time with the total being 21% as described above. The legend at the bottom shows the percentage of time that the PM2.5 concentrations were at those concentrations from all directions. In this example, the PM2.5 concentration was 0-35 ug/m3 78% of the time for the sampling period.

Figure 14.0 PM2.5 Rose Williamsdale Site Aug 2-6, 2019