TETRA TECH

PARTICULATE AIR MONITORING DURING THE IMMEDIATE RESPONSE ACTION (FORMERLY RELEASE ABATEMENT MEASURE) BEING PERFORMED AT THE FORMER TEST RANGE BERM AREA AT THE FIREWORKS SITE

ROUND 2 – NOVEMBER 2017

1.0 OBJECTIVES AND PLANNING

1.1 BACKGROUND AND CURRENT OBJECTIVES

This document describes the planning and implementation of particulate sampling associated with the Immediate Response Action (IRA), formerly conducted as a Release Abatement Measure (RAM), being performed at the Former Test Range Berm Area (FTRBA) at the Fireworks Site (Site) (RTN #4-0090 Tier IA #100223). The RAM Plan describing the cleanup activities in the FTRBA was uploaded into eDEP on May 4, 2017. Particulate sampling was previously performed in August of 2017 during the activities of the RAM that generate particulates that could become airborne and disperse from their point of release, including the generation of particulates before and after munitions detonation shots. During the first round of sampling (i.e., Round 1), particulates generated at the Site were monitored for five consecutive workdays on August 8^{th} - 11^{th} and August 14^{th}. The results of this monitoring indicated that the controlled detonations performed at the FTRBA as part of the RAM were not creating unacceptable off-site air impacts as defined by the risk-based action levels. The report describing the first round of sampling and presenting the results was uploaded to eDEP on August 23, 2017.

The work described in the RAM Plan has since been rolled up into a comprehensive IRA Plan Modification designed to cover the full scope of munitions-related investigation and cleanup activities to be performed at the Site. This IRA Plan Modification was uploaded to eDEP on September 13, 2017 and approved by MassDEP on September 29, 2017. In response to the expanded scope of munitions-related work, the layout of the work area at the Site was reconfigured. This layout change included a change in location of the sifter unit (and the potential blow-in-place location), while the location where the items that are “safe to move” are destroyed (i.e., the Demolition Shot Area) has not changed. Given the new configuration of operations, a second round of particulate monitoring (i.e., Round 2) was performed to verify that the new work area layout is still not creating unacceptable off-site air impacts. The particulate air monitoring during Round 2 used the same methods and means as were described in the August 2017 monitoring report.

1.2 CURRENT CONDITIONS AT THE FORMER TEST RANGE BERM AREA

The FTRBA is located on a wooded hillside and is approximately 300 feet wide by 100 feet long along the berm face. Excavation of the berm to remove any unexploded ordnance (UXO) or material potentially presenting an explosive hazard (MPPEH) buried within it has produced large numbers of items requiring on-site destruction by controlled detonation (see Section 2.1 of the Particulate Sampling Plan attached as Appendix A). Additional munitions and explosives of concern (MEC) and MPPEH clearance activity in the Area in Front of the Berm (AIFB) and in the adjacent Open Space Disposal Area (OSDA) will follow immediately after the completion of the work at the FTRBA berm as sequenced in the IRA Plan Modification. Since continued detonations will be required for this sequence of clearance work, Round 2 of the particulate air monitoring was conducted to ensure that unacceptable off-site air impacts were not being created by the detonation operations being performed by the Massachusetts State Police Bomb Squad. To assess the levels of particulates generated from the new site layout, a particulate air monitoring plan for a second round of monitoring was designed to mimic the August 2017 monitoring plan. This second round of particulate monitoring was performed on November 9, 10, 14, 15, 17 and 20 of 2017. This memorandum presents the results of this second round of air monitoring.

1.3 PARTICULATES OF HUMAN HEALTH CONCERNS

Concentrations of Particulate Matter-2.5µm (PM2.5) and Particulate Matter-10µm (PM10) were monitored during six days of RAM activity (i.e., November 9, 10, 14, 15, 17 and 20 of 2017). Demolition shots occurred on November 9, 10 and 17. The most important measure of particulates in air from a public health inhalation perspective is the PM2.5. The particulates (expressed in units of $\mu g/m^3$) included in the PM2.5 metric are the respirable particulates (i.e., with diameters greater than 0.1 micron and less than 2.5 microns). This size range of particulates, once inhaled, are small enough not to be cleared from the upper airway by collision with the bronchia and removal to the stomach, and are large enough to not be immediately exhaled with the next breath. The PM10 concentration (also expressed in units of $\mu g/m^3$) is the concentration of all particulates that are 10 microns or less in diameter. This metric approximates the total particulates concentration. The PM2.5 and PM10 monitoring data can be used to evaluate potential risks and the potential dispersion of contaminant-laden particles.

1.4 DEVELOPMENT OF PARTICULATE ACTION LEVELS

Section 2.6 of the Particulate Sampling Plan (which is attached in Appendix A) details the development of particulate Action Levels (ALs) to be compared to the concentrations of PM2.5 and PM10 measured at the detonation area and at the Site boundary. The ALs were designed to take into consideration the U.S. Environmental Protection Agency (USEPA) National Ambient Air Quality Standards (NAAQS) for PM2.5 and PM10 and also the potential metals and explosives composition of the particulates that may be generated by the detonations (e.g., the constituents of potential concern associated with a munitions item or the donor charge explosives used to detonate the item). The Particulate Sampling Plan described the development of risk-based inhalation exposure concentrations reflecting the toxicities of the individual metal and explosive constituents indicated to be associated with the particulates potentially ejected from a demolition shot and identified relevant and appropriate ambient air target regulatory limits. The ALs were used to evaluate the particulate monitoring results and assess whether any potential public health concerns are being created during the cleanup activities being conducted. The ALs are identified in Table 2-1 of Appendix A. Table 2-1 also indicates the averaging period associated with each risk-based or regulatory threshold concentration. Typically the averaging period for each constituent was a 24-hour average, but in some cases it was an annual average. The selected ALs are being applied here to 8-hour time-weighted average PM2.5 and PM10 particulate concentration measurements. This approach to the analysis is very conservative (i.e., protective) since AL concentrations are generally higher as the averaging period/exposure period gets shorter.

2.0 IMPLEMENTATION

Particulate monitoring devices were placed at three locations on-site:

1) Within the Demolition Shot Area at the closest point outside the exclusion zone (EZ) in the predominant downwind direction (based on multiple days observations) at the time of the demolition shot – Demolition Shot Area Monitoring Point (see Figures 2-1 and 2-2);
2) At the Site property boundary path on the hill above the FTRBA just inside the fence on a line from the detonation point to the nearest homes in the Waterford residential development – Fence Line Boundary Monitoring Point – Waterford; and
3) At the old on-site perimeter service road just inside the fence on a line from the detonation point to the nearest homes in Hanson south of Lower Factory Pond – Fence Line Boundary Monitoring Point – Lower Factory Pond.

These particulate monitoring points are illustrated in Appendix A, Figure 2-1. The locations of the three monitoring devices were not changed over the course of a daily sampling event. It should be noted that particulate concentrations at any residential area resulting from the IRA activities would be expected to be significantly lower than those measured in the Demolition Shot Area or even at one of the Fence Line Boundary monitoring points due to additional dispersion that would occur with distance and mature tree stands and topography (i.e., significant changes in ground elevation) between the monitoring stations and actual residences.

As with Round 1 of particulate monitoring at the Site, concentrations of PM2.5 and PM10 were originally planned to be monitored at each of the three monitor locations continuously over the eight hours of activity during five consecutive workdays in which demolition shots occurred. However, due to periods of rainy weather, particulate monitoring could not be performed for five consecutive workdays. In addition, no demolition shots occurred during three workdays during the planned monitoring period when: (1) the new warning siren and pole were installed; and (2) the excavation and sifting did not uncover any MEC or MPPEH during that workday. A few particulate monitor unit errors also occurred during the planned monitoring period that prevented data from being collected during all or part of a workday at the location of the malfunctioning monitor. For Round 2 of the particulate monitoring, data from at least two of the three monitors were able to be collected on November 9, 10, 14, 15, 17 and 20 of 2017. Section 2.3 provides a more detailed description of each day during the planned particulate monitoring period.

2.1 PARTICULATE MONITORING INSTRUMENT

The particulate monitoring was performed using a set of three TSI DUSTTRAK DRX Desktop 8533 Dust/Aerosol Monitors (one positioned at each identified monitoring point). This is the same make and model unit as was used during Round 1 of particulate monitoring. The monitors simultaneously measured the PM2.5 and PM10 particulate concentrations in the air, and were capable of quantifying ambient particulate concentrations between 1-150,000 $\mu g/m^3$. The instruments positioned at each monitoring point were operated continuously, logging particulate data every ten seconds for approximately eight hours of Site activity. This monitoring period typically included one or no demolition shot and the intervals of excavation, screening/sifting, and on-site vehicular movement between events. The sampling instructions and operation protocol for this instrument are included in Attachment A to Appendix A.

Figure 2-1. Photograph of the Fence Line Boundary Monitoring Point – Waterford

Figure 2-2. Photograph of the Fence Line Boundary Monitoring Point – Lower Factory Pond

Figure 2-3. Photograph of the Demolition Shot Area Monitoring Point

Note: Steam is rising from the soil pile due to the low ambient air temperature and frost is visible on the debris pile

2.2 INSTRUMENT TESTING / PROVE-OUT

Three particulate monitoring instruments were received and charged overnight in preparation for instrument testing the following morning. Prior to initiating particulate monitoring, each instrument was tested to ensure that it operated as designed (i.e., could be calibrated, had clean filters, could be charged/hold a charge). Instruments that did not pass the instrument prove-out test were replaced. Only instruments that successfully operated during this prove-out were used for particulate monitoring. Instruments were programmed with the correct date and time.

The same model of particulate monitor was used during the November 2017 monitoring event as was used in the August 2017 monitoring event. During Round 1 of particulate sampling, a preliminary testing day was included where all three monitoring devices were set up and run for 6 hours collecting data every minute to allow the persons running the monitors to get familiar with them and to test the battery life of the machines and their ability to run continuously throughout the day. During Round 2 of particulate sampling, the field staff's familiarity with the instruments made another full day of preliminary testing unnecessary. After the initial prove-out, all three particulate monitors were set out to begin the testing described in Section 2.3. A successful first day of sampling was used as evidence that the air monitoring devices were working properly. A successful operation of an instrument included verification that ambient air data was collected for the entire test duration for each log interval.

2.3 PARTICULATE MONITORING

Particulate monitoring was initiated after the instrument prove-out. A single monitor was placed at each of the monitoring points described in Section 2.0 (see Figures 2-1 through 2-3). The monitors were placed atop a stable flat surface elevated off the ground approximately 12 to 18 inches. Before operating each instrument, the "Zero Cal" operation was performed as described in Attachment A to Appendix A. The "Zero Cal" operation is required for each monitor prior to recording data using a specific Zero Filter. Performing this operation ensures that the instrument did not have any remaining zero drift that could affect the results (i.e., any apparent light scatter inside the monitor that can be read by the photodetector is set as the baseline scatter above which particulate results can be recorded). The instruments were set to calibrate for "ambient air" (i.e., outdoor ambient dust and fugitive dust monitoring) as suggested by the instrument operation manual (see Appendix A, Attachment A). Each instrument was manually set for a total sampling duration of eight hours. The ambient air data was collected at ten second intervals. Particulate monitoring began on November 9, 2017 and ended on November 20, 2017. The sampling periods typically began between approximately 7:00:00 (7:00 AM) and 8:00:00 (8:00 AM) and ended between approximately 15:00:00 (3:00 PM) and 16:00:00 (4:00 PM). On each monitoring day, the three instruments were checked regularly to verify that they continued to function properly.

- On the first day of monitoring (i.e., Thursday November 9, 2017), all three monitors were deployed at the locations described in Section 2.1 (see Figures 2-1 through 2-3). During a routine monitor check mid-morning, the monitor located in the Demolition Shot Area was found displaying a filter error. The filter was checked and cleared of any residual particles and then replaced to the Demolition Shot Area. The monitor appeared to function properly for the remainder of the day. One demolition shot occurred at 15:13 (3:13 PM). However, particulate concentration data collected from the Demolition Shot Area monitor indicated that yet another filter error occurred during this time. The filter was checked again and a spider was discovered inside. The spider was cleared from the filter. As a result of these instrument errors, the data that was collected from the Demolition Shot Area was unusable for this day. The monitors located at the two Fence Line Boundary Monitoring Points successfully collected PM data without error.

- On Friday November 10, 2017, the two working monitors were deployed at the Fence Line Boundary Monitoring Points. In an attempt to troubleshoot the malfunctioning monitor, the instrument rental company was called and several steps were taken to repair the monitor. The monitor was then placed in the Demolition Shot Area in the early afternoon. One demolition shot occurred at 15:03 (3:03 PM). Upon collecting the monitors at the end of the day, this monitor was found to be displaying negative PM concentrations (which is physically impossible). As this monitor could not be fixed after several attempts to troubleshoot the filter error, it was necessary to replace the unit.

- On Monday November 13, 2017, a new monitor was delivered to replace the malfunctioning unit. However, due to rain throughout the day, no particulate air monitoring data could be collected on this day. The replacement monitor was charged for use the following day.

- On Tuesday November 14, 2017, all three monitors were deployed. No errors were indicated during PM data collection on this day. However, due to the unannounced installation of the warning siren in the work area, no detonations took place on this day.

- On Wednesday November 15, 2017, all three monitors were deployed. No errors were indicated during PM data collection on this day. However, no MEC or MPPEH was uncovered. Therefore, no detonations took place on this day.

- On Thursday November 16, 2017, no data was collected due to heavy rain throughout the day.

- On Friday November 17, 2017, all three monitors were deployed. No errors were indicated during PM data collection on this day. One detonation took place at 15:22 (3:22 PM).

- On Monday November 20, 2017, only two monitors were deployed. The “Zero Cal” function could not be performed on one of the units. The filter was replaced on this monitor, however the “Zero Cal” function was still unable to be performed. As this function must be performed on each device before running to ensure no background scatter is left in the machine, this monitor could not be deployed. The two working monitors were placed at the Fence Line Boundary Monitoring Point – Waterford and the Demolition Shot Area as the later area had the largest data gap due to the mechanical errors experienced at the beginning of the monitoring period. During the workday, no MEC or MPPEH was uncovered. Therefore, no detonations took place on this day.

The monitors were returned to the supplier on Tuesday November 21, 2017.

3.0 RESULTS

3.1 WEATHER

A summary of the daily weather at the Site on the Round 2 particulate monitoring days is presented in Table 3-1.

Table 3-1. Weather Conditions for the Round 2 Particulate Monitoring Period

Date	Cloud Cover	Temperature (Low/High) (°F)	Wind (Direction / Apparent Speed)
11/9/2017	Clear	28 / 51	No observable wind
11/10/2017	Cloudy	24 / 47	North, Northwest / Light
11/13/2017	Partly Cloudy	29 / 46	No observable wind
11/14/2017	Rainy	39 / 43	No observable wind
11/15/2017	Cloudy	28 / 45	No observable wind
11/16/2017	Rainy	29 / 50	No observable wind
11/17/2017	Clear	29 / 44	North, Northwest / Light
11/20/2017	Clear	33 / 41	Northwest / Light

3.2 ON-SITE PARTICULATE CONCENTRATIONS

The concentrations of PM2.5 and PM10 detected at each monitoring point for each day of sampling are presented in Figures 3-1 to 3-15. Variations in the on-site concentrations of PM2.5 and PM10 were typically found to track closely with one another. Table 3-2 below provides the summary statistics of the particulate monitoring results, such as: start times; end times; minimum concentrations; maximum concentrations; and time-weighted average (TWA) concentrations of PM2.5 and PM10. As particulate concentrations were monitored in ten second intervals, TWAs were used to interpret particulate averages over the length of the typical eight-hour workday (i.e., each data point was assumed to represent the concentration of particulates for 10 seconds).

Table 3-2. Summary of the Round 2 Particulate Air Monitoring Results by Day

Sampling Date: November 9, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	NA	NA	9	10	8	8
Minimum Conc. (ug/m^3)	NA	NA	4	4	4	4
Time of Minimum Conc.	NA	NA	11:14:28	11:16:08	11:15:04	11:15:44
Maximum Conc. (ug/m^3)	NA	NA	46	49	22	23
Time of Maximum Conc.	NA	NA	7:23:38	7:23:38	8:04:14	8:03:24
TWA (8-hour) Conc. (ug/m^3)	NA	NA	**9**	**10**	**8**	**8**
Monitoring Start Time:	NA	NA	7:23:38	7:23:38	7:45:44	7:45:44
Monitoring End Time:	NA	NA	15:45:48	15:45:48	15:50:44	15:50:44
Number of Detonations:	1	1	1	1	1	1
Detonation Time (instrument):	15:13:00	15:13:00	15:13:00	15:13:00	15:13:00	15:13:00
Sampling Date: November 10, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	NA	NA	3	4	4	4
Minimum Conc. (ug/m^3)	NA	NA	1	1	3	3
Time of Minimum Conc.	NA	NA	9:10:02	9:14:22	8:11:34	8:19:54
Maximum Conc. (ug/m^3)	NA	NA	60	69	42	44
Time of Maximum Conc.	NA	NA	14:48:12	14:21:52	15:10:54	15:10:54
TWA (8hr) Conc. (ug/m^3)	NA	NA	**3**	**4**	**4**	**4**
Monitoring Start Time:	NA	NA	8:06:02	8:06:02	8:11:34	8:11:34
Monitoring End Time:	NA	NA	16:14:22	16:14:22	16:17:14	16:17:14
Number of Detonations:	1	1	1	1	1	1
Detonation Time (instrument):	15:03:00	15:03:00	15:03:00	15:03:00	15:03:00	15:03:00

Sampling Date: November 14, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	Could Not Be Calculated	Could Not Be Calculated	11	13	19	21
Minimum Conc. (ug/m^3)	5	5	4	5	9	10
Time of Minimum Conc.	14:49:04	14:54:24	14:23:04	14:20:44	14:37:46	14:37:46
Maximum Conc. (ug/m^3)	81	89	31	32	64	69
Time of Maximum Conc.	12:14:30	10:57:48	12:13:14	12:13:14	13:25:06	13:25:06
TWA (8-hour) Conc. (ug/m^3)	Could Not Be Calculated	Could Not Be Calculated	**11**	**13**	**19**	**21**
Monitoring Start Time:	6:54:08	6:54:08	7:12:24	7:12:24	7:01:36	7:01:36
Monitoring End Time:	15:04:54	15:04:54	15:13:04	15:13:04	15:10:26	15:10:26
Number of Detonations:	0	0	0	0	0	0
Detonation Time (instrument):	NA	NA	NA	NA	NA	NA

Sampling Date: November 15, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	8	10	8	9	12	13
Minimum Conc. (ug/m^3)	3	3	5	5	8	8
Time of Minimum Conc.	11:16:40	11:16:40	13:41:57	13:51:17	9:01:59	9:01:59
Maximum Conc. (ug/m^3)	61	68	53	68	86	89
Time of Maximum Conc.	14:09:50	14:09:50	9:19:17	9:19:17	11:13:09	11:13:09
TWA (8hr) Conc. (ug/m^3)	**7**	**9**	**7**	**8**	**11**	**12**
Monitoring Start Time:	9:08:10	9:08:10	8:56:27	8:56:27	9:01:59	9:01:59
Monitoring End Time:	16:33:20	16:33:20	16:26:57	16:26:57	16:29:49	16:29:49
Number of Detonations:	0	0	0	0	0	0
Detonation Time (instrument):	NA	NA	NA	NA	NA	NA

Sampling Date: November 17, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	6	6	2	3	2	2
Minimum Conc. (ug/m^3)	2	2	1	1	0	0
Time of Minimum Conc.	6:52:34	6:52:34	7:05:44	7:05:44	12:42:34	12:42:34
Maximum Conc. (ug/m^3)	623	648	93	96	8	9
Time of Maximum Conc.	10:18:34	10:18:34	9:10:14	9:10:14	12:58:04	12:58:04
TWA (8-hour) Conc. (ug/m^3)	**6**	**6**	**2**	**3**	**2**	**2**
Monitoring Start Time:	6:52:34	6:52:34	7:05:44	7:05:44	6:59:04	6:59:04
Monitoring End Time:	15:44:44	15:44:44	15:52:34	15:52:34	15:48:34	15:48:34
Number of Detonations:	1	1	1	1	1	1
Detonation Time (instrument):	15:22:00	15:22:00	15:22:00	15:22:00	15:22:00	15:22:00

Sampling Date: November 20, 2017						
Concentration / Time	**Demolition Shot Area Monitoring Point**		**Fence Line Boundary Monitoring Point – Waterford**		**Fence Line Boundary Monitoring Point – Lower Factory Pond**	
	PM2.5 (AL = 35)	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**	**PM2.5 (AL = 35)**	**PM10 (AL = 94)**
Average Conc. (ug/m^3)	2	2	3	3	NA	NA
Minimum Conc. (ug/m^3)	0	0	1	1	NA	NA
Time of Minimum Conc.	10:22:44	10:23:54	8:35:21	8:35:21	NA	NA
Maximum Conc. (ug/m^3)	17	17	35	38	NA	NA
Time of Maximum Conc.	11:38:24	11:38:24	9:56:51	9:56:51	NA	NA
TWA (8hr) Conc. (ug/m^3)	**2**	**2**	**3**	**3**	NA	NA
Monitoring Start Time:	7:49:24	7:49:24	7:58:41	7:58:41	NA	NA
Monitoring End Time:	15:50:44	15:50:44	15:58:41	15:58:41	NA	NA
Number of Detonations:	0	0	0	0	0	0
Detonation Time (instrument):	NA	NA	NA	NA	NA	NA

Note: NA = Not available

To determine whether the overall on-site particulate concentrations could have a potential effect on public health, the eight-hour TWA PM2.5 and PM10 concentrations were calculated and compared to the identified ALs. These ALs, as was noted, were developed in consideration of the NAAQS based on 24-hour exposures or risk-based concentrations based on longer (annual) continuous exposures. This comparison conservatively assumes that particulate concentrations generated during the cleanup activities (and the estimated eight-hour TWA) are representative of the potential exposure for a 24-hour period. As the on-site cleanup activities do not typically continue past eight-hours, the 24-hour TWAs for PM2.5 and PM10 would be conservative benchmarks for evaluating the particulate measurements over 8 hours since they implicitly assume a three times longer exposure period.

In addition, since the risk-based AL value calculated for the potential cobalt presence in the detonation cover material was less that the PM10 NAAQS value of 150 $\mu g/m^3$, a more stringent PM10 AL of 94 $\mu g/m^3$ based on an 8-hour average was adopted to be protective of the potential constituents of the particulates for the comparisons for PM10. Furthermore, this PM10 AL is very conservative relative to potential inhalation exposures during these detonation activities since it is based on long-term chronic exposure over a longer exposure duration.

The TWA 8-hour average concentrations calculated for each day are shown in bold in Table 3-2:

- There were no exceedances of the TWA AL for PM2.5 of 35 ug/m^3 for any of the six monitoring days (i.e., the maximum TWA for PM2.5 was 19 ug/m^3 at the Fence Line Boundary Monitoring Point – Lower Factory Pond on November 14, 2017).
- The calculated TWAs for PM2.5 were typically highest at the Fence Line Boundary Monitoring Point – Lower Factory Pond during the Round 2 monitoring period. There was no clear trend for which monitoring location had the lowest TWAs for PM2.5 (i.e., between the Fence Line Boundary Monitoring Point – Waterford and the Demolition Shot Area Monitoring Point) for each day of monitoring. As was noted above, no Demolition Shot Area data were available for the first two monitoring days due to instrument error and no Fence Line Boundary Monitoring Point – Lower Factory Pond data were available for the last monitoring day due to instrument error.
- There were no exceedances of the TWA AL for PM10 of 94 ug/m^3 for any of the six monitoring days (i.e., the maximum TWA for PM10 was 21 ug/m^3 at the Fence Line Boundary Monitoring Point – Lower Factory Pond on November 14, 2017).
- The calculated TWAs for PM10 also were typically highest at the Fence Line Boundary Monitoring Point – Lower Factory Pond during the Round 2 monitoring period. There was no clear trend for which monitoring location had the lowest TWAs for PM10 (i.e., between the Fence Line Boundary Monitoring Point – Waterford and the Demolition Shot Area Monitoring Point) for each day of monitoring. Again, no Demolition Shot Area data were available for the first two monitoring days due to instrument error and no Fence Line Boundary Monitoring Point – Lower Factory Pond data were available for the last monitoring day due to instrument error.

- Although the calculated TWA concentrations for each monitoring day were below the ALs, there were very brief exceedances of individual concentrations of PM2.5 and PM10 of the PM2.5 and PM10 ALs measured sporadically throughout the days. However, these elevated instances of particulate concentration typically did not last longer than 10 seconds (or one data collection time interval).

3.3 INTERPRETATION OF DAILY TIME TRENDS ON-SITE

Due to particulate monitoring unit errors and rain, particulate data from the Demolition Shot Area were only collected four out of the six days of the monitoring period. Of these four data collection days, only one detonation took place on November 17. Results from this second round of particulate monitoring at the Demolition Shot Area show that concentrations of PM2.5 and PM10 were relatively low throughout the day with instantaneous concentration increases (i.e., concentration increases only lasting for 10 seconds, or for one data collection interval) that appear to occur as a result of work activities other than detonations throughout the day. On November 14, no large instantaneous concentration increases were seen until around 11:00:00 (11:00 AM) when a member of the field staff performed a check-up on the instruments. Additional instantaneous concentration increases throughout the remainder of that afternoon appear to be the result of the installation of the warning siren on-site. On November 15 and 20, instantaneous concentration increases were seen during the mid-morning time period. These increases may be due to the arrival of the on-site workers in their vehicles, the commencement of the cleanup activities, and the foot traffic of the person checking the monitor. On November 17 (the only day a detonation took place and Demolition Shot Area data were available), the largest instantaneous concentration increase was seen in this mid-morning (i.e., prior to the detonation). This increase may be the result of workday activities or the foot traffic of the person checking the monitor. A small concentration increase was recorded before the detonation that was probably due to the detonation set-up and preparation activity. No concentration increase was reported during or after the detonation. Almost all elevated increases in particulate concentrations above the ALs were of very short duration and did not last longer than about 30 seconds. The calculated eight-hour TWA for PM2.5 did not exceed the PM2.5 AL of 35 ug/m^3 on any of the four monitoring days with available Demolition Shot Area data. Likewise, the calculated eight-hour TWA for PM10 did not exceed the PM10 AL of 94 ug/m^3 on any of the four monitoring days.

Particulate data were available from the Fence Line Boundary Monitoring Point – Waterford for all six days of the monitoring period. Of the six days of monitoring at the Waterford location, a detonation occurred during three of the days (i.e., on November 9, 10 and 17). The results typically show slightly higher levels of particulate concentrations in the morning (e.g., between the hours of 8:00 AM and 11:00 AM, before the detonations), lower levels mid-day, and occasional short duration concentration peaks in the afternoon (with the exception of November 10, which had lower particulate levels in the morning and slightly higher particulate levels in the middle of the day throughout the afternoon). The calculated eight-hour TWA for PM2.5 did not exceed the PM2.5 AL of 35 ug/m^3 on any of the five monitoring days with available data. Likewise, the calculated eight-hour TWA for PM10 did not exceed the PM10 AL of 94 ug/m^3 on any of the five monitoring days. The Fence Line Boundary Monitoring Point – Waterford results were compared to the Demolition Shot Area results to evaluate the possibility that on-site activities were producing elevated levels of particulates at this sampling point (please note that Demolition Shot Area data was not available on November 9 or 10). On November 14, 15, 17, and 20, the PM2.5 and PM10 concentrations at the Fence Line Boundary Monitoring Point – Waterford appear to follow the same general trends throughout the day as at the Demolition Shot Area Monitoring Point, however several instantaneous concentration increases seen at the Fence Line Boundary Monitoring Point – Waterford were not also observed at the Demolition Shot Area, and vice versa. Most of the instantaneous increases in the PM2.5 and PM10 concentrations at the Fence Line Boundary Monitoring Point – Waterford were relatively low (i.e., below 70 ug/m^3) with the exception of one spike on November 17 where PM2.5 reached 93 ug/m^3 (which was above the PM2.5 AL of 35 ug/m^3) and PM10 reached 96 ug/m^3 (slightly above the PM10 AL of 94 ug/m^3). These increases at the Fence Line Boundary Monitoring Point – Waterford may be due to off-site industrial, vehicular activities, or to the foot traffic of the person monitoring the particulate monitoring device (which happened periodically throughout the day). Instantaneous increases in particulate concentrations at the Fence Line Boundary Monitoring Point – Waterford were typically lower than the instantaneous concentration increases reported at the Demolition Shot Area. On the days that included a detonation (i.e., November 9, 10 and 17), increases in particulate levels were seen either before (i.e., November 10) or after (i.e., November 17) the time of detonation. These spikes may be due to vehicle traffic before and after the detonation as well as the detonation set-up activity. No rapid increases in particulate concentrations were reported on November 9. Again, it should be noted that particulate concentrations at the Waterford residential area due to the cleanup activities would be expected to be significantly lower that the concentrations measured in the Demolition Shot Area or the Fence Line Boundary Monitoring Point – Waterford due to the tree-covered intervening hill which would be a barrier to particulate dispersion.

Results from the Fence Line Boundary Monitoring Point – Lower Factory Pond were available for five out of the six monitoring days. No data was available for November 20 due to a malfunctioning monitor. On that day, the two working monitoring units were set up at the two alternate monitoring locations in an attempt to collect data from the Fence Line Boundary Monitoring Point – Waterford as this area is located in closer proximity to a residential area than is the Lower Factory Pond Monitoring location. The second properly functioning monitor was placed at the Demolition Shot Area on this day to fill data gaps caused by the malfunctioning monitors. These results also show that, in general, there were slightly higher concentrations of particulate concentrations in the morning (e.g., between the hours of 8:00 AM and 11:00 AM, before detonations), relatively lower concentrations mid-day, and sometimes slightly higher concentrations in the afternoon (with the exception of November 10 and 17 where there were not elevated PM concentrations recorded during the mornings). Of the five days of monitoring at the Lower Factory Pond location, a detonation occurred on three of the days (i.e., on November 9, 10 and 17). Small instantaneous increases in particulate levels appear to potentially coincide with activities taking place at the

Demolition Shot Area. However, many of the larger concentration increases seen throughout each day at the Demolition Shot Area are not also seen at the Fence Line Boundary Monitoring Point – Lower Factory Pond monitoring point and vice versa. Increases in particulate levels throughout the day at the Fence Line Boundary Monitoring Point – Lower Factory Pond were possibly the result of the activities of the person regularly checking on the monitoring device. On days including detonations, an increase in particulate concentrations was only seen on November 10 minutes after the time of detonation. This area is near Lower Factory Pond, which is secured before a detonation by the local Town of Hanover Fire Department detail. Firemen patrolling the area at this time may have kicked up dry dirt in the area of the instrument during this site security assurance activity which may have caused the instantaneous increase in PM concentrations. No increases in particulate concentrations were recorded immediately before or after the detonation on November 9 or 17. The calculated eight-hour PM2.5 TWA did not exceed the PM2.5 AL of 35 ug/m^3 on any of the six monitoring days at the Fence Line Boundary Monitoring Point – Lower Factory Pond. Likewise, the calculated eight-hour PM10 TWA did not exceed the PM10 AL of 94 ug/m^3 on any of the six monitoring days.

These general daily trends were further assessed by graphically comparing concentrations of PM2.5 and PM10 along a time series for all three sampling locations. These comparisons are presented in Figures 3-16 to 3-27. The comparisons support the conclusion that the PM2.5 and PM10 concentrations at each monitoring point generally follow the same daily pattern. The changes in the Fence Line Boundary Monitoring Point – Waterford data tend to more closely track the changes in the particulate concentrations seen in the Demolition Shot Area data than the changes in the Fence Line Boundary Monitoring Point – Lower Factory Pond data for most of the monitoring days. On November 17, this trend does not appear to be evident as the PM concentrations in the Demolition Shot Area data are generally higher than PM concentrations recorded at the Fence Line Boundary Monitoring Point – Waterford (see Figures 3-24 and 3-25).).

3.4 SUMMARY OF ADDITIONAL AIR MONITORING

A second round of particulate air monitoring was conducted to determine whether unacceptable off-site air impacts were being created by the detonation operations being performed by the Massachusetts State Police Bomb Squad to destroy MEC or MPPEH items recovered during the excavation and sifting operations after the reconfiguration of the Site layout. This second round of particulate monitoring began on November 9, 2017 and ended on November 20, 2017. Particulate monitoring instruments were positioned at three different monitoring points: the Demolition Shot Area, the Fence Line Boundary Monitoring Point – Waterford and the Fence Line Boundary Monitoring Point – Lower Factory Pond. Monitors were operated continuously, recording particulate concentrations every ten seconds during the typical eight hour period of on-site cleanup activity. This monitoring period included the one or no daily demolition shots that occurred and the intervals of excavation, screening/sifting, and on-site vehicular movement that occurred before and after the shots.

The results of the Round 2 particulate monitoring are summarized as follows:

- There were no TWA exceedances of the PM2.5 AL on any of the six monitoring days at any monitoring location.
- There were no TWA exceedances of the PM10 AL on any of the six monitoring days at any monitoring location.
- TWAs for PM2.5 and PM.10 were typically lower for this second round of particulate sampling than during the August 2017 monitoring round. This is likely due to several factors, including a change to the on-site vehicle traffic pattern and the colder and wetter weather. In August 2017, the on-site workers and public safety personnel parked their vehicles in the Demolition Shot Area and then moved their vehicles just before the detonations. This vehicle movement kicked up soil and particles from the ground in this area. After the reconfiguration of the Site layout, the on-site workers and public safety personnel now park their vehicles at the entrance to the Site near the new Field Office Trailer location. The Demolition Shot Area had visibly less suspended dust/particles during the second round of monitoring. Additionally, the Site was dry and warm during the August monitoring event. These conditions allowed for soil and particles on the ground to dry out and become more easily entrained into the air during disturbances such as vehicle traffic. In contrast, the Site was cold and damp from frost cover and melt during the November monitoring event (see Figure 2-3). These conditions helped to mitigate the amount of dust and particulates generated at the Site from sources other than the detonation shots.
- Elevated particulate concentrations were typically highest at the Fence Line Boundary Monitoring Point – Lower Factory Pond. However, the largest instantaneous increases in concentration were not typically coincident with the detonation times (when detonations occurred on monitoring days). Increases in particulate concentrations in this area were typically seen between early morning and mid-day and are probably due to off-site industrial activity, vehicular traffic in the neighborhood, or to the foot traffic of the person checking the particulate monitoring device. At the time of the daily detonations, large increases in particulate concentrations were not recorded at this sampling point except on November 10 when an increase was seen minutes after the detonation. This increase is indicated to be due to the foot traffic of the person checking on the monitoring device or the firefighters securing and patrolling the area before a detonation
- In general, increases in particulate concentrations recorded at the Fence Line Boundary Monitoring Point – Waterford were typically seen between early morning and mid-day and were probably due to off-site industrial or vehicular activities or to the foot traffic of the person checking the monitoring device. On November 10, two relatively large instantaneous increases in concentration were seen before the detonation. This may be due to the foot traffic of the person checking the monitoring device or off-site vehicular traffic. It did not appear that the larger particulate concentration increases recorded at the Fence

Line Boundary Monitoring Point – Waterford correlated with those seen at the Demolition Shot Area.

- The only day for which data was available for the Demolition Shot Area when a detonation occurred was November 17. The largest instantaneous concentration increase on that day occurred mid-morning. No instantaneous increase was seen after the detonation. On November 14, the largest instantaneous increase occurred while the person checking the monitor was doing maintenance on the unit's filter. As with the other two monitors, PM concentrations were typically slightly higher between early mornings and mid-day. The instantaneous particulate concentration increases recorded at this location are indicated to be the result of the foot traffic of the person checking the particulate monitoring device and the cleanup activities.

- It should again be noted that particulate concentrations at any residential property resulting from on-site cleanup activities would be expected to be significantly lower than particulate concentrations measured in the Demolition Shot Area or at one of the Fence Line Boundary monitoring points. This is due to the fact that further dispersion and deposition of particulates occurs between the monitoring points and the residential properties. At this Site, the change in topography (i.e., the hill) and the trees are expected to be very effective barriers to further particulate transport.

Based on this additional particulate monitoring, the detonation activities being performed at the Site as part of the cleanup activities are not creating unacceptable off-site air impacts.

FIGURES

FIGURES (continued)

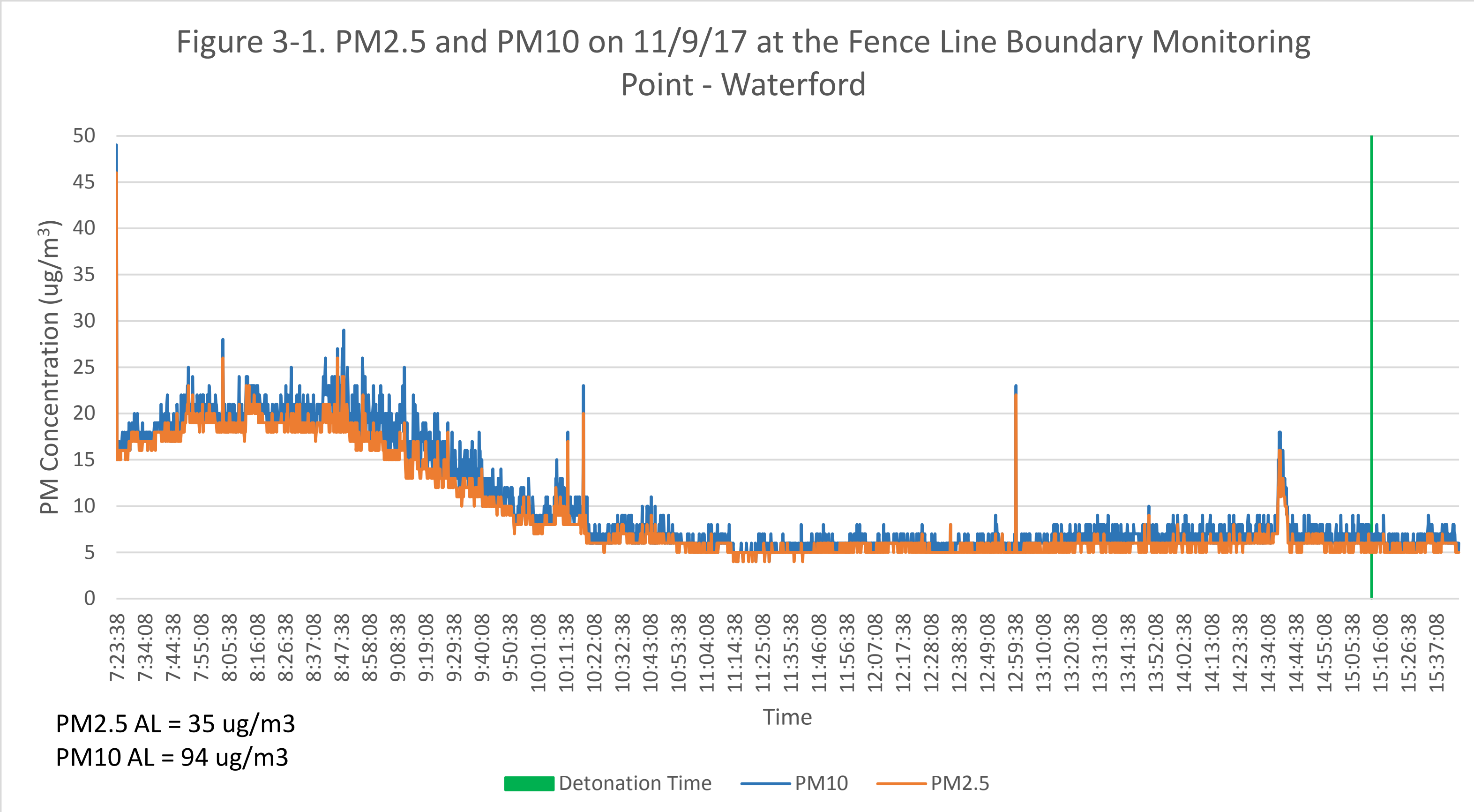
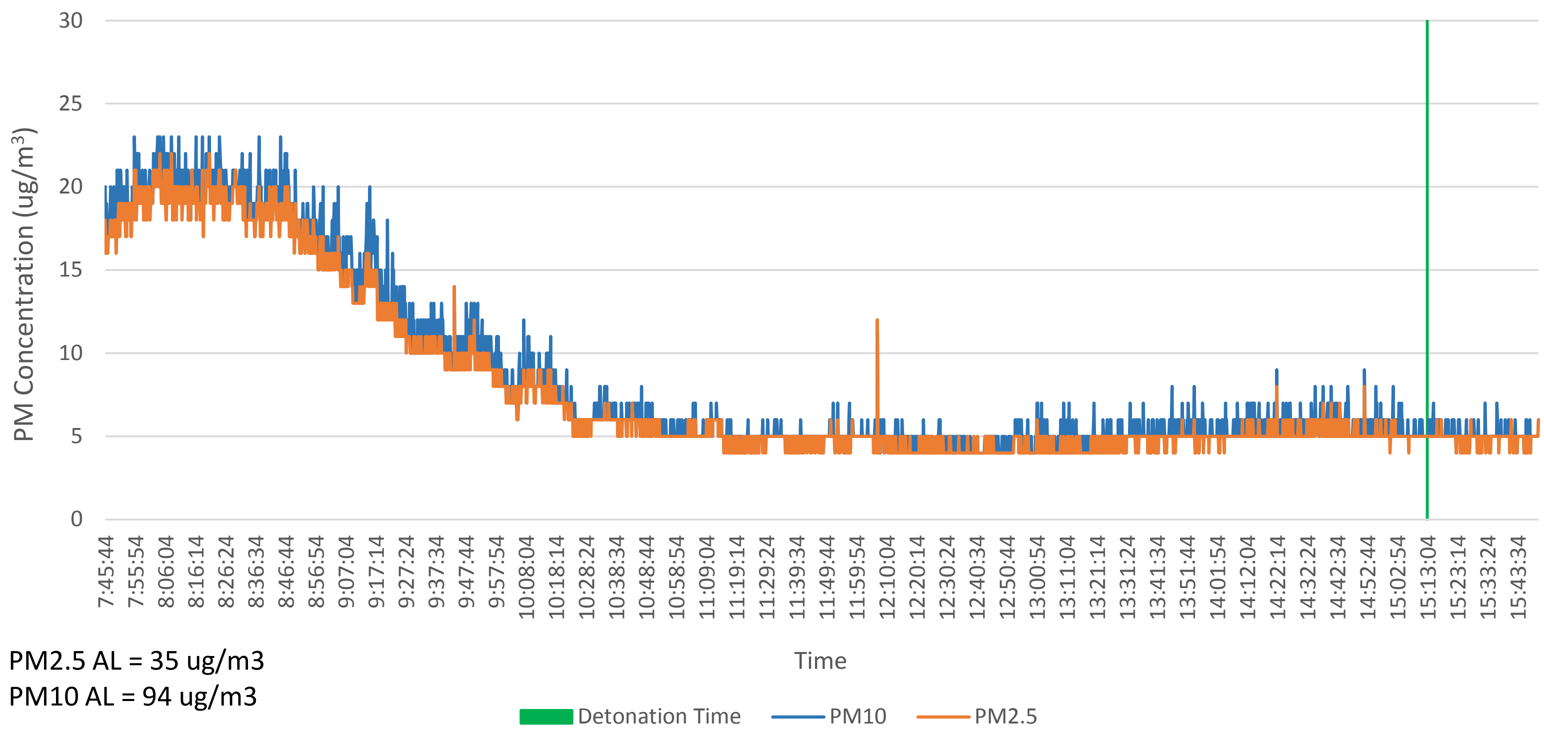
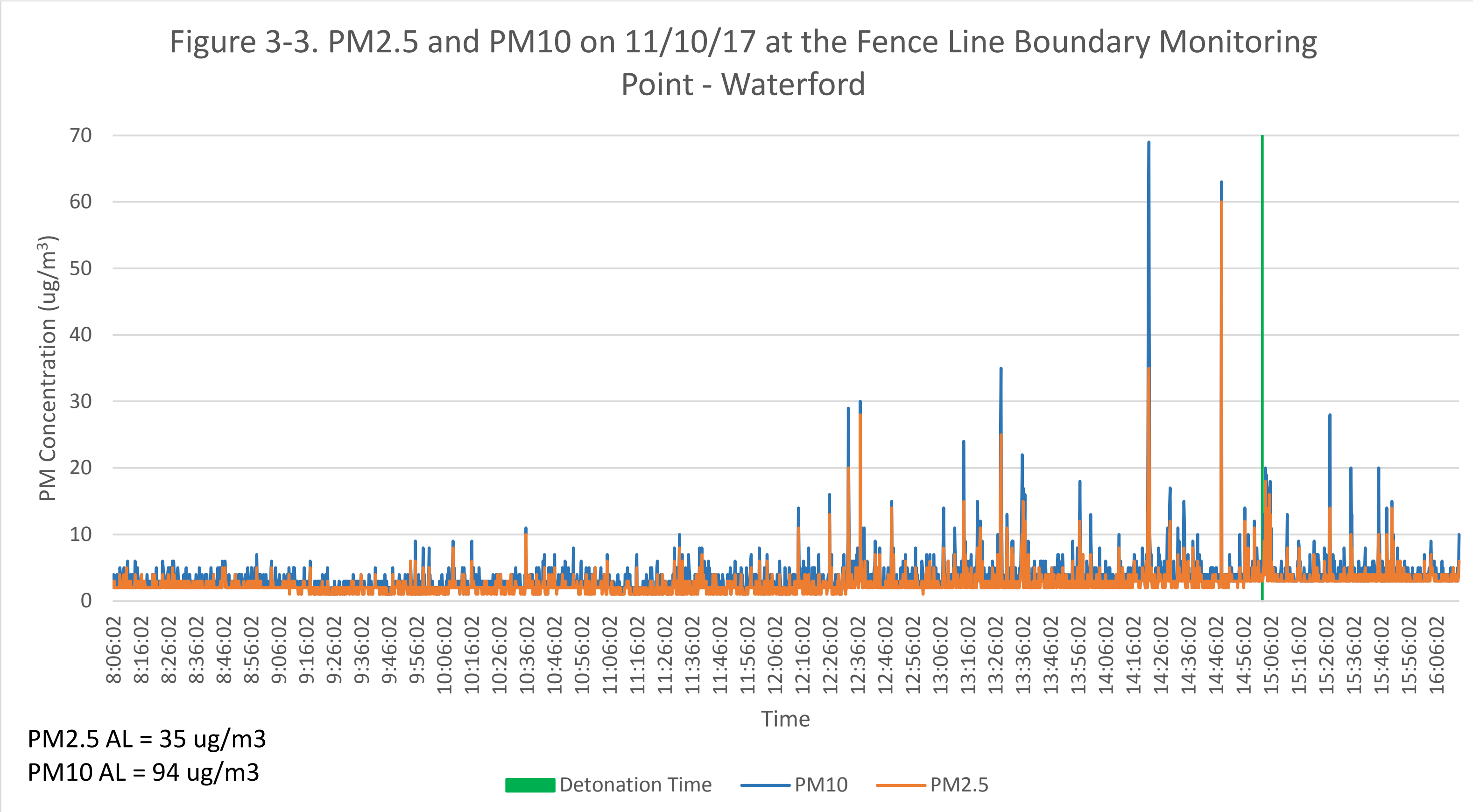


Figure 3-1. PM2.5 and PM10 on 11/9/17 at the Fence Line Boundary Monitoring Point - Waterford
PM Concentration (ug/m³)
50
45
40
35
30
25
20
15
10
5
0
7:23:38
7:34:08
7:44:38
7:55:08
8:05:38
8:16:08
8:26:38
8:37:08
8:47:38
8:58:08
9:08:38
9:19:08
9:29:38
9:40:08
9:50:38
10:01:08
10:11:38
10:22:08
10:32:38
10:43:08
10:53:38
11:04:08
11:14:38
11:25:08
11:35:38
11:46:08
11:56:38
12:07:08
12:17:38
12:28:08
12:38:38
12:49:08
12:59:38
13:10:08
13:20:38
13:31:08
13:41:38
13:52:08
14:02:38
14:13:08
14:23:38
14:34:08
14:44:38
14:55:08
15:05:38
15:16:08
15:26:38
15:37:08
Time
PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3
Detonation Time
PM10
PM2.5

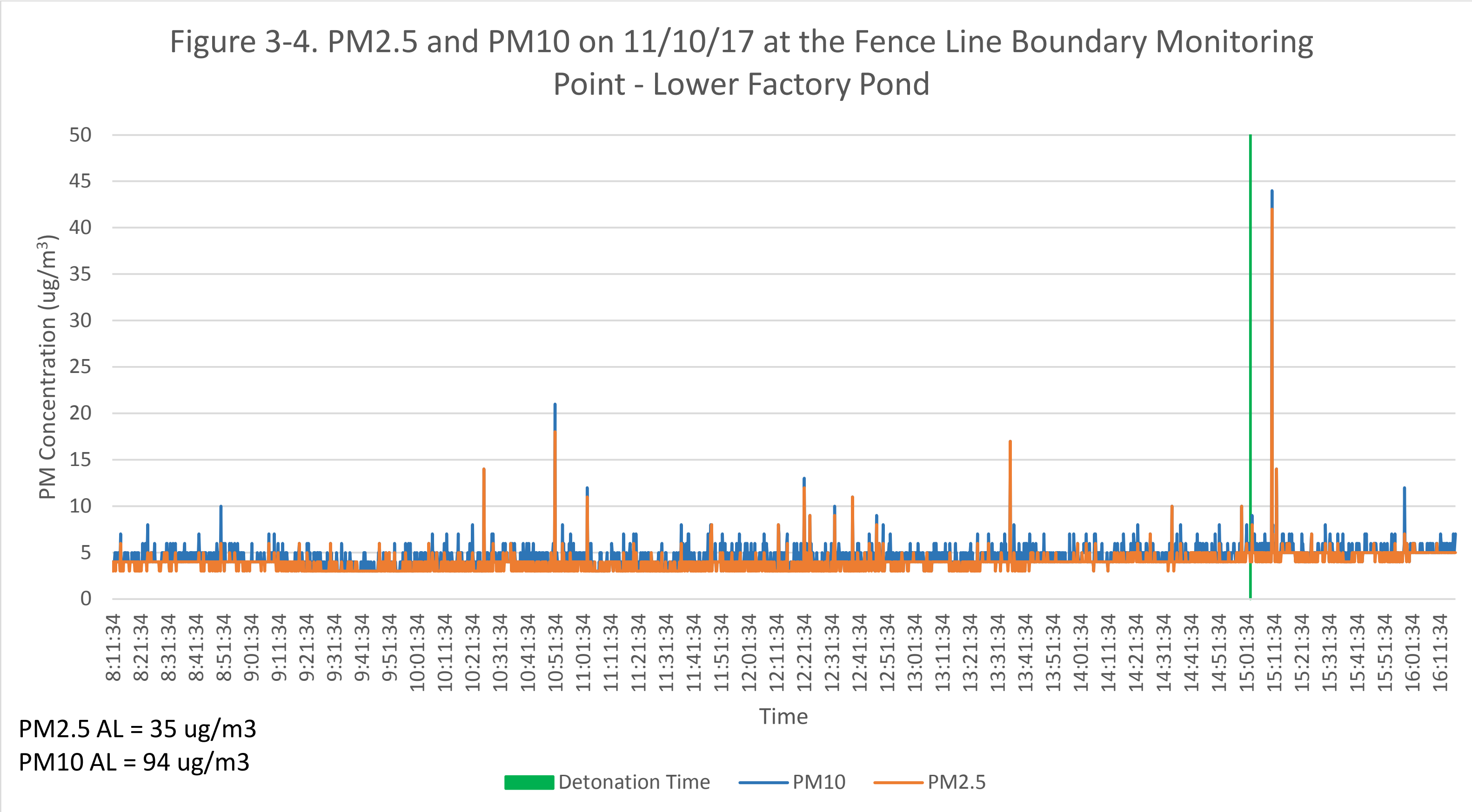
Figure 3-2. PM2.5 and PM10 on 11/9/17 at the Fence Line Boundary Monitoring Point - Lower Factory Pond





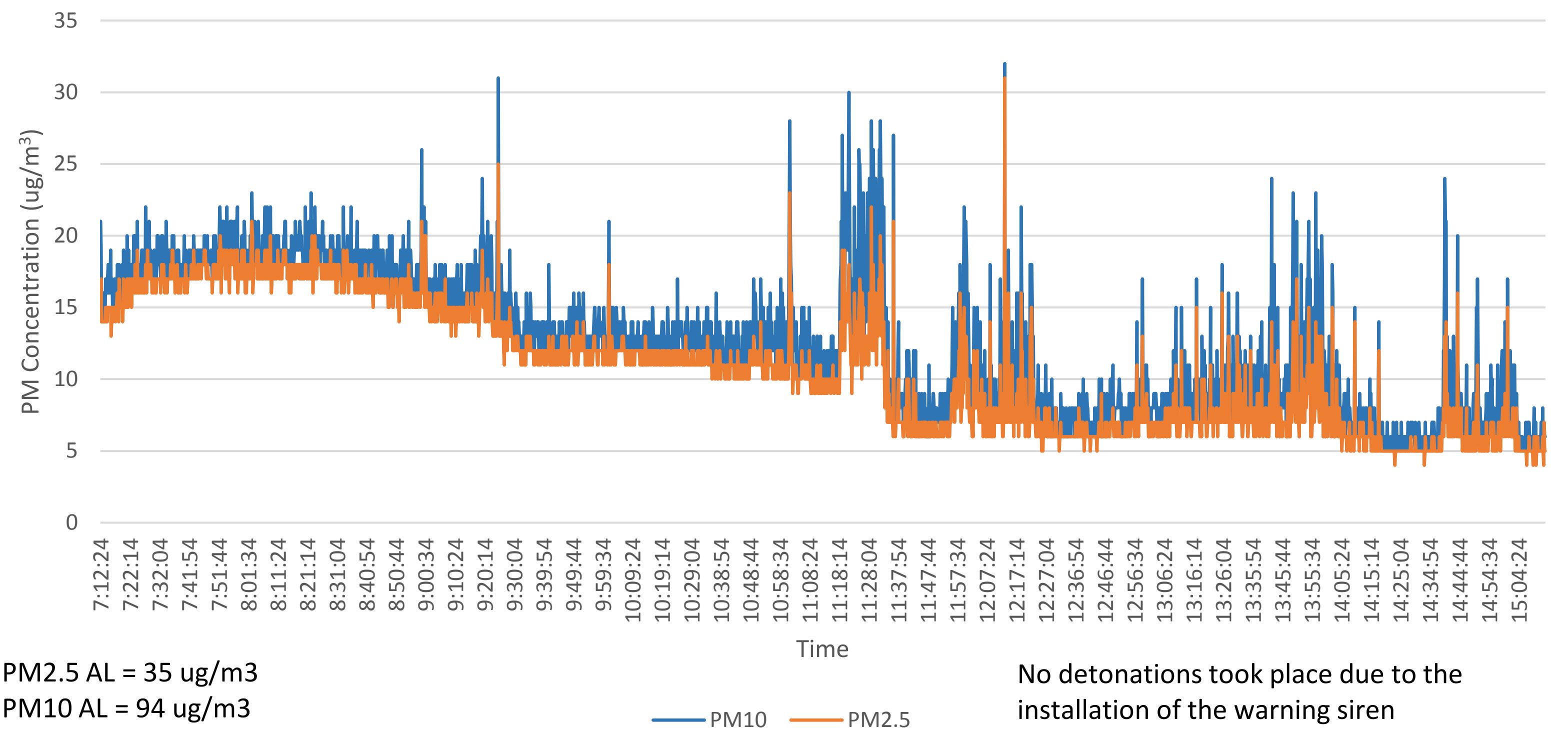
PM2.5 AL = 35 ug/m3

PM10 AL = 94 ug/m3



PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3

Figure 3-5. PM2.5 and PM10 on 11/14/17 at the Fence Line Boundary Monitoring Point - Waterford



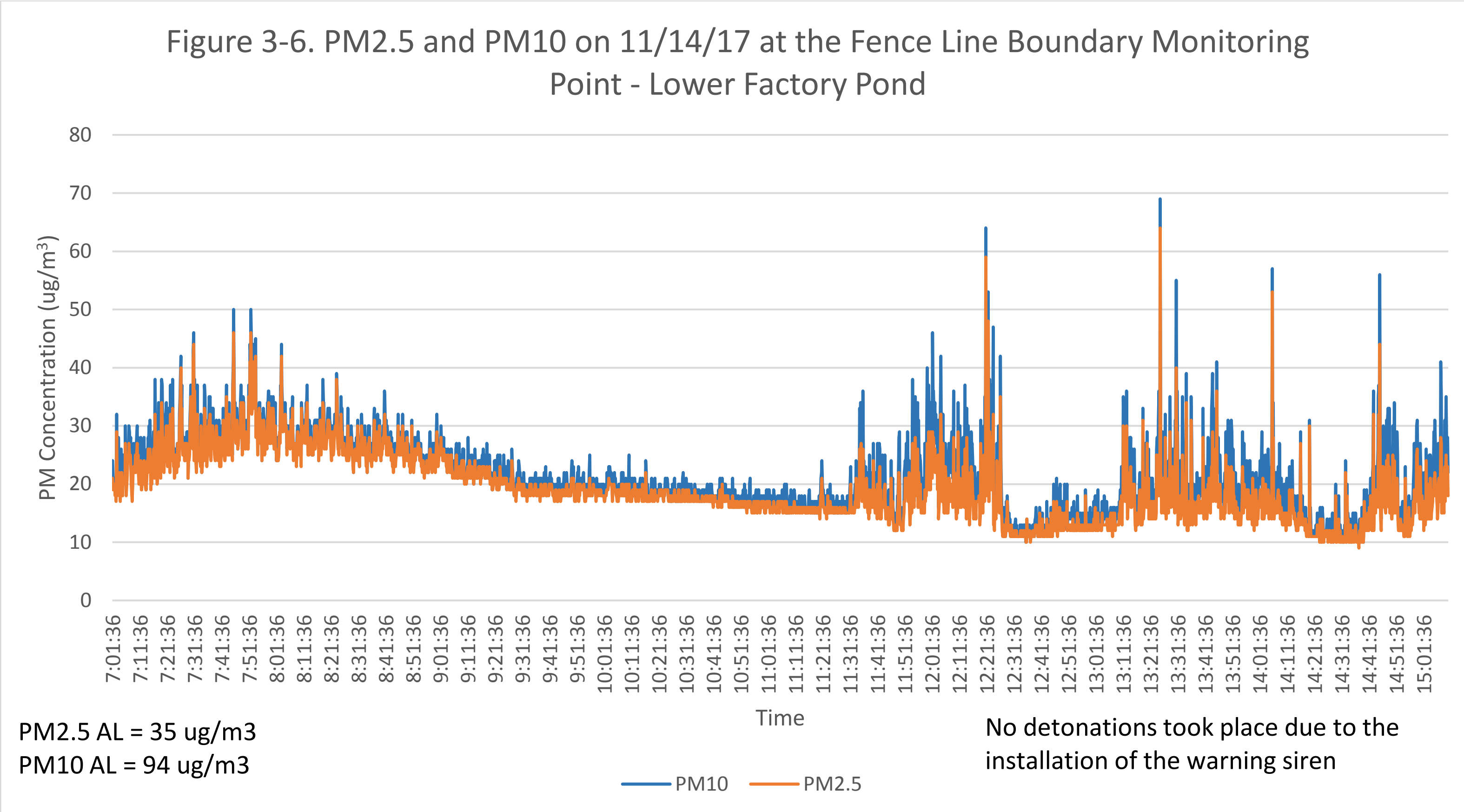


Figure 3-6. PM2.5 and PM10 on 11/14/17 at the Fence Line Boundary Monitoring Point - Lower Factory Pond
PM Concentration (ug/m³)
0
10
20
30
40
50
60
70
80
7:01:36
7:11:36
7:21:36
7:31:36
7:41:36
7:51:36
8:01:36
8:11:36
8:21:36
8:31:36
8:41:36
8:51:36
9:01:36
9:11:36
9:21:36
9:31:36
9:41:36
9:51:36
10:01:36
10:11:36
10:21:36
10:31:36
10:41:36
10:51:36
11:01:36
11:11:36
11:21:36
11:31:36
11:41:36
11:51:36
12:01:36
12:11:36
12:21:36
12:31:36
12:41:36
12:51:36
13:01:36
13:11:36
13:21:36
13:31:36
13:41:36
13:51:36
14:01:36
14:11:36
14:21:36
14:31:36
14:41:36
14:51:36
15:01:36
Time
PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3
No detonations took place due to the installation of the warning siren
PM10
PM2.5

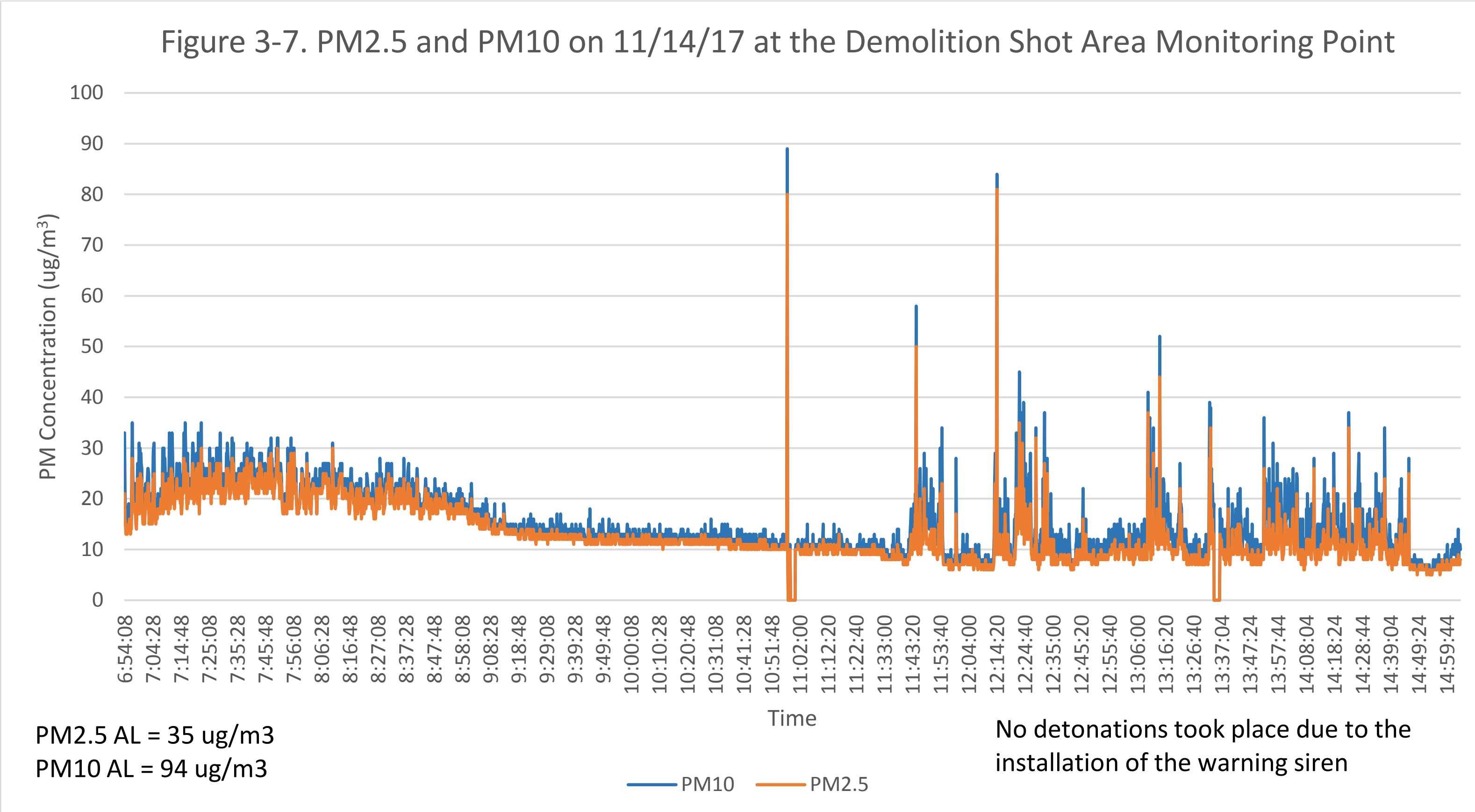


Figure 3-7. PM2.5 and PM10 on 11/14/17 at the Demolition Shot Area Monitoring Point
PM Concentration (ug/m3)
Time
PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3
No detonations took place due to the installation of the warning siren
PM10
PM2.5

Figure 3-8. PM2.5 and PM10 on 11/15/17 at the Fence Line Boundary Monitoring Point - Waterford

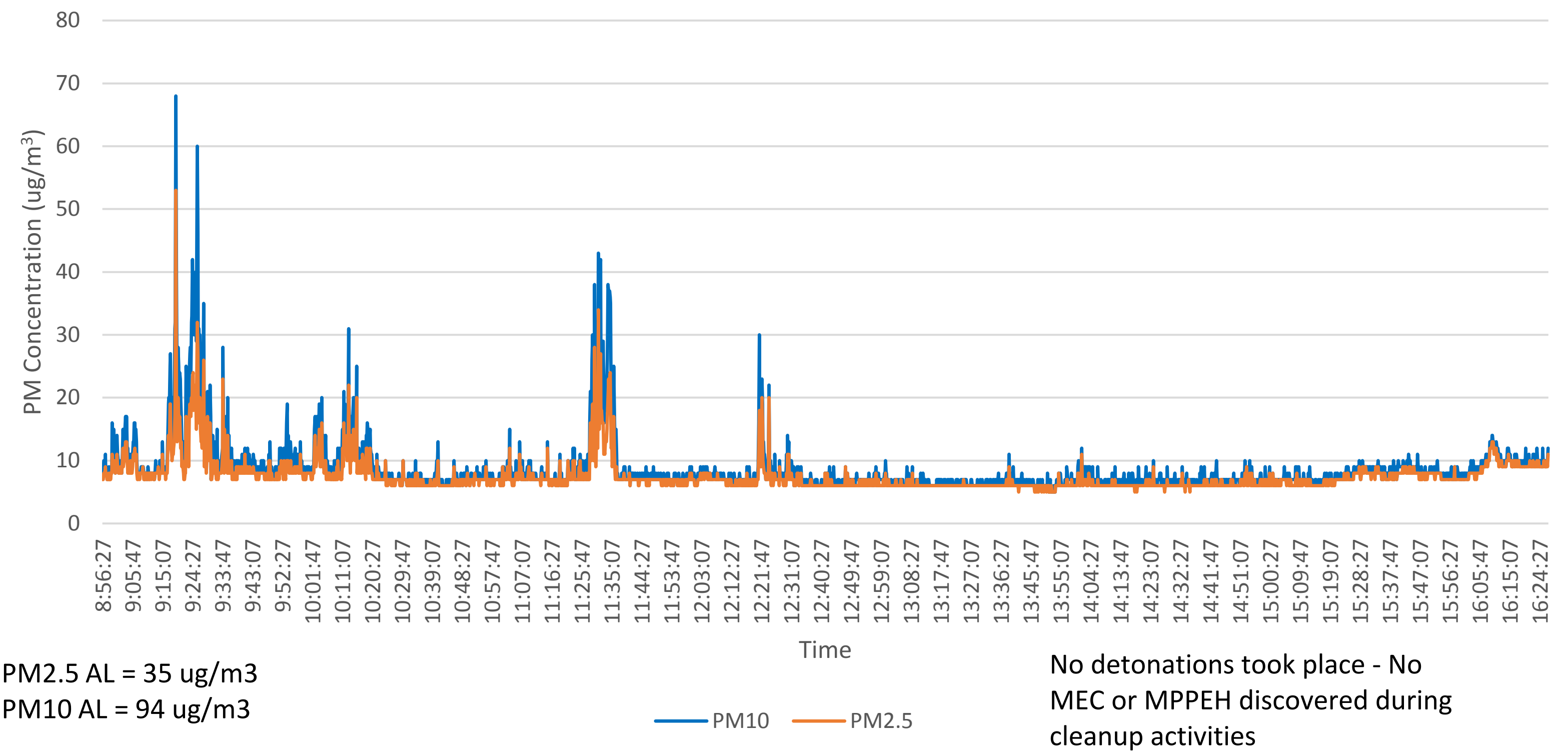
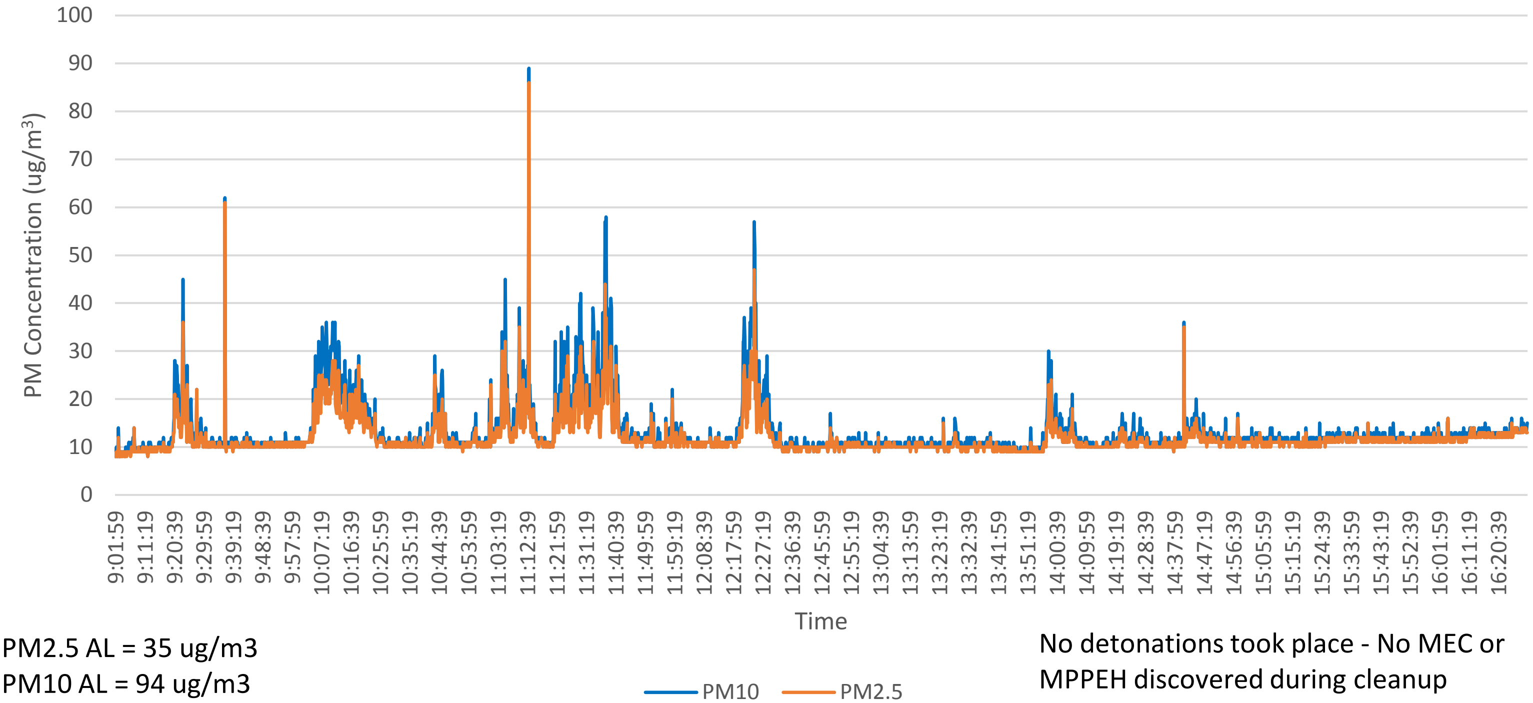


Figure 3-9. PM2.5 and PM10 on 11/15/17 at the Fence Line Boundary Monitoring Point - Lower Factory Pond



PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3

No detonations took place - No MEC or MPPEH discovered during cleanup activities

Figure 3-10. PM2.5 and PM10 on 11/15/17 at the Demolition Shot Area Monitoring Point

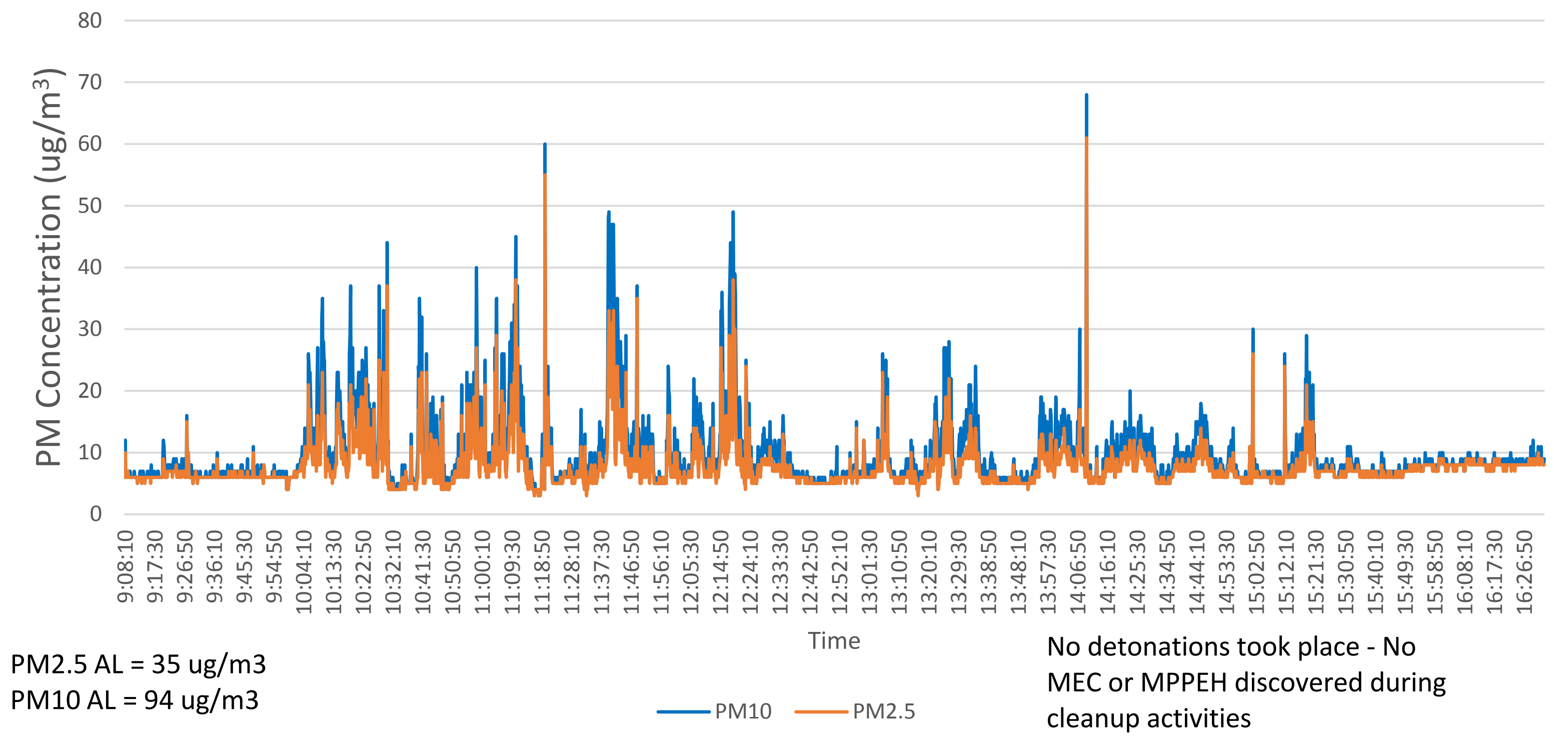
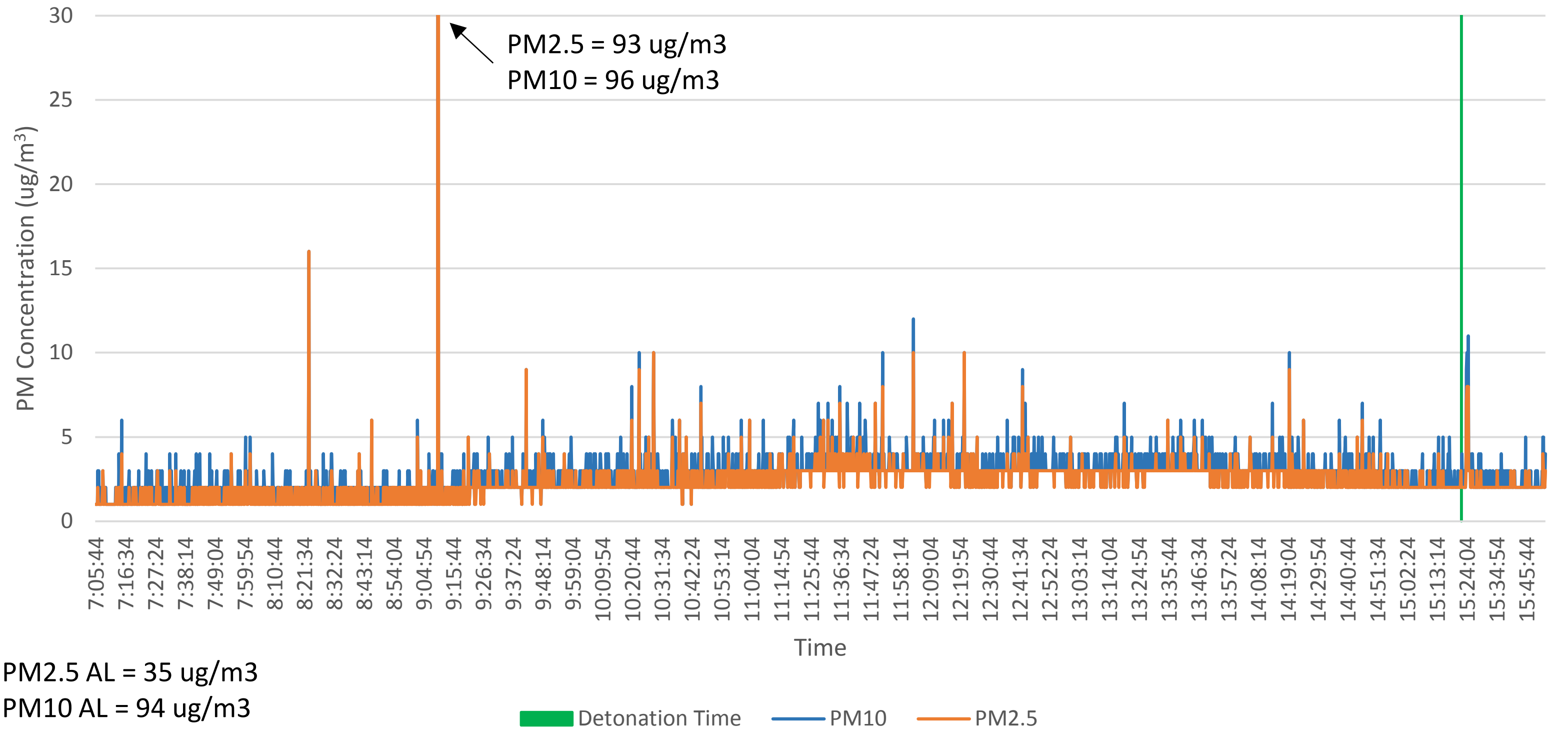


Figure 3-11. PM2.5 and PM10 on 11/17/17 at the Fence Line Boundary Monitoring Point - Waterford



PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3

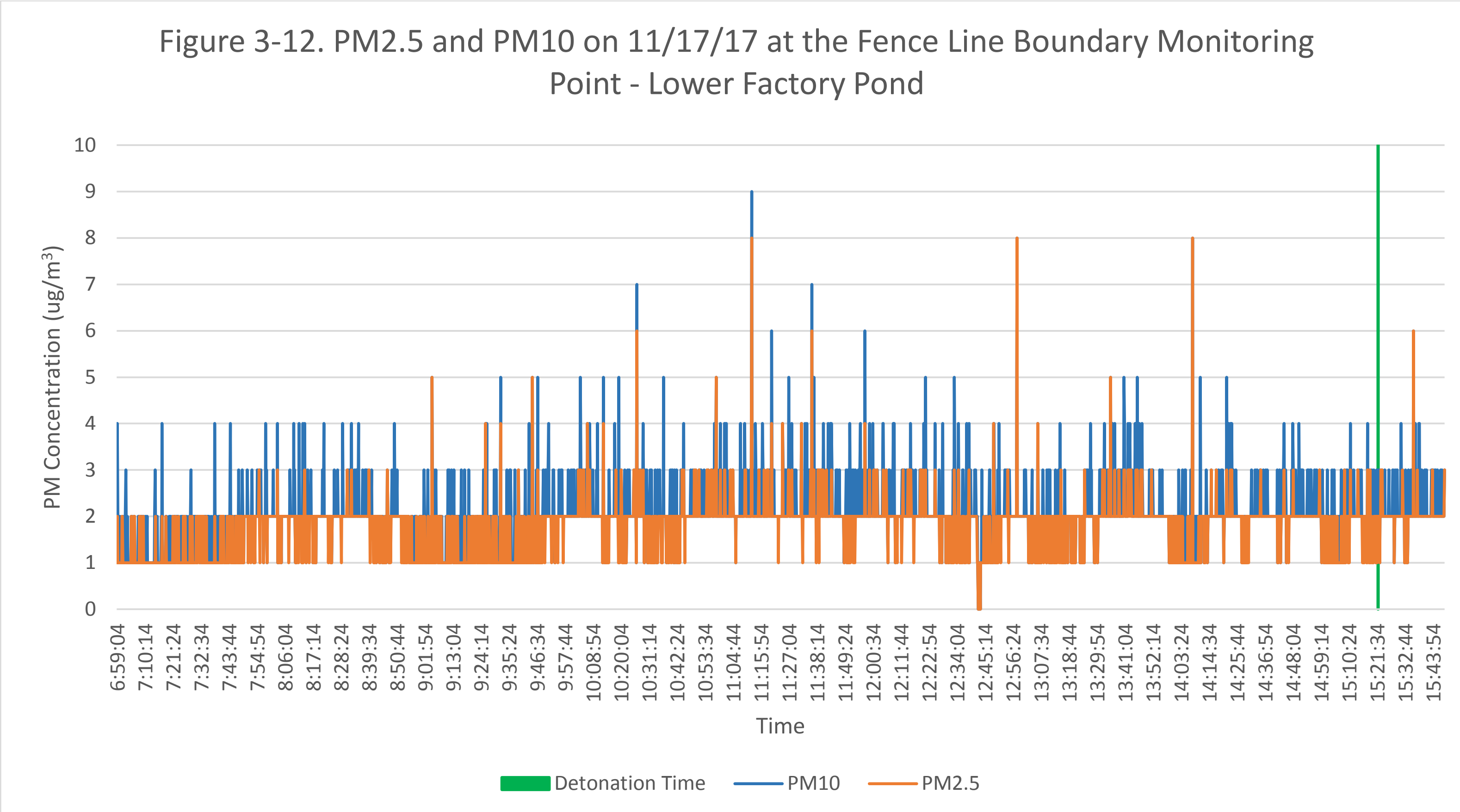


Figure 3-12. PM2.5 and PM10 on 11/17/17 at the Fence Line Boundary Monitoring Point - Lower Factory Pond
PM Concentration (ug/m³)
0
1
2
3
4
5
6
7
8
9
10
6:59:04
7:10:14
7:21:24
7:32:34
7:43:44
7:54:54
8:06:04
8:17:14
8:28:24
8:39:34
8:50:44
9:01:54
9:13:04
9:24:14
9:35:24
9:46:34
9:57:44
10:08:54
10:20:04
10:31:14
10:42:24
10:53:34
11:04:44
11:15:54
11:27:04
11:38:14
11:49:24
12:00:34
12:11:44
12:22:54
12:34:04
12:45:14
12:56:24
13:07:34
13:18:44
13:29:54
13:41:04
13:52:14
14:03:24
14:14:34
14:25:44
14:36:54
14:48:04
14:59:14
15:10:24
15:21:34
15:32:44
15:43:54
Time
Detonation Time
PM10
PM2.5

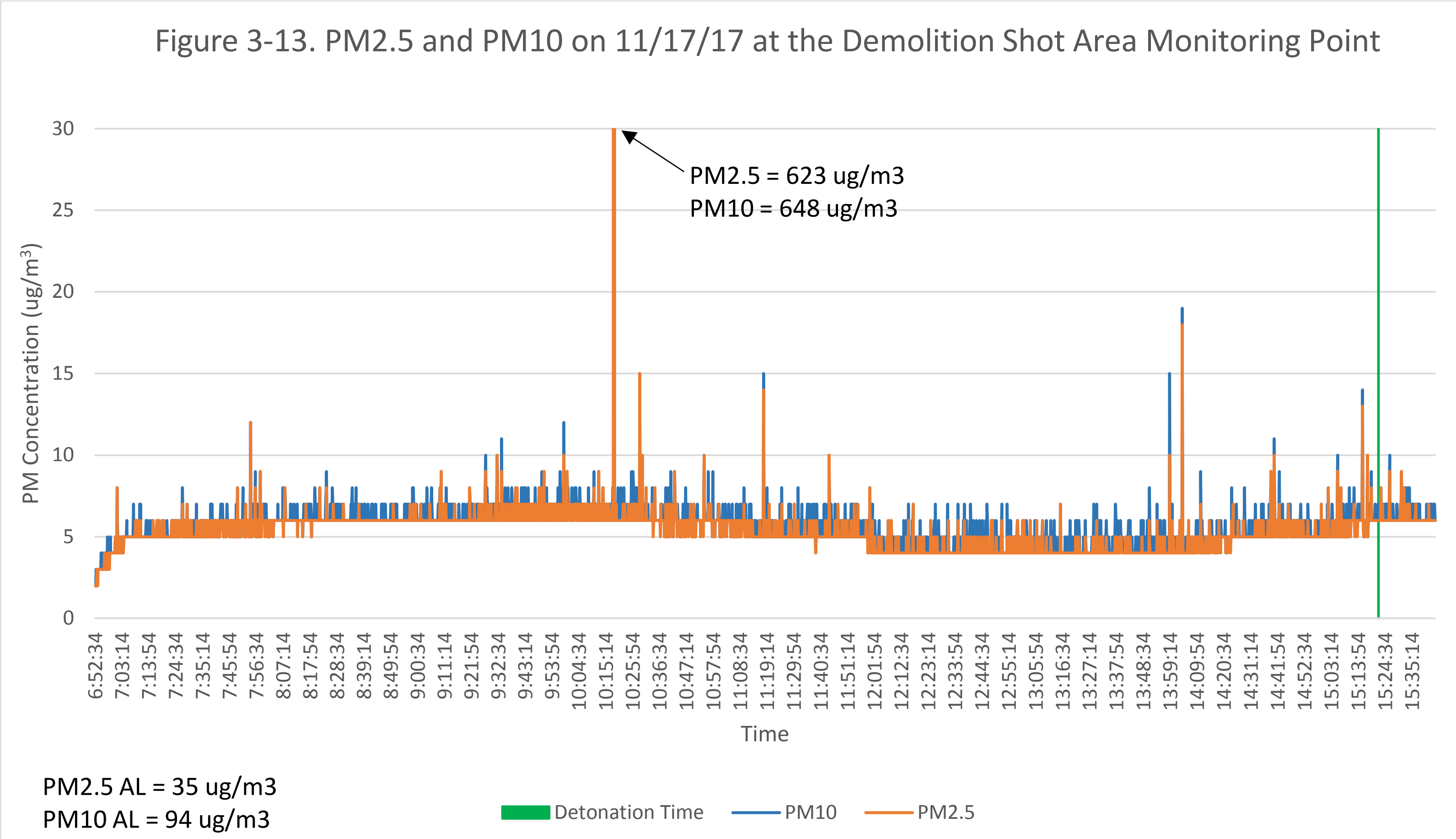


Figure 3-13. PM2.5 and PM10 on 11/17/17 at the Demolition Shot Area Monitoring Point
PM2.5 = 623 ug/m3
PM10 = 648 ug/m3
PM Concentration (ug/m3)
Time
PM2.5 AL = 35 ug/m3
PM10 AL = 94 ug/m3
Detonation Time
PM10
PM2.5

Figure 3-14. PM2.5 and PM10 on 11/20/17 at the Fence Line Boundary Monitoring Point - Waterford

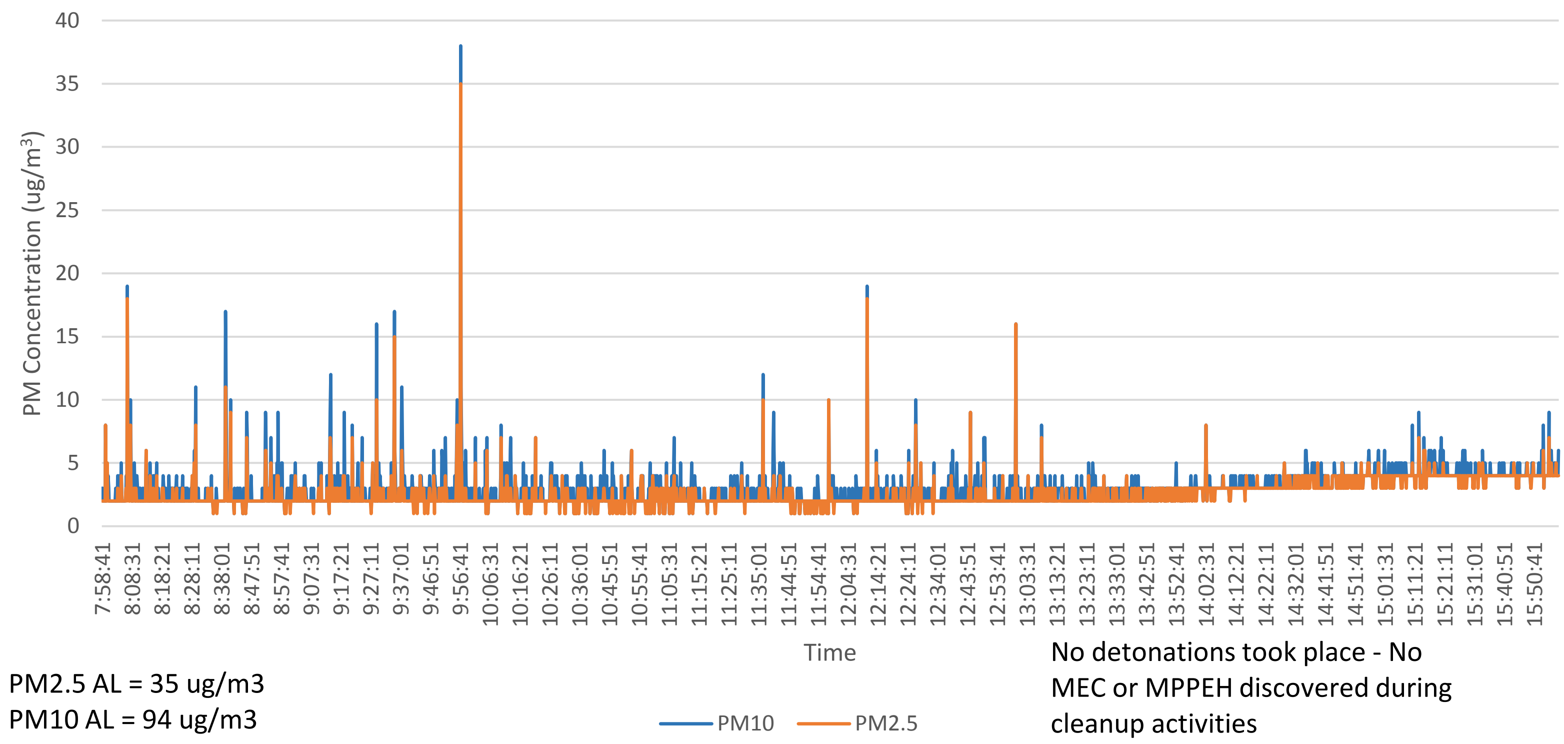
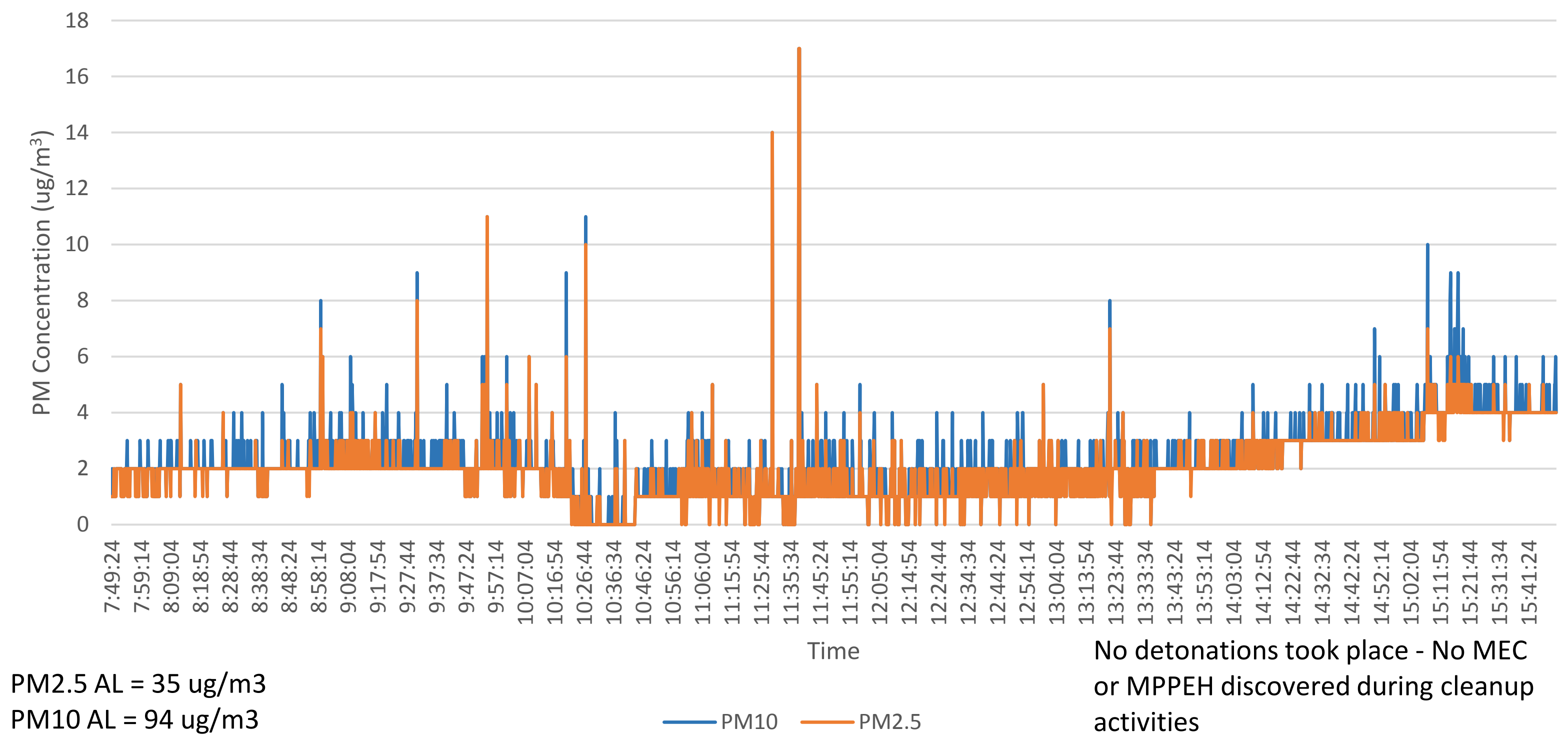


Figure 3-15. PM2.5 and PM10 on 11/20/17 at the Demolition Shot Area Monitoring Point



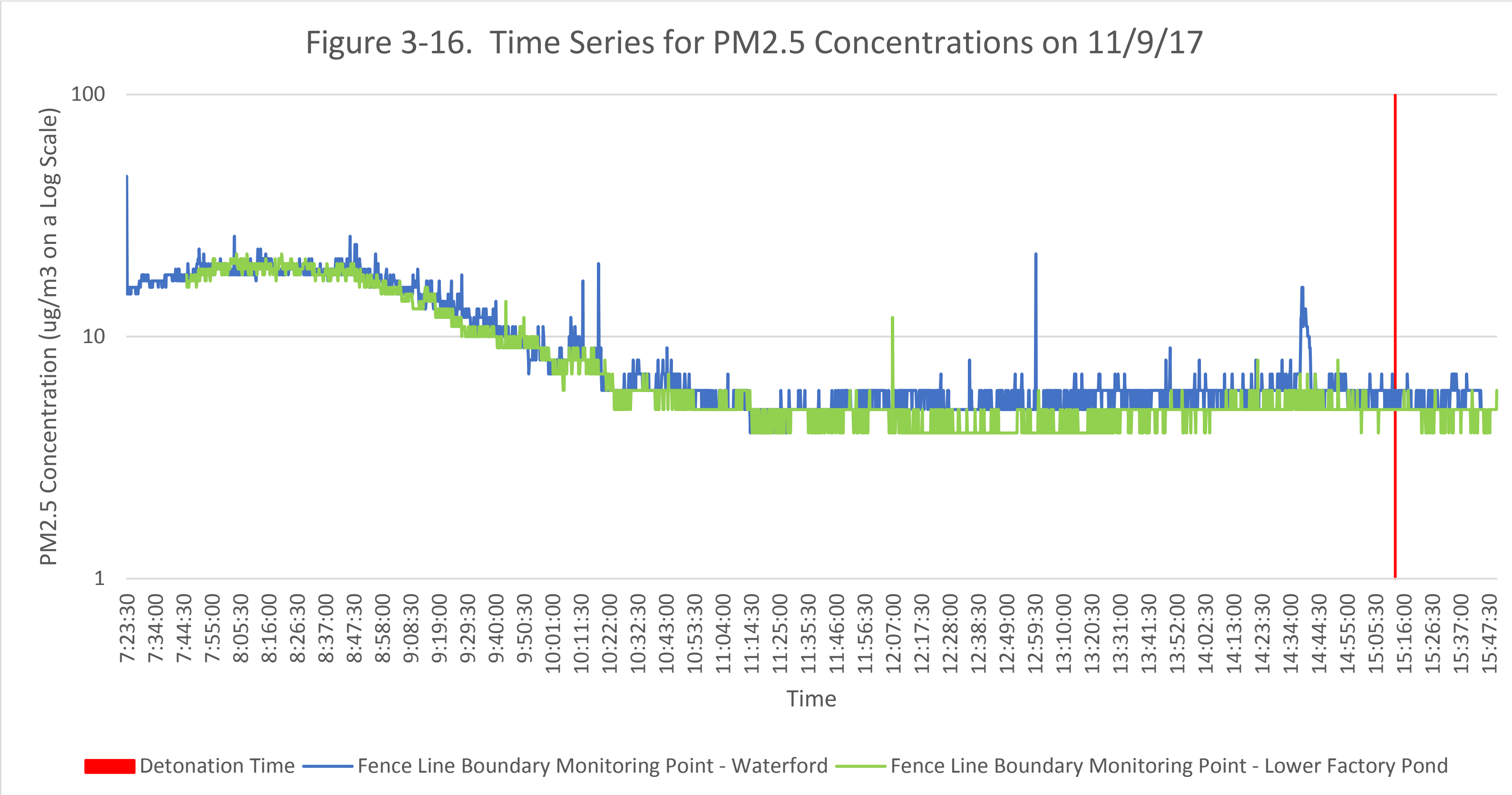


Figure 3-16. Time Series for PM2.5 Concentrations on 11/9/17
PM2.5 Concentration (ug/m3 on a Log Scale)
100
10
1
7:23:30
7:34:00
7:44:30
7:55:00
8:05:30
8:16:00
8:26:30
8:37:00
8:47:30
8:58:00
9:08:30
9:19:00
9:29:30
9:40:00
9:50:30
10:01:00
10:11:30
10:22:00
10:32:30
10:43:00
10:53:30
11:04:00
11:14:30
11:25:00
11:35:30
11:46:00
11:56:30
12:07:00
12:17:30
12:28:00
12:38:30
12:49:00
12:59:30
13:10:00
13:20:30
13:31:00
13:41:30
13:52:00
14:02:30
14:13:00
14:23:30
14:34:00
14:44:30
14:55:00
15:05:30
15:16:00
15:26:30
15:37:00
15:47:30
Time
Detonation Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond

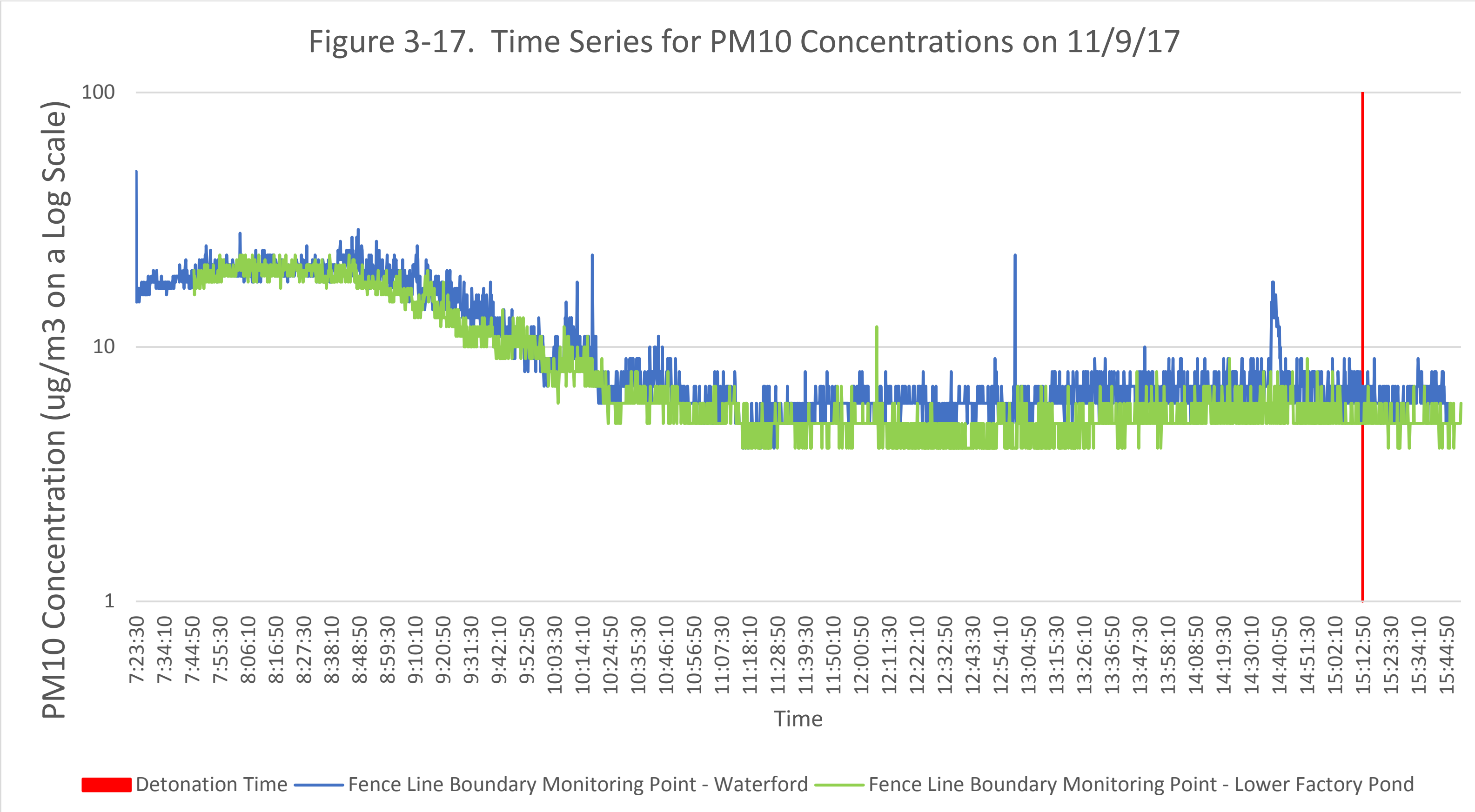
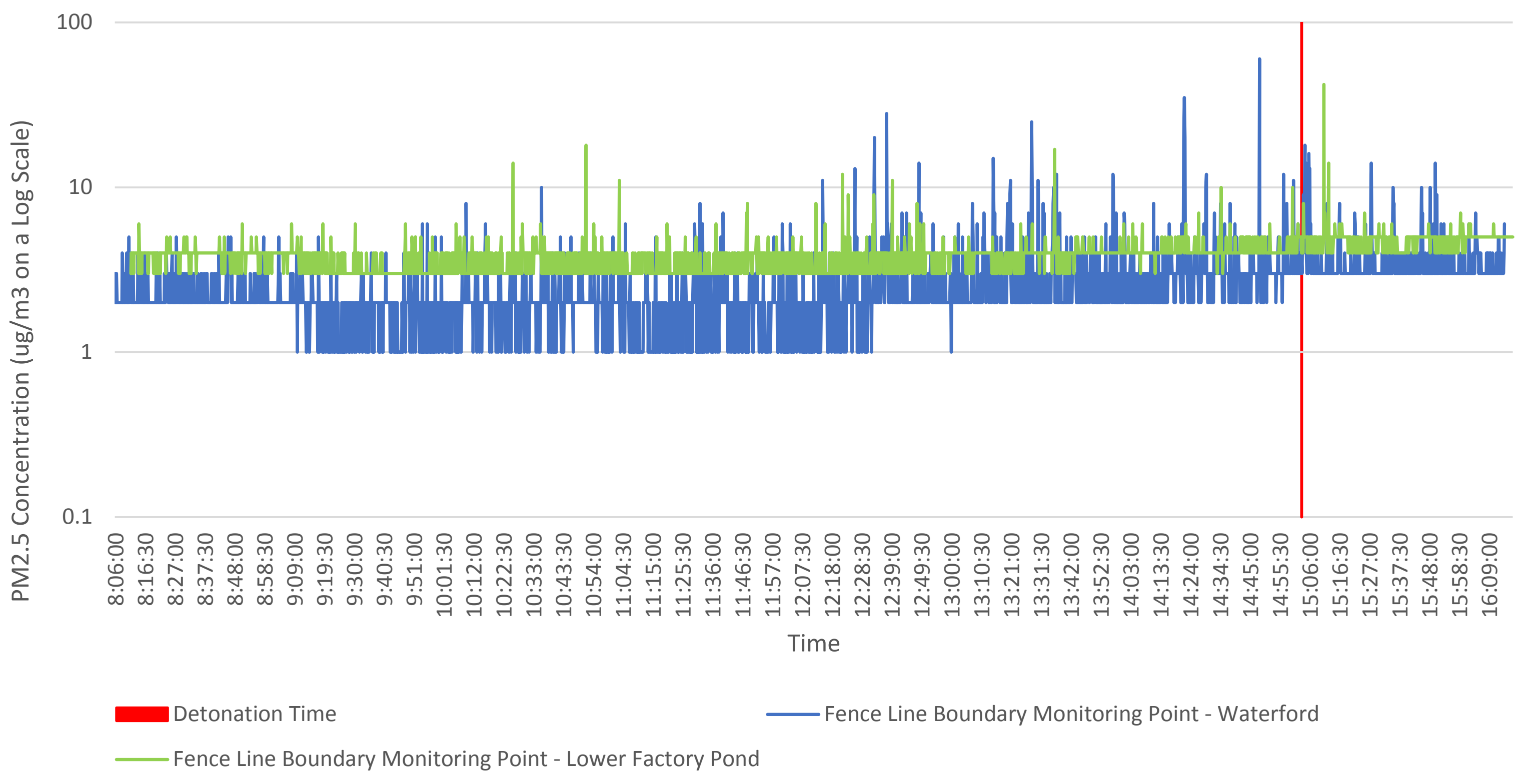


Figure 3-17. Time Series for PM10 Concentrations on 11/9/17
PM10 Concentration (ug/m3 on a Log Scale)
100
10
1
7:23:30
7:34:10
7:44:50
7:55:30
8:06:10
8:16:50
8:27:30
8:38:10
8:48:50
8:59:30
9:10:10
9:20:50
9:31:30
9:42:10
9:52:50
10:03:30
10:14:10
10:24:50
10:35:30
10:46:10
10:56:50
11:07:30
11:18:10
11:28:50
11:39:30
11:50:10
12:00:50
12:11:30
12:22:10
12:32:50
12:43:30
12:54:10
13:04:50
13:15:30
13:26:10
13:36:50
13:47:30
13:58:10
14:08:50
14:19:30
14:30:10
14:40:50
14:51:30
15:02:10
15:12:50
15:23:30
15:34:10
15:44:50
Time
Detonation Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond

Figure 3-18. Time Series for PM2.5 Concentrations on 11/10/17



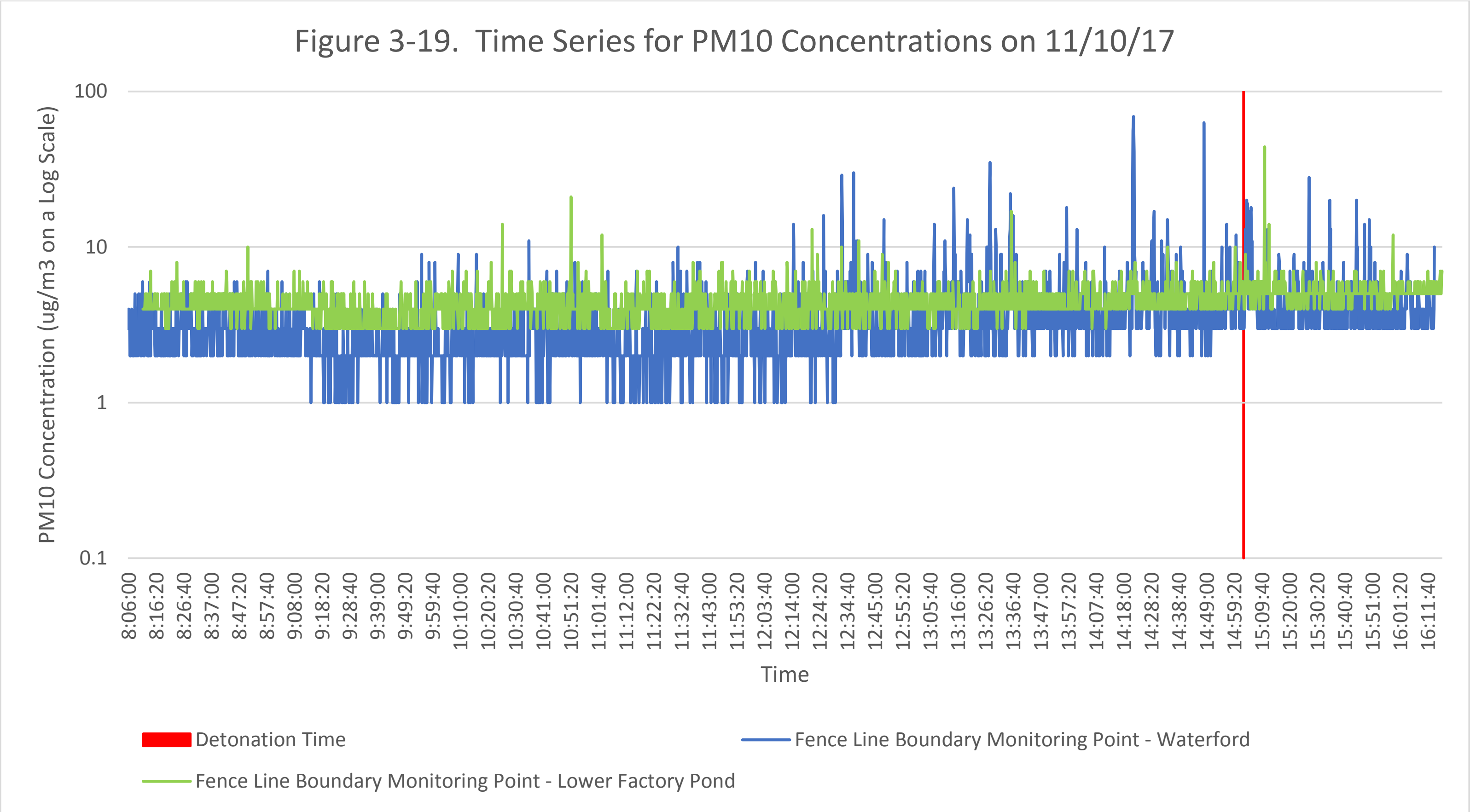


Figure 3-19. Time Series for PM10 Concentrations on 11/10/17
PM10 Concentration (ug/m3 on a Log Scale)
100
10
1
0.1
8:06:00
8:16:20
8:26:40
8:37:00
8:47:20
8:57:40
9:08:00
9:18:20
9:28:40
9:39:00
9:49:20
9:59:40
10:10:00
10:20:20
10:30:40
10:41:00
10:51:20
11:01:40
11:12:00
11:22:20
11:32:40
11:43:00
11:53:20
12:03:40
12:14:00
12:24:20
12:34:40
12:45:00
12:55:20
13:05:40
13:16:00
13:26:20
13:36:40
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15:40:40
15:51:00
16:01:20
16:11:40
Time
Detonation Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond

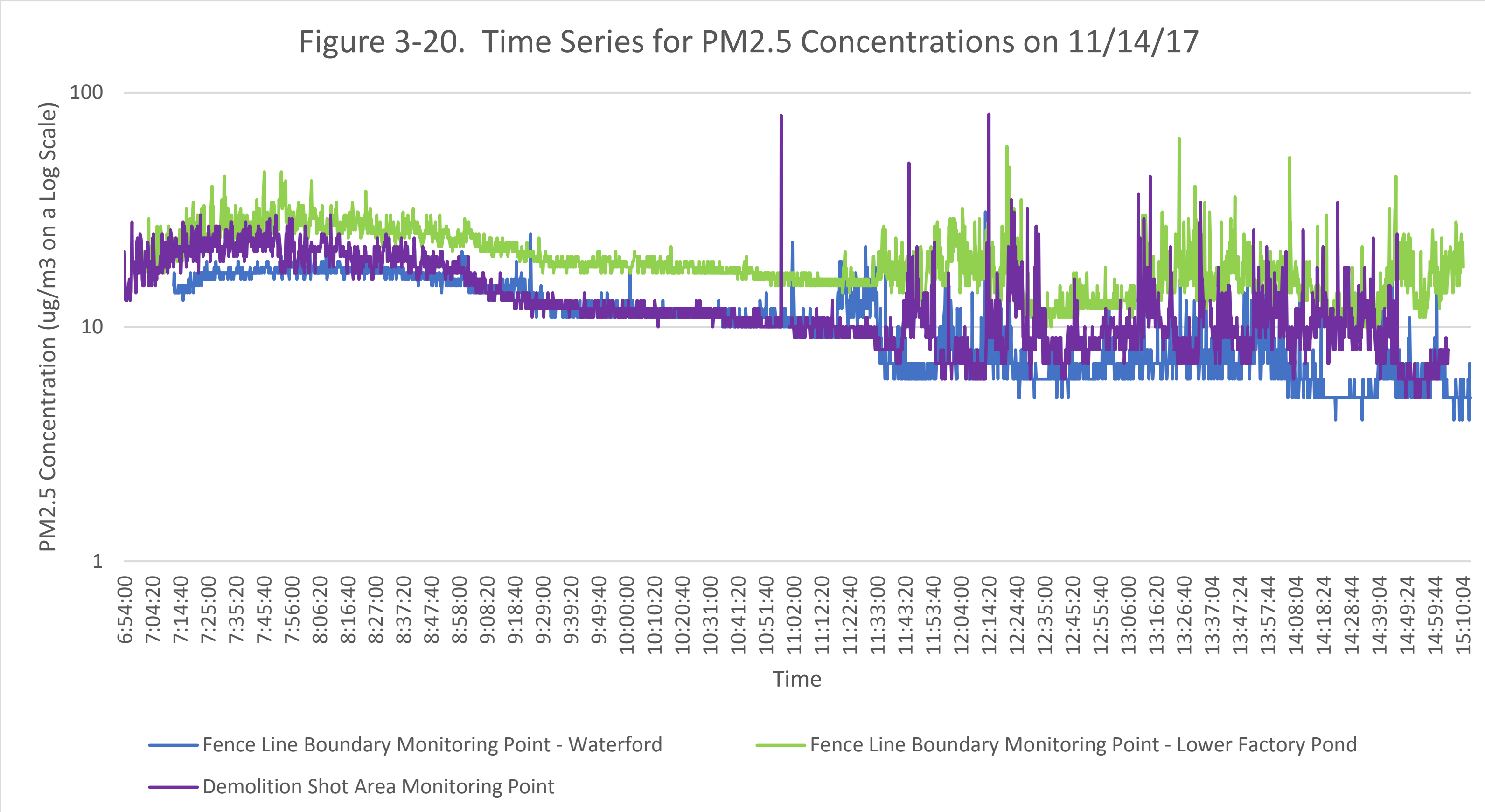
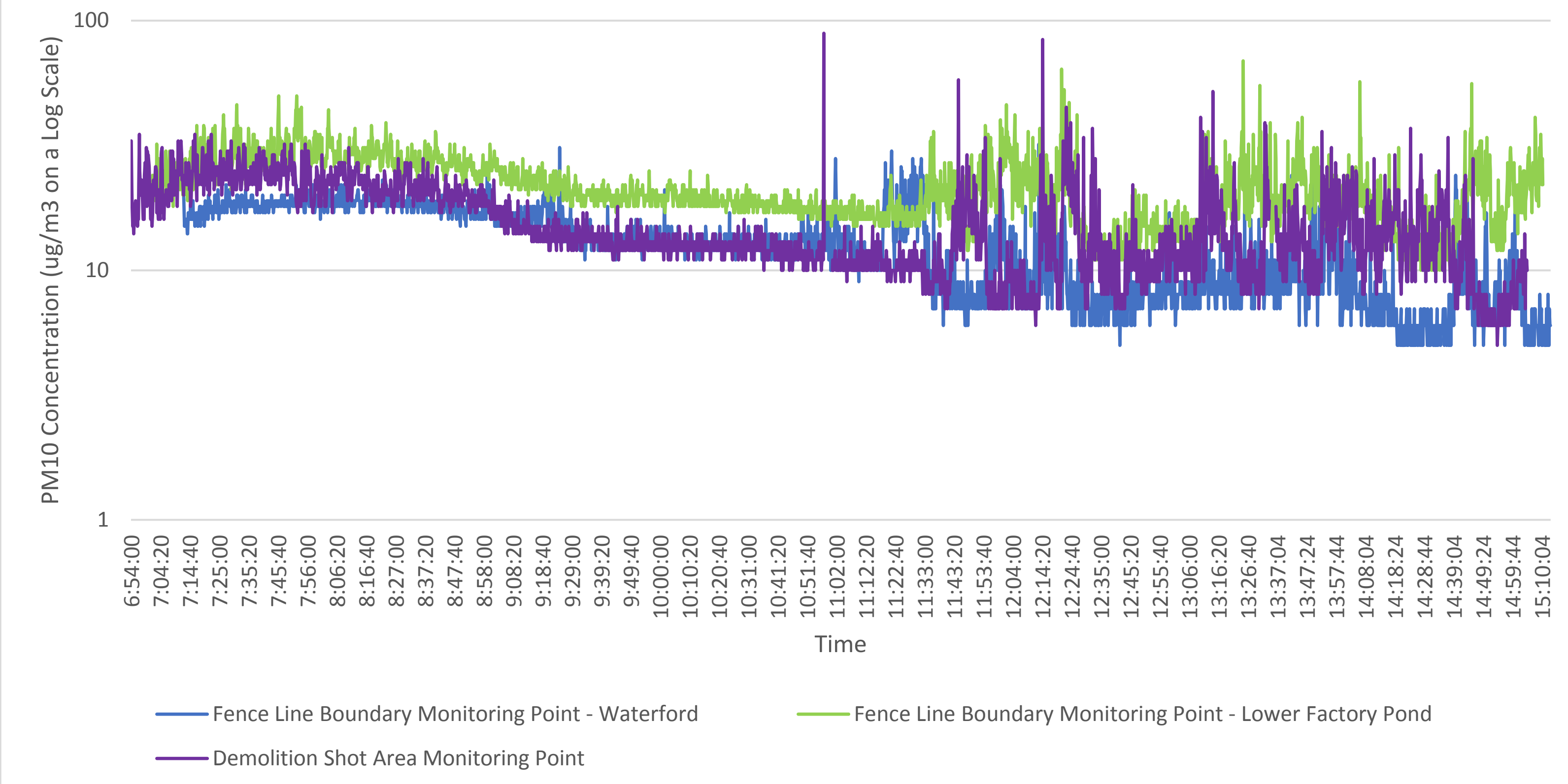


Figure 3-20. Time Series for PM2.5 Concentrations on 11/14/17
PM2.5 Concentration (ug/m3 on a Log Scale)
100
10
1
Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond
Demolition Shot Area Monitoring Point

Figure 3-21. Time Series for PM10 Concentrations on 11/14/17



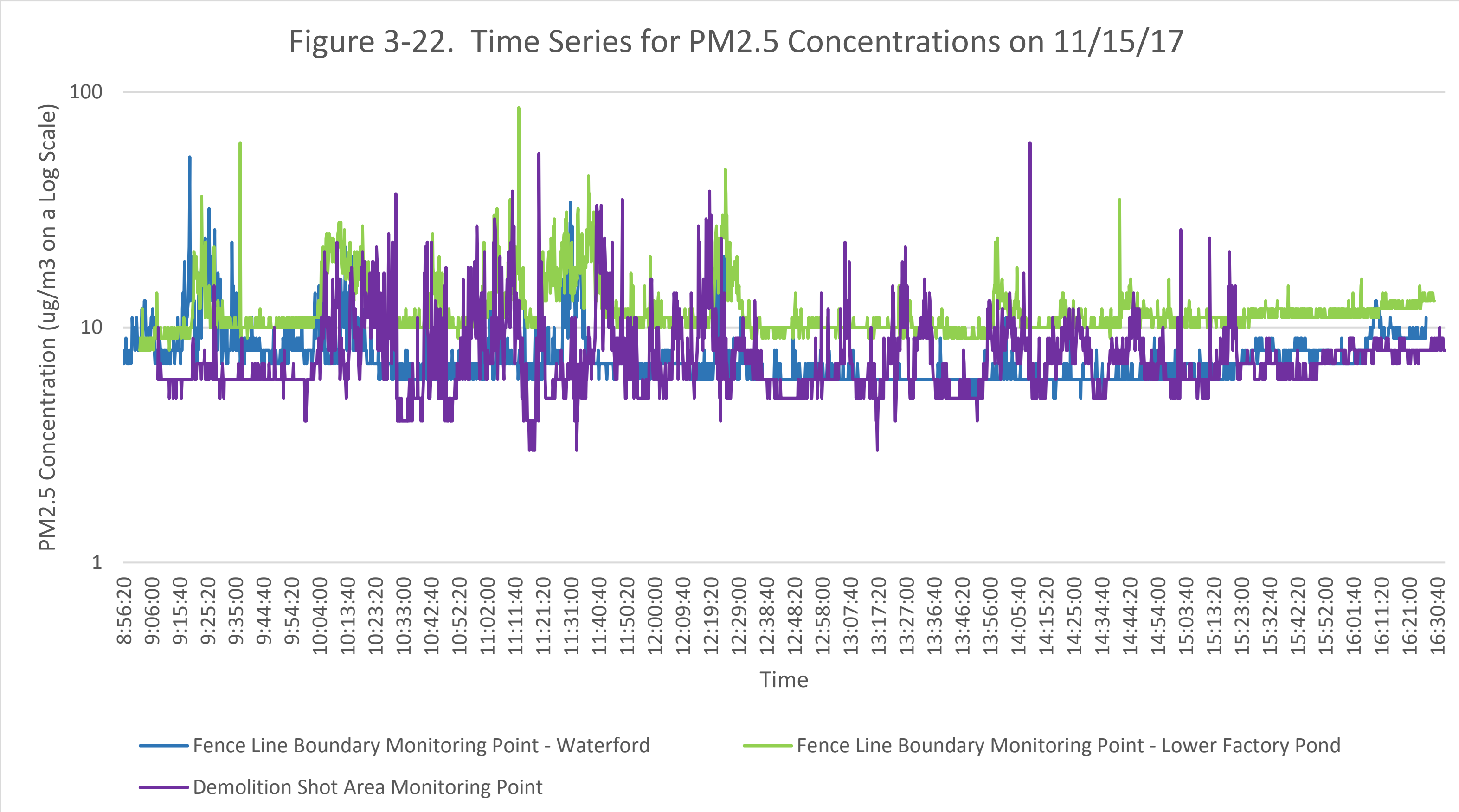


Figure 3-22. Time Series for PM2.5 Concentrations on 11/15/17
PM2.5 Concentration (ug/m3 on a Log Scale)
100
10
1
8:56:20
9:06:00
9:15:40
9:25:20
9:35:00
9:44:40
9:54:20
10:04:00
10:13:40
10:23:20
10:33:00
10:42:40
10:52:20
11:02:00
11:11:40
11:21:20
11:31:00
11:40:40
11:50:20
12:00:00
12:09:40
12:19:20
12:29:00
12:38:40
12:48:20
12:58:00
13:07:40
13:17:20
13:27:00
13:36:40
13:46:20
13:56:00
14:05:40
14:15:20
14:25:00
14:34:40
14:44:20
14:54:00
15:03:40
15:13:20
15:23:00
15:32:40
15:42:20
15:52:00
16:01:40
16:11:20
16:21:00
16:30:40
Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond
Demolition Shot Area Monitoring Point

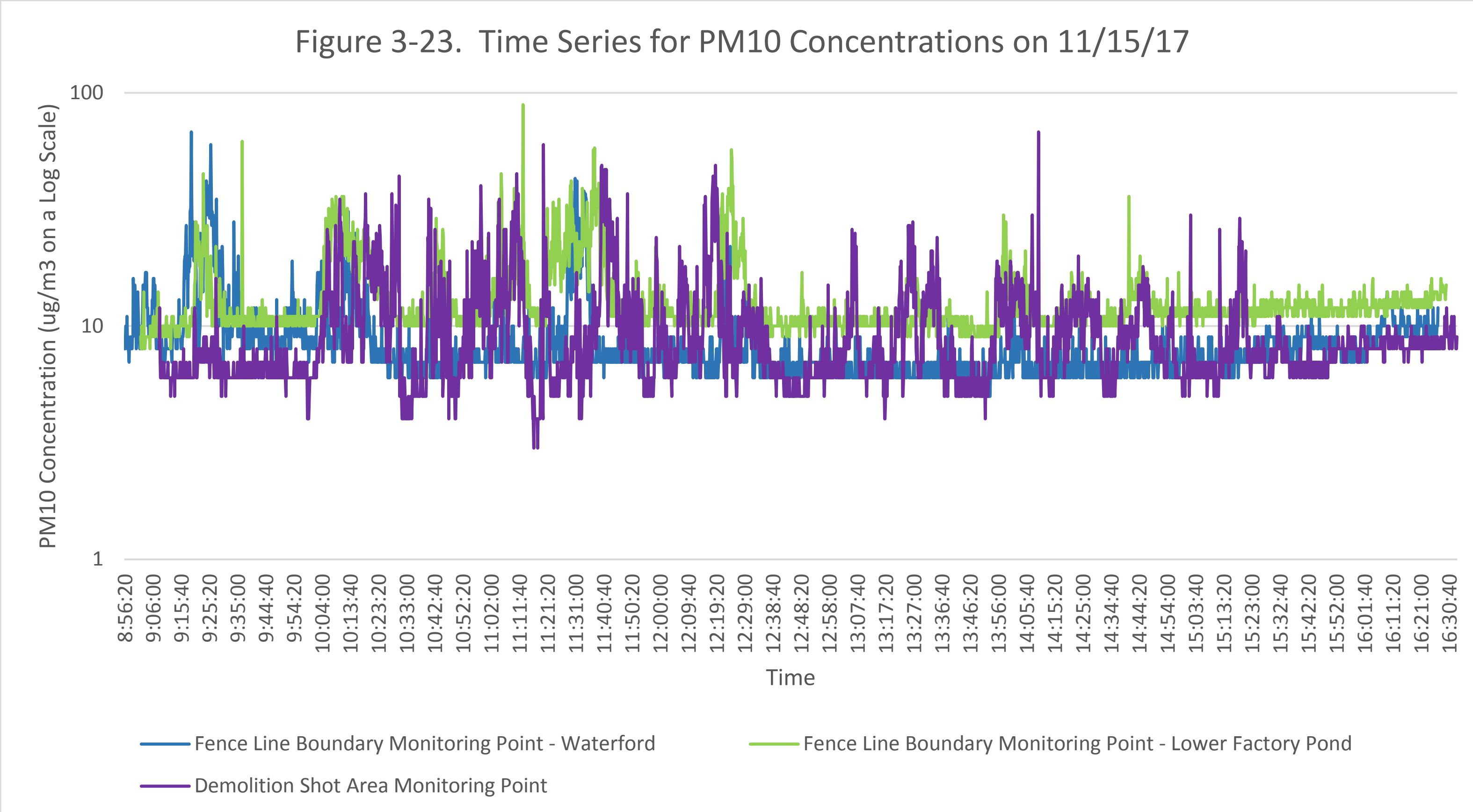


Figure 3-23. Time Series for PM10 Concentrations on 11/15/17
PM10 Concentration (ug/m3 on a Log Scale)
100
10
1
8:56:20
9:06:00
9:15:40
9:25:20
9:35:00
9:44:40
9:54:20
10:04:00
10:13:40
10:23:20
10:33:00
10:42:40
10:52:20
11:02:00
11:11:40
11:21:20
11:31:00
11:40:40
11:50:20
12:00:00
12:09:40
12:19:20
12:29:00
12:38:40
12:48:20
12:58:00
13:07:40
13:17:20
13:27:00
13:36:40
13:46:20
13:56:00
14:05:40
14:15:20
14:25:00
14:34:40
14:44:20
14:54:00
15:03:40
15:13:20
15:23:00
15:32:40
15:42:20
15:52:00
16:01:40
16:11:20
16:21:00
16:30:40
Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond
Demolition Shot Area Monitoring Point

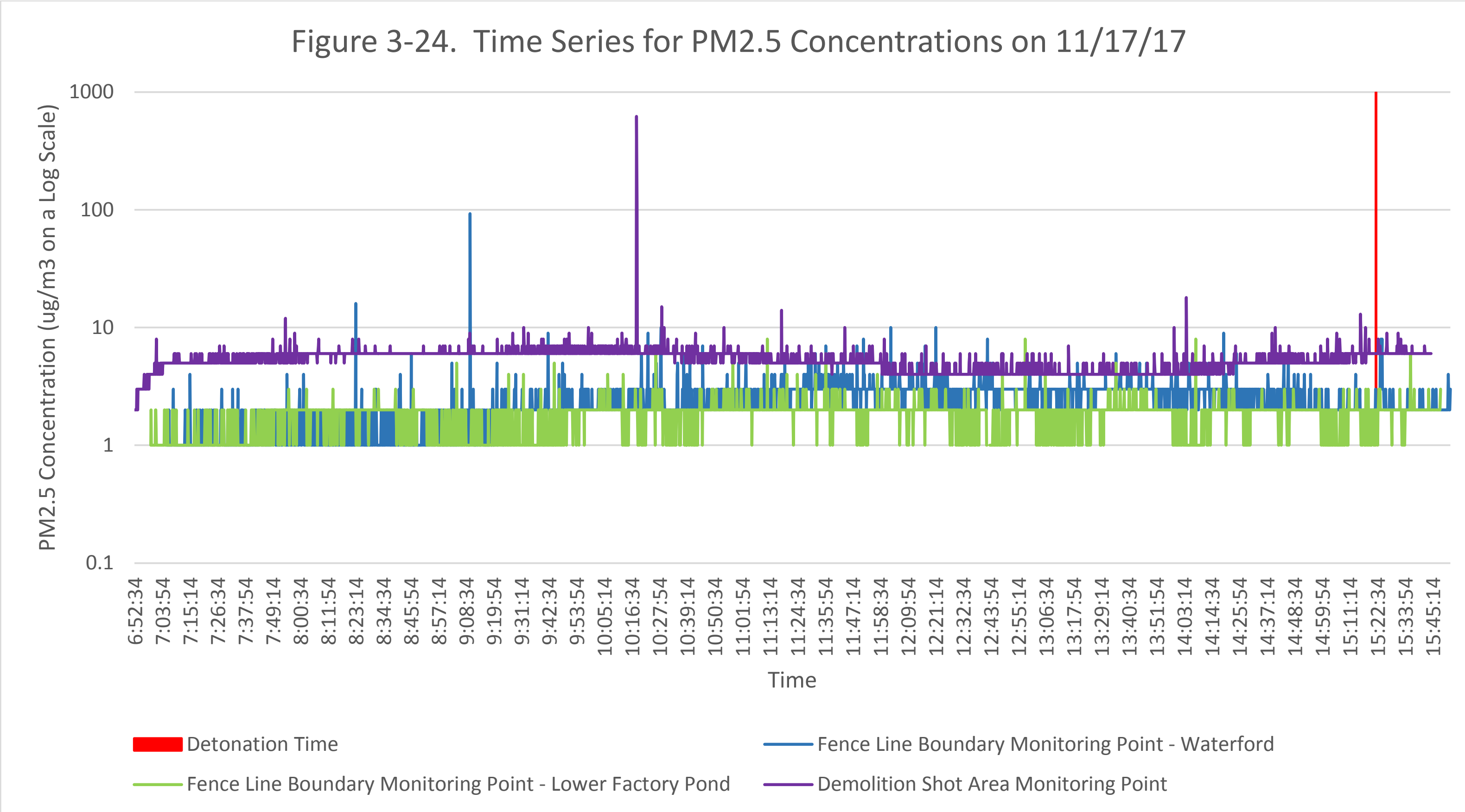


Figure 3-24. Time Series for PM2.5 Concentrations on 11/17/17
PM2.5 Concentration (ug/m3 on a Log Scale)
1000
100
10
1
0.1
6:52:34
7:03:54
7:15:14
7:26:34
7:37:54
7:49:14
8:00:34
8:11:54
8:23:14
8:34:34
8:45:54
8:57:14
9:08:34
9:19:54
9:31:14
9:42:34
9:53:54
10:05:14
10:16:34
10:27:54
10:39:14
10:50:34
11:01:54
11:13:14
11:24:34
11:35:54
11:47:14
11:58:34
12:09:54
12:21:14
12:32:34
12:43:54
12:55:14
13:06:34
13:17:54
13:29:14
13:40:34
13:51:54
14:03:14
14:14:34
14:25:54
14:37:14
14:48:34
14:59:54
15:11:14
15:22:34
15:33:54
15:45:14
Time
Detonation Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond
Demolition Shot Area Monitoring Point

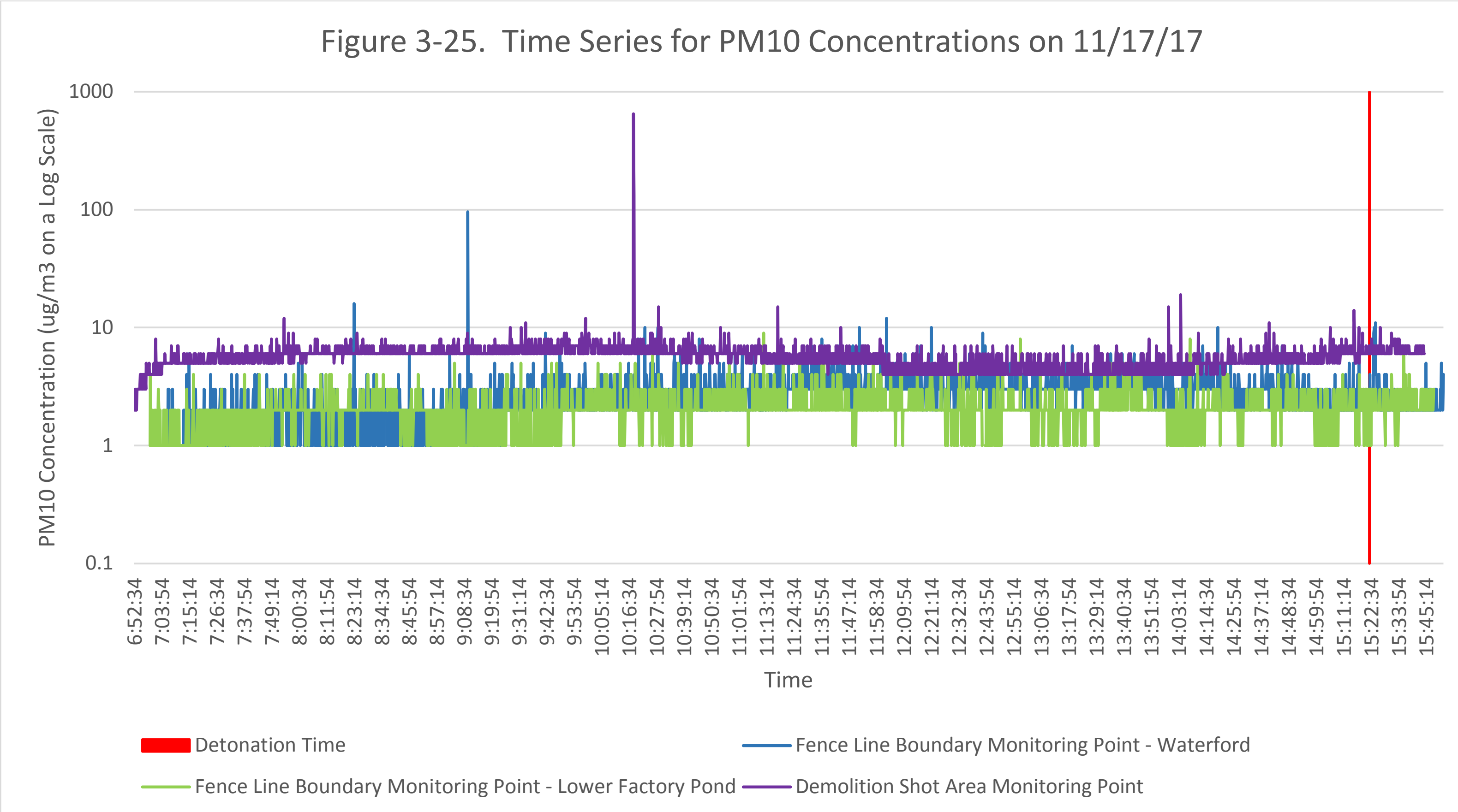
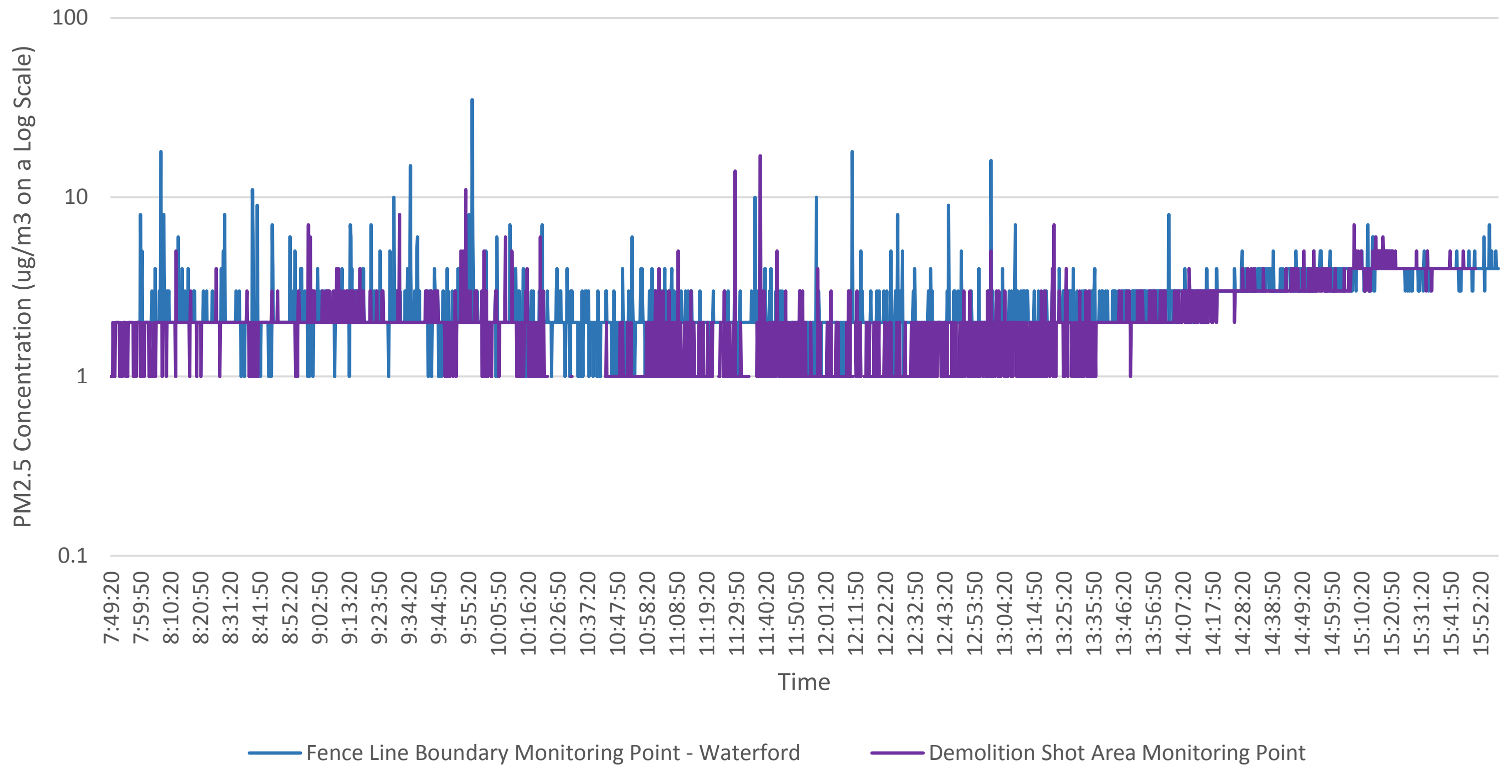


Figure 3-25. Time Series for PM10 Concentrations on 11/17/17
PM10 Concentration (ug/m3 on a Log Scale)
1000
100
10
1
0.1
6:52:34
7:03:54
7:15:14
7:26:34
7:37:54
7:49:14
8:00:34
8:11:54
8:23:14
8:34:34
8:45:54
8:57:14
9:08:34
9:19:54
9:31:14
9:42:34
9:53:54
10:05:14
10:16:34
10:27:54
10:39:14
10:50:34
11:01:54
11:13:14
11:24:34
11:35:54
11:47:14
11:58:34
12:09:54
12:21:14
12:32:34
12:43:54
12:55:14
13:06:34
13:17:54
13:29:14
13:40:34
13:51:54
14:03:14
14:14:34
14:25:54
14:37:14
14:48:34
14:59:54
15:11:14
15:22:34
15:33:54
15:45:14
Time
Detonation Time
Fence Line Boundary Monitoring Point - Waterford
Fence Line Boundary Monitoring Point - Lower Factory Pond
Demolition Shot Area Monitoring Point

Figure 3-26. Time Series for PM2.5 Concentrations on 11/20/17



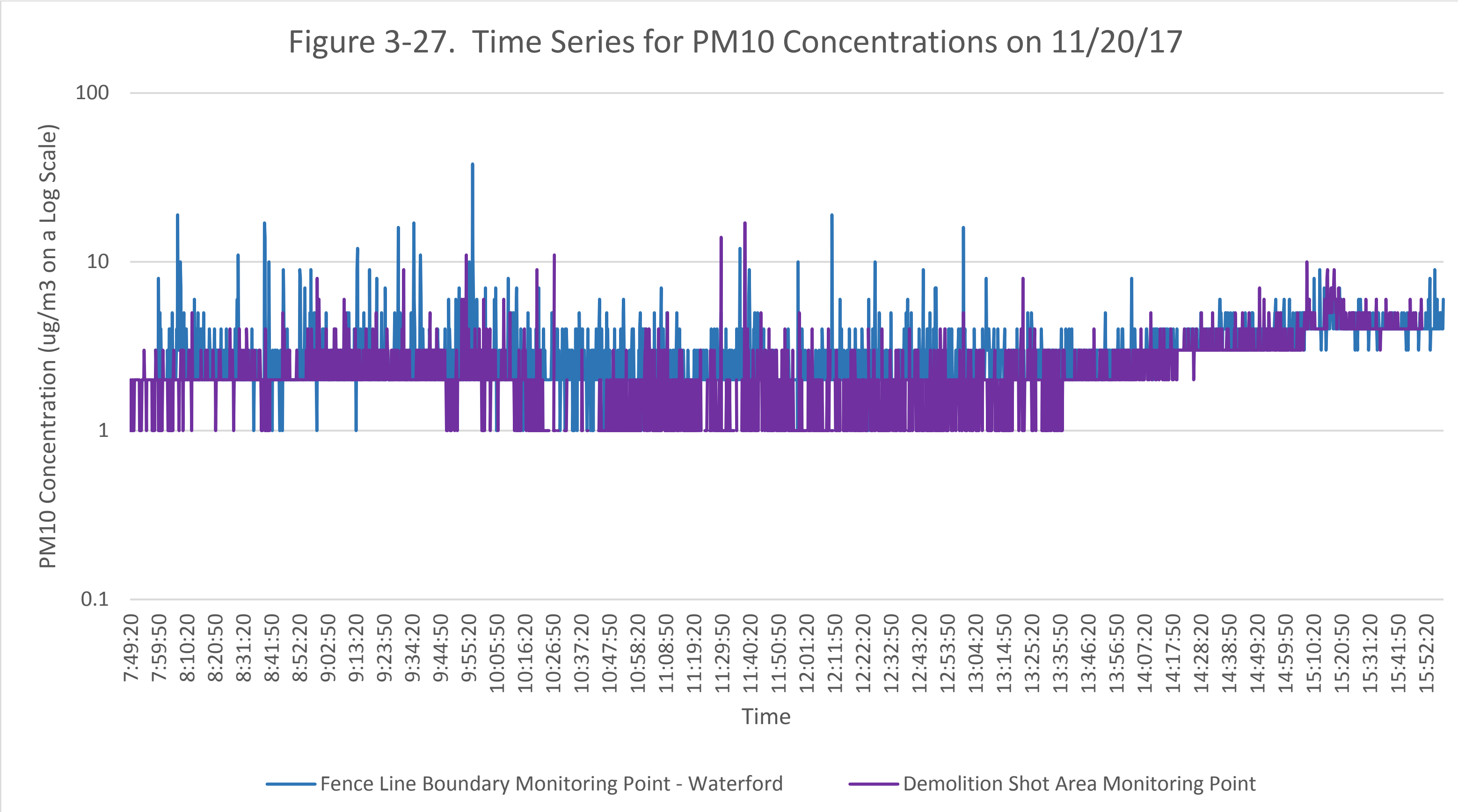


Figure 3-27. Time Series for PM10 Concentrations on 11/20/17
PM10 Concentration (ug/m3 on a Log Scale)
100
10
1
0.1
7:49:20
7:59:50
8:10:20
8:20:50
8:31:20
8:41:50
8:52:20
9:02:50
9:13:20
9:23:50
9:34:20
9:44:50
9:55:20
10:05:50
10:16:20
10:26:50
10:37:20
10:47:50
10:58:20
11:08:50
11:19:20
11:29:50
11:40:20
11:50:50
12:01:20
12:11:50
12:22:20
12:32:50
12:43:20
12:53:50
13:04:20
13:14:50
13:25:20
13:35:50
13:46:20
13:56:50
14:07:20
14:17:50
14:28:20
14:38:50
14:49:20
14:59:50
15:10:20
15:20:50
15:31:20
15:41:50
15:52:20
Time
Fence Line Boundary Monitoring Point - Waterford
Demolition Shot Area Monitoring Point

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Appendix A

Particulate Sampling Plan for Particulates Generated at the Former Test Range Berm Area and the Cold Waste Area

(Dated August 4, 2017)

Particulate Sampling Plan (PSP)
for Particulates Generated at the
Former Test Range Berm Area and the Cold Waste Area

NATIONAL FIREWORKS SITE
RTN 4-0000090
HANOVER, MA

Prepared for:
The Fireworks Site Joint Defense Group

Prepared by:

TETRA TECH

160 Federal Street
3rd Floor
Boston, MA 02110

August 4, 2017

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1.0 INTRUDUCTION

This Particulate Sampling Plan describes the approach to performing particulate sampling during aspects of the Release Abatement Measure (RAM) being implemented at the Former Test Range Berm Area (FTRBA) at the Fireworks Site (Site) (RTN #4-0090 Tier IA #100223). The Site is located in Hanover, Massachusetts, and is comprised of approximately 240 acres, portions of which have a history of use, storage, and disposal of potentially hazardous materials associated with the manufacture and development of munitions and pyrotechnics (see Figure 1-1).

The FTRBA is located on a hillside and is approximately 300 feet wide by 100 feet long along the berm face. The FTRBA is located within a wooded area in the southeastern portion of the Site. Excavation of the berm to remove any unexploded ordnance (UXO) or material potentially presenting an explosive hazard (MPPEH) buried within it has produced large numbers of items requiring on-site destruction by controlled detonation. The detonations eject some of the cover material used to dampen the dispersion of metal fragments produced by the destruction operation into the air. This cover material is predominantly sand. Given the number and size of the detonation shots that have been required, particulate sampling of the air near these detonation shots will be conducted to ensure that unsafe on-site conditions or unacceptable off-site impacts are not being generated by the detonation operations that are being performed under the direction of the Massachusetts State Police Bomb Squad. Observations of the initial detonations showed that the fallout or “throw” of the larger sand and cover material particles occurred within 5 to 10 seconds and was limited to a radius of 50 to 200 feet. The smoke and fine dust cloud generated stayed low to the ground (typically not rising above the top of the trees in the adjacent area) and dissipated within 30 to 120 seconds of the shot.

2.0 PROPOSED REMEDIAL ACTIVITIES

The activities associated with this Particulate Sampling Plan (PSP) relate primarily to the FTRBA and the on-site UXO destruction operations being conducted by the Massachusetts State Police Bomb Squad, addresses the monitoring of particulates generated by those detonations. This monitoring will be self-performed by Tetra Tech.

2.1 PARTICULATE CONDITIONS TO BE MONITORED

During a demolition shot, the items to be destroyed are positioned on a bed of sand in the RAM activity staging area at what will be the detonation point or, if the item was determined to not be safe to move, it will be prepared to be detonated in place. Items that are safe to move are positioned and the necessary donor charge and detonators are placed in relation to the items. The set-up is then covered carefully with sand to contain the dispersion of fragments and dampen the propagation of the overpressure and noise. Additional sand is added to the pile as required to control these aspects to acceptable levels. For an item that is not safe to move, the donor charge and detonator is placed around the item where it was discovered. The set-up is then covered carefully with sand and multiple sand bags are added to the pile to contain the fragments from the detonation and dampen the noise. Upon detonation, the cover sand is typically projected upward and outward. Given the size, shape and density of the sand particles, the ejected sand tends to fall back to the ground relatively quickly. For the shots that were conducted earlier in the project that used relatively larger amounts of donor charge, the radius within which the fallout was contained was up to 200 feet. More recently, when the number of concurrently destroyed items was reduced and the amount of donor explosives was reduced accordingly, the radius within which the fallout was contained has been more like 200 feet. The elected material tends to disperse in all direction within this circle (which is termed the "throw") within a few seconds. During a detonation, all on-site staff and emergency personnel are pulled away from the detonation point to a distance outside of the exclusion zone.

2.2 PARTICULATE PARAMETERS TO MONITOR

The most important measure of particulates in air from a public inhalation perspective is the Particulate Matter-2.5µm (PM2.5). This concentration (in units of $\mu g/m^3$) is the concentration of particulates that are respirable (i.e., with diameters greater than 0.1 micron and less than 2.5 microns). These particulates can be inhaled; but are large enough to not be immediately exhaled with the next breath and are small enough to be able to be deep in the lung and not be cleared by the body's mechanisms for removing particulates from the upper airways. A second measure of particulates of interest is the Particulate Matter-10µm (PM10). This concentration (also in units of $\mu g/m^3$) is the concentration of all particulates that are 10 microns in diameter or less and approximates the total particulates concentration. The PM10 monitoring data can be used to evaluate potential risks and the potential migration of contaminant-laden particles.

2.3 PARTICULATE MONITORING POINTS

Particulates released during the detonation shots will be monitored to ensure that there is no transport of particulates to areas accessible to the public that would create potential short-term or long-term health concerns. For this purpose, particulates will be monitored within the detonation area at the closest point outside the exclusion zone (EZ) in the downwind direction at the time of the shot. The typical wind direction at the EZ has been observed to be along a northwest/southeast axis. This monitor will be placed in a cleared area to the northwest of the detonation point. Monitors also will be positioned on-site but as close as possible to the nearest residential areas. These two areas are the Hanover Waterford residential development located east of the detonation point and the homes in Hanson across Lower Factory Pond south of the detonation points. The particulate sampling point relative to the Waterford development will be on the property boundary path on the hill above the Former Test Range Berm just inside the fence on a line from the detonation point to the nearest home. Similarly, the sampling point relative to the Hanson homes south of Lower Factory Pond will be located on the old perimeter service road just inside the fence on a line from the detonation point to the nearest home on the other side of the pond. These particulate monitoring points are illustrated in Figure 2-1. Given this monitor siting approach, the location of the three monitoring points will not change over the course of a sampling event.

2.4 PARTICULATE MONITORING INSTRUMENTATION

The ambient air monitoring will be performed using a set of three TSI DUSTTRAK DRX Desktop 8533 Dust/Aerosol Monitors (one for each identified monitoring point) or equivalent. This instrument is capable of simultaneously measuring the PM2.5 and PM10 particulate concentrations in the air for ambient particulate concentrations between 1-150,000 $\mu g/m^3$. The instrument positioned at each monitoring point will be operated continuously logging particulate data every 10 seconds for eight hours during the RAM work-day. This period would typically include 2 to 4 detonation shots and the intervals of excavation and screening/sifting between them. The sampling instructions and operation protocol for this instrument is included as Attachment A. The battery life of the monitor is typically 24-40 hours between recharges. Particulate monitoring results will be compared to the action levels described below.

2.5 FREQUENCY OF MONITORING

The base period of monitoring will be one week. This sampling period will be preceded by a test-out period to ensure the instrument is in good working order. The need for continued sampling beyond this period will be determined based on the results of the initial data.

2.6 DEVELOPMENT OF THE PARTICULATE ACTION LEVELS

To judge the significance of the particulate concentrations measured at the boundary of the EZ and the selected property fence lines during detonation events, particulate action levels were developed. The approach used to development these action levels considered the overall concentration of total particulates as well as the potential metals and explosives composition of the particulates (the constituents of potential concern for a munitions item detonation). The steps of the process included:

1. Record the National Ambient Air Quality Standard (NAAQS) concentrations for PM2.5 and PM10.

2. Identify a risk-based inhalation exposure concentration or appropriate regulatory ambient air target concentration for the air toxics constituents that could be associated with the particulates ejected from the detonation set-up and its associated exposure/averaging time for compliance or screening. The hierarchy of these target levels that was applied was:

   <u>Public Protection</u>

   A. MassDEP Threshold Effects Exposure Levels (TELs) which are 24-hour average air toxics guideline values. These values were last updated in January of 2015. The corresponding Allowable Ambient Limits (AALs) are annual average concentration limits developed for longer-term exposure scenarios. The AALs were not appropriate for these very short potential exposure episodes.

   B. USEPA Regional Screening Levels for Residential Air which are risk-based longer-term chronic inhalation exposure limits corresponding to an individual constituent excess inhalation cancer risk of $1x10^{-6}$ or an individual constituent inhalation Hazard Quotient of 1.

These values are tabulated in the central columns of Table 2-1.

As the monitoring instrument to be employed only records total particulate PM2.5 and PM10 measurements (i.e., not chemical-specific particulate concentrations), the constituent-specific concentrations shown in Table 2-1 must be expressed as an equivalent total particulate concentration (comparable to PM10) using some assumption regarding the composition of the particles that are ejected during a detonation. As described above, the approach for dampening the sound and dispersion of blast fragments during the detonation shots involves the placement of large quantities of clean sand over the staged items, and it is this sand that is the material that is primarily ejected during a controlled detonation. The imported fill material that was brought onto the site for the RAM stabilization effort for the CWA was essentially the same material as the sand being used as cover material for the detonations. The CWA fill sand was analyzed and the results for this material also are shown on the left side of Table 2-1.

These ambient air target concentrations were then combined with the analytical data for the clean imported fill and the required unit conversion factors to estimate a total particulates concentration that would correspond to the risk-based or regulatory ambient air target concentration for the constituent of concern. The equation used was:

$$AL_{TPi} = \frac{AATC_i}{CMC_i}\ x \left[\frac{mg_i}{1000\ \mu g_i}\right] x \left[\frac{1000\ g}{kg}\right] x \left[\frac{1000\ mg}{g}\right] x \left[\frac{1000\ \mu g}{mg}\right]$$

Where:

AL_{TPi} = Action Level for Total Particulates [$\mu g_{TP}/m^3$] (approximately equivalent to PM10);

AATCi = Ambient Air Target Concentration for constituent i [$\mu g_i/m^3$]; and

CMCi = Cover Material Concentration of constituent i [mg_i/kg].

The AL_{TPi} for each constituent was calculated as shown on the far right column of Table 2-1. The lowest value from this set would then be the total particulate concentrations that would achieve or comply with all of the published constituent-specific concentrations. This value turned out to be 94 µg/m3, which was calculated to correspond to the chronic cobalt UESPA RSL Residential Air screening level. This risk-based value corresponds to an excess cancer risk of $1x10^{-6}$ and continuous long-term exposure. As such, a value for shorter duration potential exposures and an excess cancer risk of $1x10^{-5}$ would be at least an order of magnitude higher.

As seen in Table 2-1, the NAAQSs for particulate matter are:

- PM2.5 Primary/Welfare-based NAAQS evaluated on a 24-hour average = 35 $\mu g/m^3$
- PM10 Primary/Welfare-based NAAQS evaluated on a 24-hour average = 150 $\mu g/m^3$

Since the air toxics AL_{TP} value calculated for the potential cobalt presence in the cover material was less that the PM10 NAAQS value of 150 µg/m^3, a PM10 action level of 94 µg/m^3 based on an 8-hour average was adopted for both PM2.5 and PM10 for evaluating public protection. This action level is very conservative relative to potential inhalation exposures during these detonation activities given its basis is long-term chronic exposure over a longer exposure duration.

2.7 Analysis of the Collected Data

The collected particulate concentration results will be compiled, interpreted, and presented in a Technical Memorandum. This information will be used to inform any required decision-making to protect public health and document conditions created by these RAM activities.

3.0 PROCUREMENT

The additional procurement support required to implement this the particulate monitoring described in this PMP will be limited to the rental of a set of monitoring instruments. Procurement of this equipment and any needed supplies will be performed using a purchase requisition to a proven supplier.

4.0 IMPLEMENTATION SCHEDULE (310 CMR 40.0444(1)(C))

This monitoring will begin as soon as the PMP is completed and approved, the instruments, can be rented, and the field personnel are trained in their set-up and use. This is expected to be during the week of August 1, 2017. The baseline duration of monitoring is planned to be five work days (one workweek).

Figure 1-1. Site Layout of the Fireworks Site

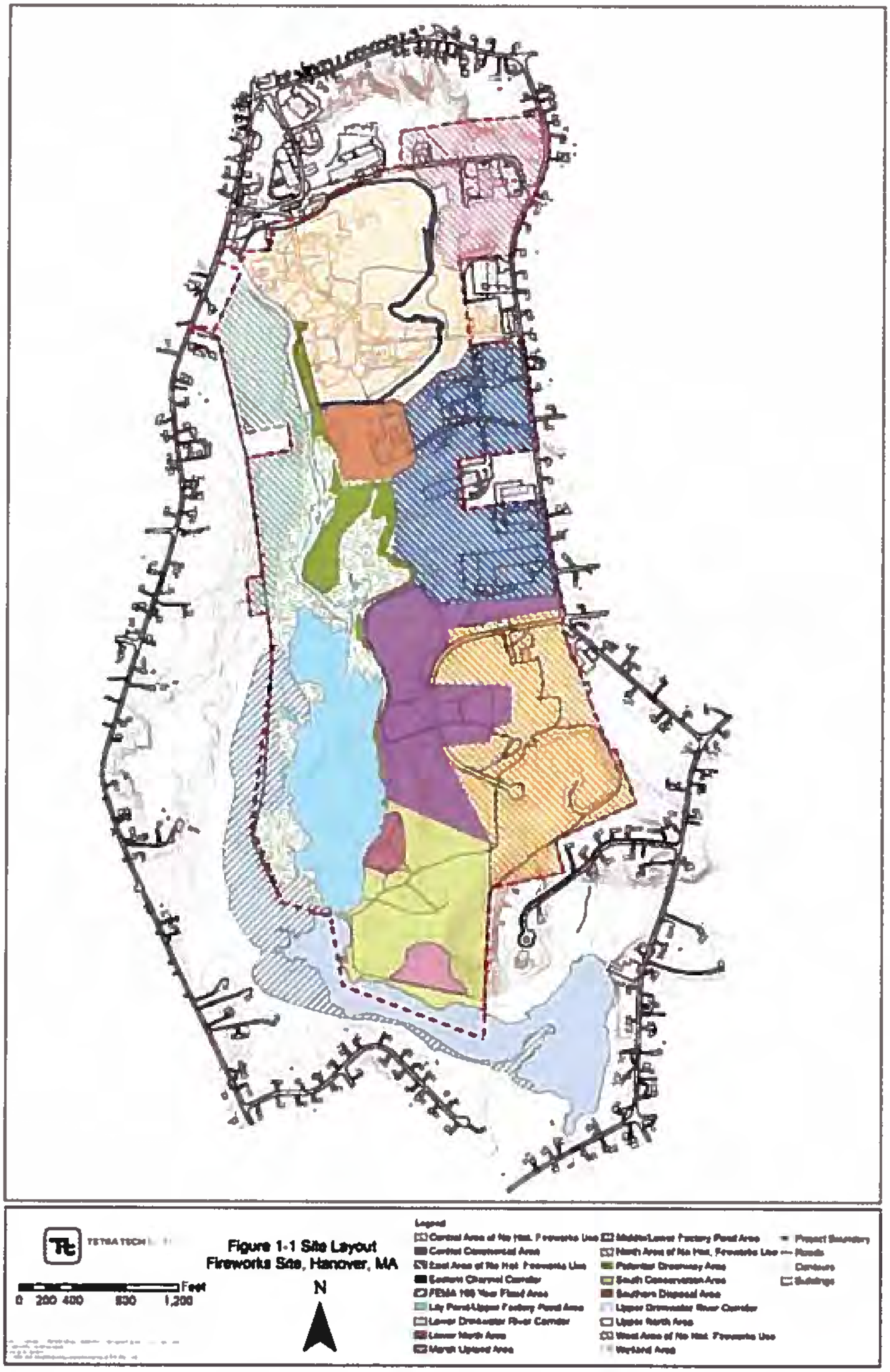
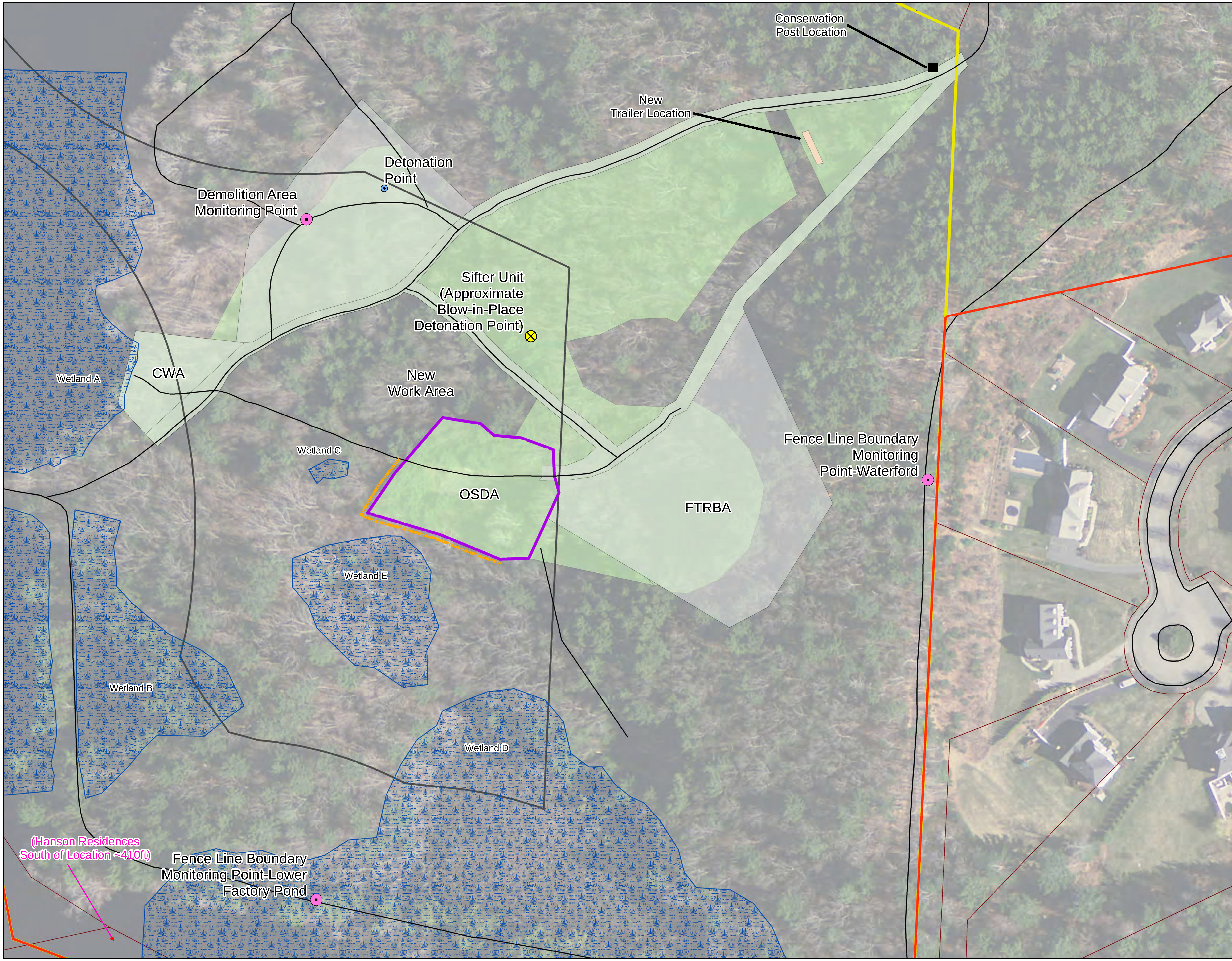


Figure 1-1. Site Layout of the Fireworks Site

Figure 2-1. Illustrative Particulates Monitoring Point Placement



Legend

- Project Boundary
- Detonation Point
- Wetland Boundary
- Property Boundary
- Road
- Fence
- Cleared Area
- CONCOM Approved
- 450' Parcel Boundary Buffer
- Parcel Boundary
- Silt Sock

CWA = Cold Waste Area

FTRBA = Former Test Range Berm Area

OSDA = Open Space Disposal Area

Note: Wetlands Delineated by Edward Hutchinson of Tetra Tech, November 2016

Pariculates Monitoring Point Locations Fireworks Site, Hanover, Plymouth County, MA

Applicant:
Fireworks Joint Defense Group
Property Owner:
Town of Hanover
Address:
Rear King Street (between King St. and Winter ST.)
Lot 68-45
Prepared by:
Tetra Tech Inc. 12/13/17

TETRA TECH

N

Feet
0 75 150

1 inch = 50 feet

Table 2-1. Development of Short-term Particulate Action Levels for Detonation Shot Air Monitoring

Table 2-1. Development of Short-Term Particulate Action Levels for Detonation Shot Air Monitoring

Client Sample ID	CAS	Analyte	Result	Unit	Flag	Standard	Value	Units	Averaging Time	Standard	Value	Units	Averaging Time	Target Concentration (µg/m^3)	Assumed Particulate Concentration	Unit	Net Conversion Factor	Target Total Particulate Concentration (µg/m^3)
FW-CWA-IF	7429-90-5	Aluminum	5650	mg/Kg		RSL RA	5.2	µg/m3						5.2	5650	mg/Kg	1000000	920
FW-CWA-IF	7440-36-0	Antimony	0.54	mg/Kg	U	TEL	0.02	µg/m^3	24-hour	AAL	0.02	µg/m^3	annual	0.02	0.27	mg/Kg	1000000	74074
FW-CWA-IF	7440-38-2	Arsenic	2.2	mg/Kg		TEL	0.003	µg/m^3	24-hour	AAL	0.0003	µg/m^3	annual	0.003	2.2	mg/Kg	1000000	1364
FW-CWA-IF	7440-39-3	Barium	23.6	mg/Kg		RSL RA	0.52	µg/m3						0.52	23.6	mg/Kg	1000000	22034
FW-CWA-IF	7440-41-7	Beryllium	0.29	mg/Kg		TEL	0.001	µg/m^3	24-hour	AAL	0.0004	µg/m^3	annual	0.001	0.29	mg/Kg	1000000	3448
FW-CWA-IF	7440-43-9	Cadmium	0.089	mg/Kg	J	TEL	0.002	µg/m^3	24-hour	AAL	0.0002	µg/m^3	annual	0.002	0.089	mg/Kg	1000000	22472
FW-CWA-IF	7440-70-2	Calcium	5170	mg/Kg	B											mg/Kg		
FW-CWA-IF	7440-47-3	Chromium	10.7	mg/Kg		TEL	1.36	µg/m^3	24-hour	AAL	0.68	µg/m^3	annual	1.36	10.7	mg/Kg	1000000	127103
FW-CWA-IF	7440-48-4	Cobalt	3.3	mg/Kg		RSL RA	0.00031	µg/m3						0.00031	3.3	mg/Kg	1000000	94
FW-CWA-IF	7440-50-8	Copper	4.8	mg/Kg		TEL	0.54	µg/m^3	24-hour	AAL	0.54	µg/m^3	annual	0.54	4.8	mg/Kg	1000000	112500
FW-CWA-IF	7439-89-6	Iron	9640	mg/Kg		RSL RA	No Value									mg/Kg		
						NAAQS Primary	0.15	µg/m^3	3-mo rolling	NAAQS Secondary	0.15	µg/m^3	3-mo rolling	0.15	6.1	mg/Kg	1000000	24590
FW-CWA-IF	7439-92-1	Lead	6.1	mg/Kg		TEL	0.14	µg/m^3	24-hour	AAL	0.07	µg/m^3	annual	0.14	6.1	mg/Kg	1000000	22951
FW-CWA-IF	7439-95-4	Magnesium	1860	mg/Kg	B	RSL RA	No Value									mg/Kg		
FW-CWA-IF	7439-96-5	Manganese	187	mg/Kg		RSL RA	0.052							0.052	187	mg/Kg	1000000	278
FW-CWA-IF	7440-02-0	Nickel	6.3	mg/Kg		TEL	0.27	µg/m^3	24-hour	AAL	0.18	µg/m^3	annual	0.27	6.3	mg/Kg	1000000	42857
FW-CWA-IF	7440-09-7	Potassium	487	mg/Kg		RSL RA	No Value									mg/Kg		
FW-CWA-IF	7782-49-2	Selenium	0.54	mg/Kg	U	TEL	0.54	µg/m^3	24-hour	AAL	0.54	µg/m^3	annual	0.54	0.27	mg/Kg	1000000	2000000
FW-CWA-IF	7440-22-4	Silver	0.54	mg/Kg	U	RSL RA	No Value									mg/Kg		
FW-CWA-IF	7440-23-5	Sodium	66.5	mg/Kg	J B	RSL RA	No Value									mg/Kg		
FW-CWA-IF	7440-28-0	Thallium	1.1	mg/Kg	U	RSL RA	No Value									mg/Kg		
FW-CWA-IF	7440-62-2	Vanadium	17.6	mg/Kg		TEL	0.27	µg/m^3	24-hour	AAL	0.27	µg/m^3	annual	0.27	17.6	mg/Kg	1000000	15341
FW-CWA-IF	7440-66-6	Zinc	21	mg/Kg		RSL RA	No Value									mg/Kg		
FW-CWA-IF	14797-73-0	Perchlorate	0.24	ug/Kg	J B	RSL RA	No Value									ug/Kg		
FW-CWA-IF	7439-97-6	Mercury	0.021	mg/Kg	U	TEL	0.14	µg/m^3	24-hour	AAL	0.01	µg/m^3	annual	0.14	0.0105	mg/Kg	1000000	13333333
FW-CWA-IF	99-35-4	1,3,5-Trinitrobenzene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	99-65-0	1,3-Dinitrobenzene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	118-96-7	2,4,6-Trinitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	6629-29-4	2,4-diamino-6-nitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	121-14-2	2,4-Dinitrotoluene	94.2	µg/Kg	U	RSL RA	0.032	µg/m3						0.032	47.1	µg/Kg	1000000	679
FW-CWA-IF	59229-75-3	2,6-diamino-4-nitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	606-20-2	2,6-Dinitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	35572-78-2	2-Amino-4,6-dinitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	88-72-2	2-Nitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	99-08-1	3-Nitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	19406-51-0	4-Amino-2,6-dinitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	99-99-0	4-Nitrotoluene	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	2691-41-0	HMX	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	98-95-3	Nitrobenzene	94.2	µg/Kg	U	TEL	13.690	µg/m^3	24-hour	AAL	6.84	µg/m^3	annual	13.69	47.1	µg/Kg	1000000	290658
FW-CWA-IF	55-63-0	Nitroglycerin	1880	µg/Kg	U *	RSL RA	No Value									µg/Kg		
FW-CWA-IF	78-11-5	PETN	4710	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	88-89-1	Picric acid	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	121-82-4	RDX	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
FW-CWA-IF	479-45-8	Tetryl	94.2	µg/Kg	U	RSL RA	No Value									µg/Kg		
																	Minimum	94
																		150

Notes:

PM2.5 NAAQS Standards: NAAQS Annual Average= 12 µg/m^3 (Primary)
NAAQS Annual Average= 15 µg/m^3 (Secondary based on Welfare)
NAAQS 24-hour = 35 µg/m^3 (Primary and Secondary)

PM10 NAAQS Standards: NAAQS 24-hour = 150 µg/m^3 (Primary)
NAAQS 24-hour = 150 µg/m^3 (Secondary based on Welfare)

RSL residential air screening levels are in gray.
NAAQS = USEPA National Ambient Air Quality Standard
RSL RA = USEPA Regional Screening Levels for Residential Air
TEL = MassDEP Threshold Effects Exposure Levels
AAL = MassDEP Allowable Ambient Limits
J = Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
B = Compound was found in the blank and sample.
U = Indicates the analyte was analyzed for but not detected.
* = LCS or LCSD is outside acceptance limits.
Assumed particulate concentrations for chemicals that were not detected were assumed to be 1/2 the detection limit presented in the Results column.

ATTACHMENT A

Particulate Sampling Instructions and Instrument Operational Protocol

Particulate Sampling Instructions
RAM for the Former Test Range Berm Area and the Cold Waste Area
National Fireworks Site, Hanover, MA

I. Ensure that the air monitors are fully charged the night before a planned monitoring day.

II. The day of planned monitoring, each monitor should be placed at its designated location on top of a stable surface at least 8 hours before the intended shut-off and pick up time. Air monitor locations include:
   a. Inside the Site property boundary fence on a line from the detonation point to the nearest homes at the Waterford development.
   b. Inside the Site property boundary fence on a line from the detonation point to the nearest Hanson homes south of Lower Factory Pond.
   c. Just outside the exclusion zone (EZ) in the clearing to the northwest of the detonation point. This monitor should be set behind a shield (i.e., metal drum) to for protection from rocks that could possibly be projected from the detonations.

III. On the first day of monitoring, take photos of each monitoring location site. Record the weather conditions for the day on the Monitoring Log provided in Attachment B.

IV. Before setting the monitors to begin to collect data, record the date, monitor instrument number, the sampling location, and the sampling start time on the particulate monitoring log found in Attachment B.

V. To start the machine:
   a. Turn unit on using the on/off button found at the top of the device just above the screen.
   b. Once the machine is on, verify the battery is fully charged.
   c. Next, select the Setup tab at the bottom of the screen.
      i. From the Setup tab, the **Zero Cal** operation can be selected. Run the Zero Cal by following the instructions on the monitor display before each day of testing in the location where the monitor is being placed. This operation requires using the white zero filter which should be removed once the Zero Cal has been completed.
      ii. Once the Zero Cal has been completed, check the **Flow Cal** to make sure the flow rate is 1.00.
      iii. Select the **User Cal** and use the scroll box to select **Ambient Cal**.
         1. The Ambient Cal **Size Corr** should be set to 1.00, the factory machine setting is based on particle distributions from Arizona Road Dust. The size correlation for comparison of the factory setting for particle size distribution and the particle size distribution at this Site was tested on 8-2-17. The results indicated that the particle size distribution at the site had a size correlation factor of 1.01 (a 1% difference from the factory settings). Because this correlation had a less than 5% difference from the factory settings (1.00), the Size Corr was left a 1.00 for all units.

iv. Verify all alarms are off for each unit by selecting **Alarms** and using the dropdown box for each of the five alarm types. Alarms should be off so as not to disturb residential areas. The five alarm settings that include:
   1. AlarmPM1
   2. AlarmPM2.5
   3. AlarmResp
   4. AlarmPM10
   5. AlarmTotal

d. Next, select the **Run Mode** tab at the bottom of the screen and use the dropdown box to set the Run Mode to **Manual**.
   i. The **log interval** should be 10 seconds (i.e., the length of time between air testing events).
   ii. Set the **test length** to 8 hours (i.e., the length of time during which the testing events take place).
   iii. Set the **time constant** to 60 seconds (i.e., how often the main screen updates real-time information).

e. Next, select the **Settings** tab at the bottom of the screen and verify that the date and time are accurate for each unit.

f. Before being the particulate monitoring process, verify that the Zero Cal filter has been removed from the intake valve and place the inlet cap on top of the intake valve for each unit before starting.

g. Go to the **Main** tab on the bottom of the screen, press **Start** to begin recording particulate data.

VI. Verify the Flow, Laser, and Filter light are all green on the monitor display screen. If a light is red, consult the operation manual for the monitor included with these instructions in Attachment A.

VII. After 8 hours press **Stop** to stop recording data for all units. Collect each unit from its sampling location. If possible, leave the stable surface in place to ensure that data is being collected each day at the same location.

a. The machine automatically stores collected data so the entire machine can be turned off using the on/off button at the top of the monitor and the data will be stored internally.

b. If possible data should be uploaded to a computer for permanent storage before the next day.

VIII. The units cannot be left outside while it is raining without a waterproof encasement. If rain is suspected to take place during a testing day, the monitor should either be placed inside a waterproof encasement or should be stopped and collected during the duration of the rain event. The monitor should be placed back in the sampling location at the end of the rain event. Any disruptions in monitoring should be logged with a description of why monitoring was stopped using the Monitoring Log found in Attachment B.

IX. Monitors should be placed in the same locations at each of the three sampling locations for 5 consecutive, 8-hour workdays.

DUSTTRAK™ DRX
AEROSOL MONITOR
MODEL 8533/8534/8533EP

OPERATION AND SERVICE MANUAL

P/N 6001898, REVISION M
JANUARY 2017

DustTrak DRX 8533 Desktop and 8534 Handheld

DustTrak DRX 8533EP Monitor

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LIMITATION OF WARRANTY AND LIABILITY (effective April 2014)
(For country-specific terms and conditions outside of the USA, please visit www.tsi.com.)

Seller warrants the goods, excluding software sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for twenty-four (24) months, or if less, the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions and exceptions:

a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment;
b. DustTrak internal pump for Models 8530 and 8533 is warranted for two (2) years or 4000 hours, whichever comes first;
c. DustTrak external pump for Models 8530EP and 8533EP is warranted for two (2) years or 8760 hours, whichever comes first;
d. DustTrak internal pump for Models 8530 and 8533 is warranted for operation within ambient temperatures between 5–45°C. Warranty is void when the internal pump is operating outside of this temperature range;
e. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment;
f. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies;
g. This warranty does not cover calibration requirements, and seller warrants only that the instrument or product is properly calibrated at the time of its manufacture. Instruments returned for calibration are not covered by this warranty;
h. This warranty is **VOID** if the instrument is opened by anyone other than a factory authorized service center with the one exception where requirements set forth in the manual allow an operator to replace consumables or perform recommended cleaning;
i. This warranty is **VOID** if the product has been misused, neglected, subjected to accidental or intentional damage, or is not properly installed, maintained, or cleaned according to the requirements of the manual. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

The foregoing is **IN LIEU OF** all other warranties and is subject to the **LIMITATIONS** stated herein. **NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. WITH RESPECT TO SELLER'S BREACH OF THE IMPLIED WARRANTY AGAINST INFRINGEMENT, SAID WARRANTY IS LIMITED TO CLAIMS OF DIRECT INFRINGEMENT AND EXCLUDES CLAIMS OF CONTRIBUTORY OR INDUCED INFRINGEMENTS. BUYER'S EXCLUSIVE REMEDY SHALL BE THE RETURN OF THE PURCHASE PRICE DISCOUNTED FOR REASONABLE WEAR AND TEAR OR AT SELLER'S OPTION REPLACEMENT OF THE GOODS WITH NON-INFRINGING GOODS.**

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Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer of Seller.

Service Policy
Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (800) 874-2811 (USA) or (001 651) 490-2811 (International) or visit www.tsi.com.

CONTENTS

These Application Notes can also be found on TSI's web site:
http://www.tsi.com

EXPMN-002 DustTrak DRX Theory of Operation.pdf
EXPMN-004 DRX-TEOM Comparison.pdf
EXPMN-005 DustTrak DRX Standard and Advance Calibration.pdf

Safety Information

IMPORTANT
There are no user serviceable parts inside the instrument. Refer all repair and maintenance to a qualified factory-authorized technician. All maintenance and repair information in this manual is included for use by a qualified factory-authorized technician.

Laser Safety

- The Model 8533/8534 DustTrak DRX monitor is a Class I laser- based instrument
- During normal operation, you will ***not*** be exposed to laser radiation
- Precaution should be taken to avoid exposure to hazardous radiation in the form of intense, focused, visible light
- Exposure to this light may cause blindness

Take these precautions:

- ***DO NOT*** remove any parts from the DustTrak DRX monitor unless you are specifically told to do so in this manual
- ***DO NOT*** remove the housing or covers. There are no serviceable components inside the housing

WARNING
The use of controls, adjustments, or procedures other than those specified in this manual may result in exposure to hazardous optical radiation.

WARNING
There are no user-serviceable parts inside this instrument. The instrument should only be opened by TSI or a TSI approved service technician.

WARNING
If the DustTrak monitor is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

When operated according to the manufacturer's instruction, this device is a Class I laser product as defined by U.S. Department of Health and Human Services standards under the Radiation Control for Health and Safety Act of 1968. A certification and identification label like the one shown below is affixed to each instrument.

Labels

Advisory labels and identification labels are attached to the instrument.

1. Serial Number Label (bottom)	
2. Laser Radiation Label (internal)	**DANGER!** VISIBLE LASER RADIATION WHEN OPEN. AVOID DIRECT EXPOSURE TO BEAM WARNING: NO USER SERVICABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL
3. Battery label	 or 
4. European symbol for non-disposable item. Item must be recycled.	

Description of Caution/Warning Symbols

Appropriate caution/warning statements are used throughout the manual and on the instrument that require you to take cautionary measures when working with the instrument.

Caution

C a u t i o n

Failure to follow the procedures prescribed in this manual might result in irreparable equipment damage. Important information about the operation and maintenance of this instrument is included in this manual.

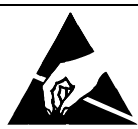
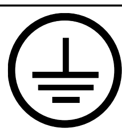
Warning

W A R N I N G

Warning means that unsafe use of the instrument could result in serious injury to you or cause damage to the instrument. Follow the procedures prescribed.

Caution and Warning Symbols

The following symbols may accompany cautions and warnings to indicate the nature and consequences of hazards:

	Warns that the instrument contains a laser and that important information about its safe operation and maintenance is included in the manual.
	Warns that the instrument is susceptible to electro-static discharge (ESD) and ESD protection should be followed to avoid damage.
	Indicates the connector is connected to earth ground and cabinet ground.

Reusing and Recycling

As part of TSI Incorporated's effort to have a minimal negative impact on the communities in which its products are manufactured and used:

- Do ***not*** dispose of used batteries in the trash. Follow local environmental requirements for battery recycling.
- If instrument becomes obsolete, return to TSI for disassembly and recycling.

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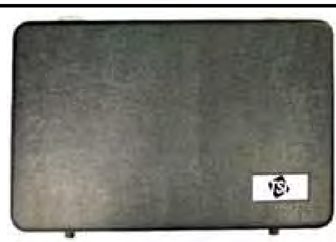
Chapter 1

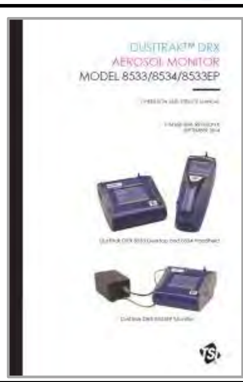
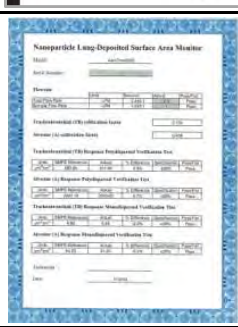
Unpacking and Parts Identification

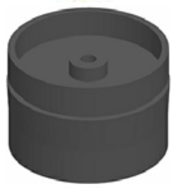
Carefully unpack the Model 8533/34 DustTrak DRX Aerosol Monitor from the shipping container. Use the tables and illustrations below to make certain that there are no missing components. Contact TSI immediately if anything is missing or damaged.

Unpacking the DustTrak DRX Aerosol Monitor

Compare all the components you received with those listed in the table below. If any parts are missing, contact TSI.

Item	**Qty**	**Part Number**	**Description**
 *or* 	1	8533 8534	Desktop DRX Handheld DRX
	1	801670 801669	Desktop DRX Carrying Case Handheld DRX Carrying Case
	1	1090014	Data Analysis Software CD-ROM

Item	Qty	Part Number	Description
	1	800663	Zero Filter
 *or* 	1	801680 801681	7800 mAH Lithium Ion Rechargeable Battery (Desktop) Rechargeable lithium ion battery (Handheld)
	1	1303740	USB cable
	1	801652	Analog/alarm output cable (Desktop models only)
	1	6001898	Operation and Service Manual
	1	N/A	Calibration Certificate

Item	Qty	Part Number	Description
	1	801688	Conductive Tubing
	1	801668	Filter removal tool (Spanner Driver)
  	4 2 1	801673	Spare Internal Filter Elements Desktop Model Only 37-mm filter includes: Filter body top Filter body bottom Mesh Screen Comes with 37-mm cartridge opening tool.
	8	801666	Spare Internal Filters Handheld Model Only
	1	801671	Calibration Impactor Kit $PM_{2.5}$ which includes: Impactor top Impactor bottom Impaction plate

Item	Qty	Part Number	Description
	1	801692	Power Supply – Desktop
		801694	Power Supply - Handheld
	2	N/A	Stylus When shipped, one stylus will be in the accessory bag, the second stylus is attached to instrument.
	1	3012094	Screwdriver, dual ended. (For Handheld Models only)
	1	801674	Impactor Oil
	2	801698	Inlet cap When shipped, one inlet will be in the accessory bag, the second inlet is attached to instrument.
	1	801675	External Pump Kit *for 8533EP only*

Item	Qty	Part Number	Description
	1	801797	External Pump Power Cable (to DustTrak monitor) *for 8533EP only*
	1	801798	External Pump Flow Tube (to DustTrak monitor) *for 8533EP only*
	1		Exhaust Adapter, DustTrak monitor *for 8533EP only*

Optional Accessories

The following photos and table list optional accessories. If you ordered optional accessories, make certain they have been received and are in working order.

Accessories	Qty	Part Number	Description
	1	801675	External Pump Kit *for 8533EP only*
	2	801795	DustTrak II/DRX External Pump Service Kit for 8533EP only. Contains two filters for External Pump.
	1	801685	Battery Charger, 2-Bay, Battery 801680 for Desktop DustTrak monitor
	1	801686	Battery Charger, Battery 801681 for Handheld DustTrak monitor

Parts Identification for the DustTrak DRX Desktop Aerosol Monitor Model 8533

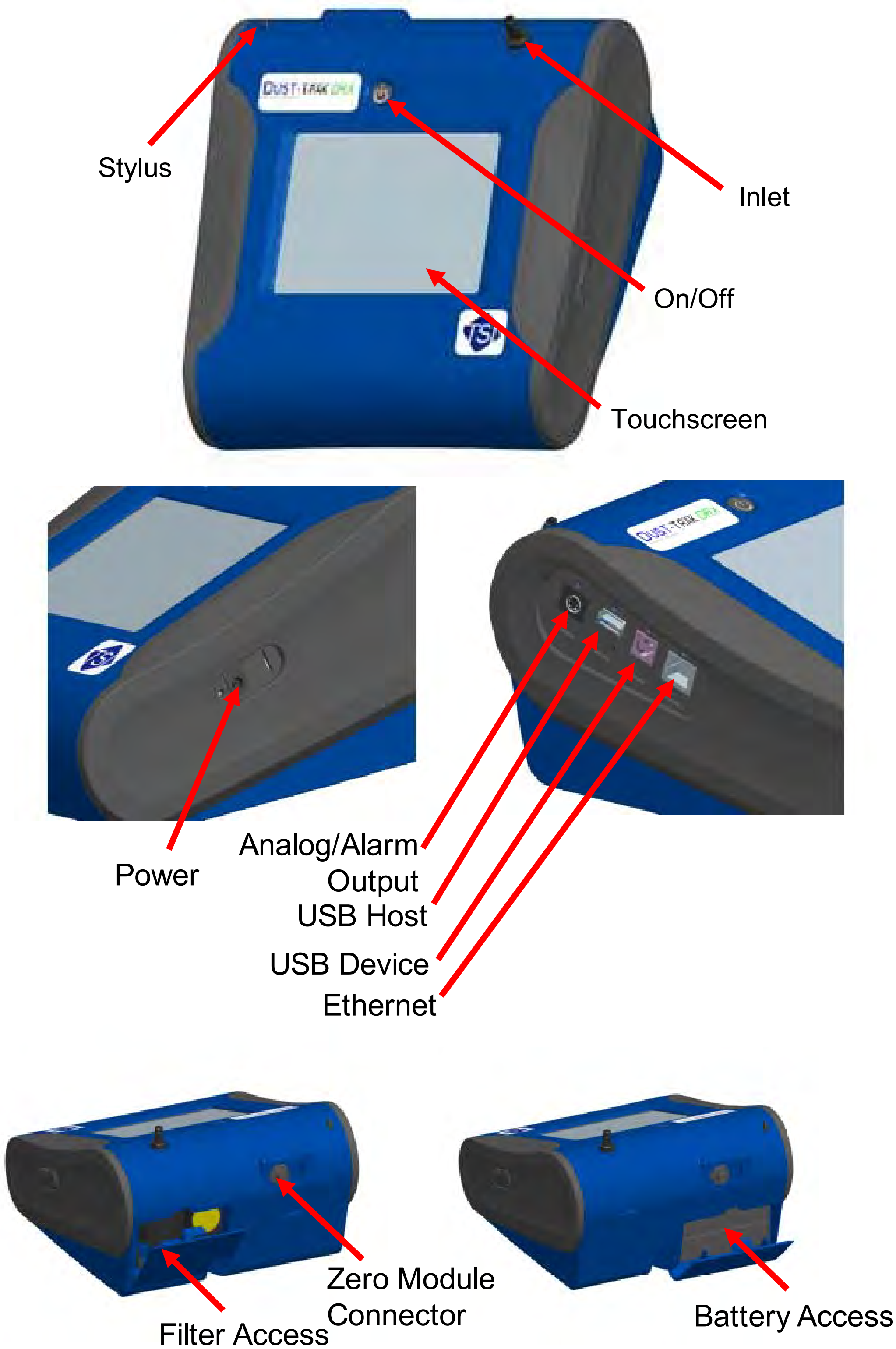
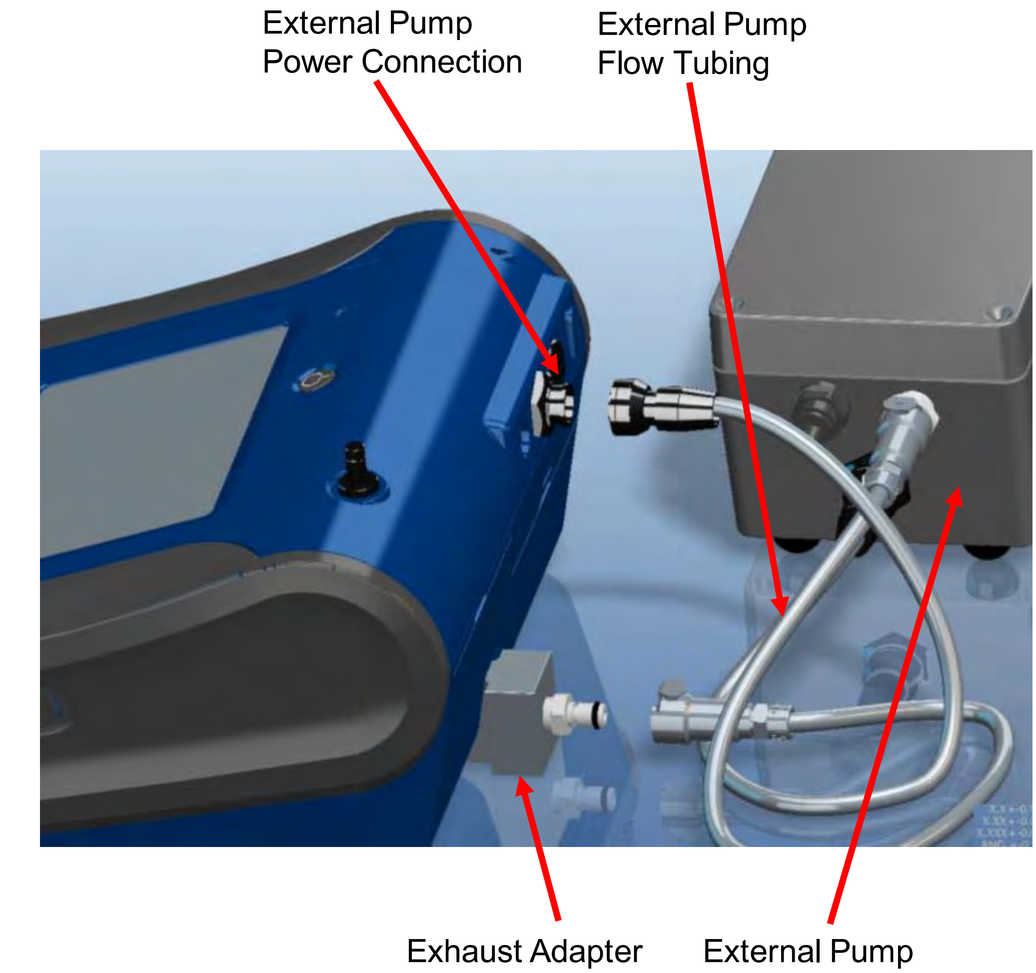


Figure 1-1: Features on Desktop Model

Parts Identification for the DustTrak II Desktop Aerosol Monitor Model 8533EP



External Pump Module (8533EP only)

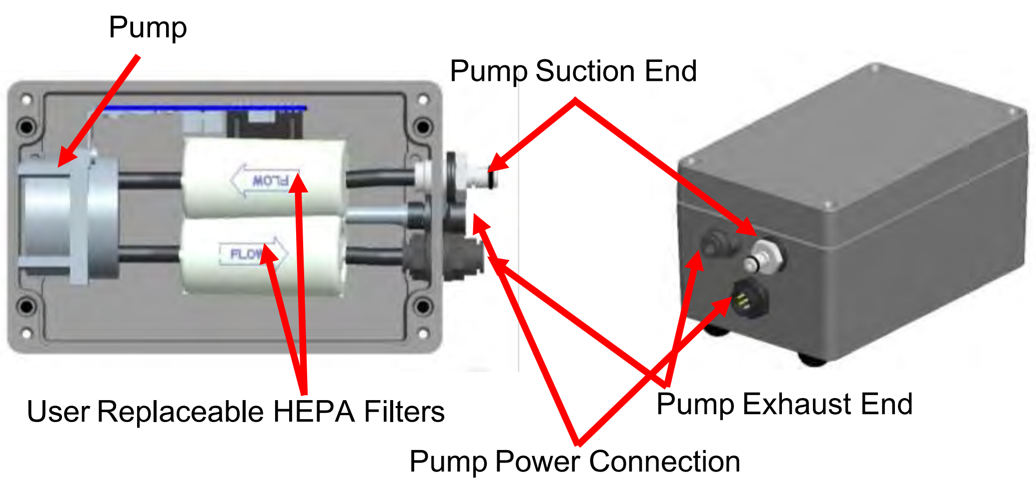


Figure 1-2: Features on Desktop Model 8533EP

Parts Identification for the DustTrak DRX Handheld Aerosol Monitor Model 8534

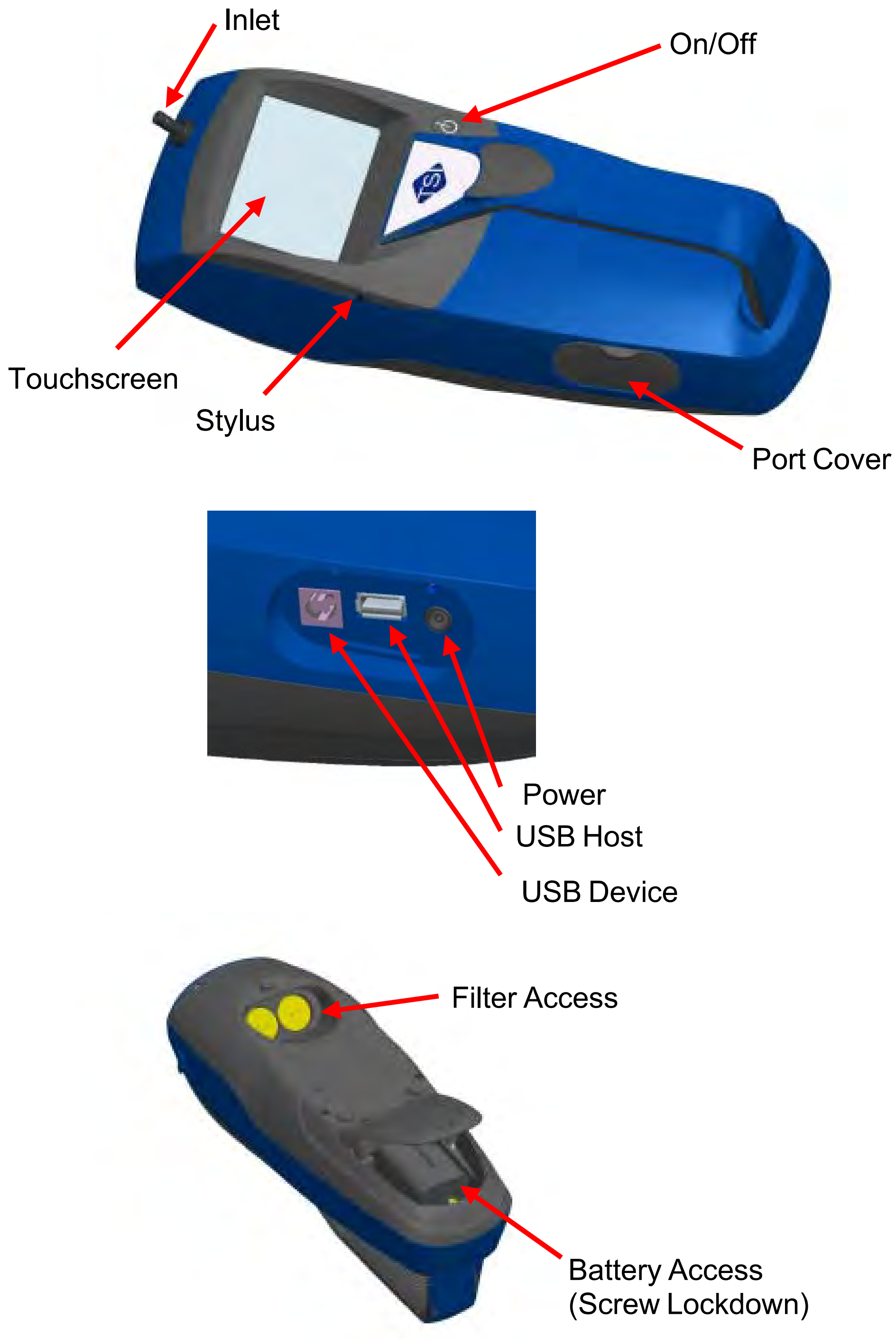


Figure 1-3: Features on Handheld Model

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Chapter 2

Setting Up

Supplying Power to the DustTrak DRX Aerosol Monitor

The Model 8533 and 8534 DustTrak DRX Aerosol Monitor must be powered by either batteries or using the external AC adapter.

WARNING

The instrument has been design to be used with batteries supplied by TSI. Do ***not*** use a substitute.

Disposing of old batteries must be recycled in accordance with the local environmental regulations.

WARNING

Do ***not*** use non-rechargeable batteries in this instrument. Fire, explosions, or other hazards may result.

Installing the Batteries in 8533/8533EP Desktop

Remove the battery cover and slide one or two batteries into the battery slots. A single battery can be put into either slot. Orient the batteries with the label side facing up (see Figure 2-1).

Figure 2-1: Batteries into Desktop Unit

Installing the Batteries in 8534 Handheld

Remove the battery cover by loosening captured screw on the bottom of the unit. Orient battery with brass connectors facing forward. Insert battery into cavity and slide forward to engage into pins. Replace the battery cover and secure by tightening screw (see Figure 2-2).

Figure 2-2: Batteries into Handheld Unit

Connecting the External Pump to DustTrak Model 8533EP

The Model 8533EP is a Desktop DustTrak monitor with an external pump. This DustTrak monitor has no internal pump and will not work with any other external pump other than the one provided by TSI (p/n 801675). The Model 8533EP is intended for applications where the DustTrak monitor is operated continuously over extended periods (several days to months) under wide temperature fluctuations (0 to 50°C). The external pump is designed to be more robust for 24/7 operation of the DustTrak monitor and is warranted to operate continuously for one full year or 8760 hours. The Model 8533EP is ideal for fugitive dust monitoring.

The pump and the DustTrak monitor come separately and require assembly. Follow the steps below to connect the pump with the Model 8533EP DustTrak monitor.

W A R N I N G
Turn the DustTrak monitor OFF before connecting the external pump. Turn the DustTrak monitor ON only after connecting the External Module.

1. Connect the pump end of the quick connect to the pump module (see Figure 2-3).

Figure 2-3: Connect Pump End of Quick Connect to Pump Module

2. Likewise, plug one end of the power connector to the pump module as shown above. Turn the power connector until it clicks and locks in place. This prevents the connector from disconnecting due to vibration or movement.

3. Connect the exhaust adapter to the exhaust of the DustTrak monitor (see Figure 2-4).

Figure 2-4: Connect Exhaust Adapter to Exhaust of DustTrak Monitor

4. Connect the other end of the flow tubing to the exhaust adapter of the DustTrak monitor.

5. Connect the other end of the power connector to the DustTrak monitor (see Figure 2-5).

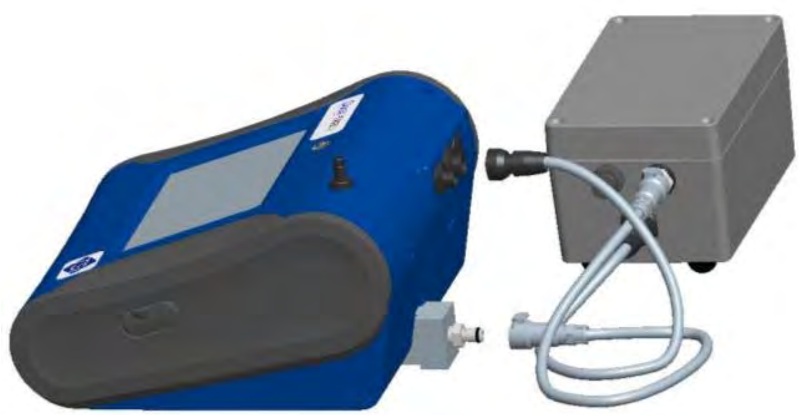


Figure 2-5: Connect Power Connector to DustTrak Monitor

WARNING

The Pump module design does not allow for installation outdoors without any protection from the elements. Always operate it within an enclosure.

The DustTrak external pump module does not require an A/C adapter. It is always powered off the DustTrak monitor.

Notes

1. The power connector and the flow quick connect “click” when securely connected. The power connector must be rotated clockwise past the locking pin.
2. Do ***not*** hot-plug the External Pump Module when the DustTrak monitor is turned ON. Always connect the External Pump module first and then turn the DustTrak monitor ON.
3. TSI recommends that the DustTrak monitor with the external pump be operated in the Model 8535 Environmental Enclosure.
4. TSI recommends that the pump module be operated when mounted on its feet and avoid operating at other orientations as much as possible.
5. Pump module and the DustTrak monitor should be at the same electrical potential.
6. The additional port on the external pump module is where the pump exhausts the flow. For applications where the DustTrak monitor is sampling from a chamber or a duct at pressures significantly different from the ambient, TSI recommends plumbing the exhaust of the external pump back in to the chamber/duct.

Using the AC Adapter to Run Instrument

The AC adapter allows you to power the DustTrak monitor from an AC wall outlet. When using the AC adapter, the batteries (if installed) are bypassed.

Battery Charging

This instrument will charge the Lithium Ion battery packs. Insert the batteries into the battery compartment, plug the instrument into AC power, and turn the instrument on. Batteries will charge only when the instrument is on and in stand-by mode. Batteries will not charge if the instrument is turned off or is actively taken measurements. Charging will stop when the batteries are fully charged.

WARNING

When Charging Battery the ambient temp must ***not*** exceed 42°C.

Inlet Cap

When using the DustTrak monitor to sample environmental air, the inlet cap should be put over the instrument. This cap will keep large objects from dropping into and plugging the inlet. The cap will also keep direct light from shinning into the chamber and skewing the results.

The inlet cap can simply be pressed onto the instruments inlet.

Figure 2-6: Putting on Inlet Cap

Instrument Setup

The DustTrak DRX monitor can be connected to a computer to download data and upload sampling programs.

Connecting to the Computer

Connect the USB host port of a Microsoft® Windows®-based computer to the USB device port on the side of the DustTrak monitor.

Installing TrakPro™ Data Analysis Software

TrakPro software can preprogram the DustTrak monitor, download data, view and create raw data and statistical reports, create graphs, and combine graphs with data from other TSI instruments that use TrakPro software. The following sections describe how to install the software and set up the computer.

Note
To use TrakPro software with the DustTrak Aerosol Monitor, the PC must be running Microsoft Windows® and the computer must have an available Universal Serial Bus (USB) port.

1. Insert the TrakPro Data Analysis Software CD into the CD-ROM drive. The install screen starts automatically.

Note
If the software does not start automatically after a few minutes, manually run the program listed on the label of the CD using the **Run** command on the Windows Start Menu.

2. Follow the directions to install TrakPro software.

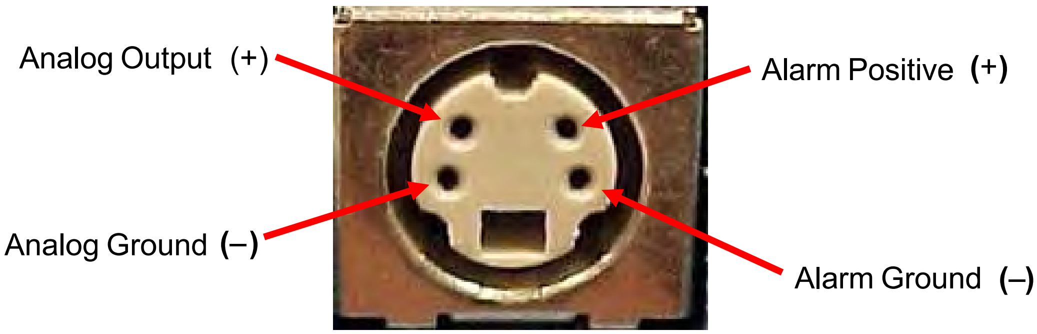
®Microsoft and Windows are registered trademarks of Microsoft Corporation.

TrakPro software contains a comprehensive installation guide. TSI recommends printing out this guide prior to starting the TrakPro software installation on your computer, so it may be consulted during the installation. The TrakPro Software manual is located in the “Help” file in TrakPro software. There is no separately printed TrakPro Data Analysis software manual.

Connecting Analog/Alarm Output

The Analog/Alarm Output Cable plugs into the alarm connection on the side of the instrument. This feature is on the desktop models (II, II HC and 8533) only.

The cable contains a 4-pin, mini-DIN connector. The pin-outs for the connector and the wiring for the cable are shown below.



4-pin miniDIN connector

Cable Wiring Diagram	
Brown Wire	Analog Ground
Orange Wire	Analog Out
Red Wire	Alarm (+)
White Wire	Alarm (-)
Black Wire	Shield

Figure 2-7: Cable Wiring Diagram

Wiring the Analog Output

- Output voltage: 0 to 5 VDC. With a maximum output of 15 mA.
- Output Current 4 mA to 20 mA with a maximum load impendence of 250 ohms.
- Correct polarity must be observed (see pin-outs above).

The output cable supplied by TSI (part no. 801652) is labeled with the pin-out wiring diagram. Additional equipment may be needed for making connections to the system that TSI does not supply. It is your responsibility to specify and supply all additional equipment.

Wiring the Alarm

System specifications:

- Maximum voltage: 15 VDC (**DO NOT USE AC POWER**)
- Maximum current: 1 Amp
- Correct polarity must be observed (see pin-outs above)
- The alarm switch, located inside the DustTrak monitor must be located on the ground side of the alarm system.

WARNING
The DustTrak monitor Alarm Output function should ***not*** be used to detect hazardous conditions or to provide an alarm for protecting human life, health or safety.

Caution
The alarm switch must ***not*** be wired to AC power! Failure to install the user alarm properly could damage the DustTrak instrument and/or void the instrument warranty! Please read and follow all instructions before wiring or operating the user alarm.

WARNING
When connected to the analog out and alarm out connector, you **must** use safety certified equipment and/or power sources.

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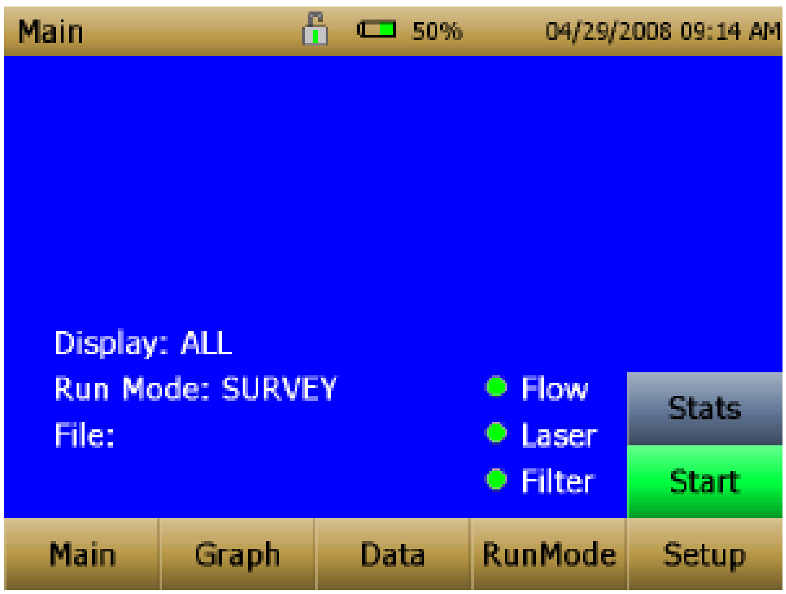
Operation

Getting Started

The **START UP** screen is displayed initially when the instrument is turned on, following the initial TSI logo splash screen.



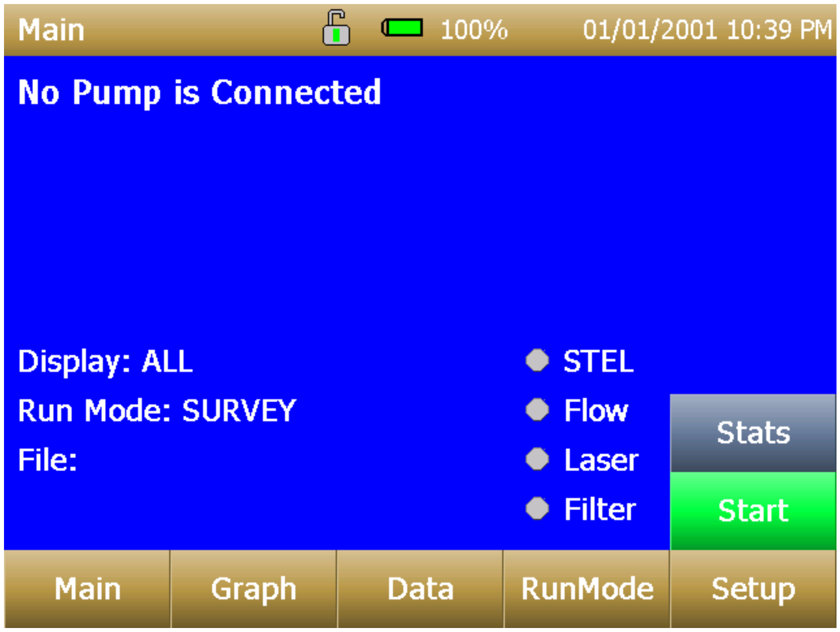
Using a stylus or fingertip, touch the “buttons” on the screen to activate different menus.

For Model DustTrak 8533EP only

WARNING
Always setup and operate the DustTrak monitor with External Pump Module with the External Pump Module connected to the DustTrak monitor. Failure to do so will result in communication errors.

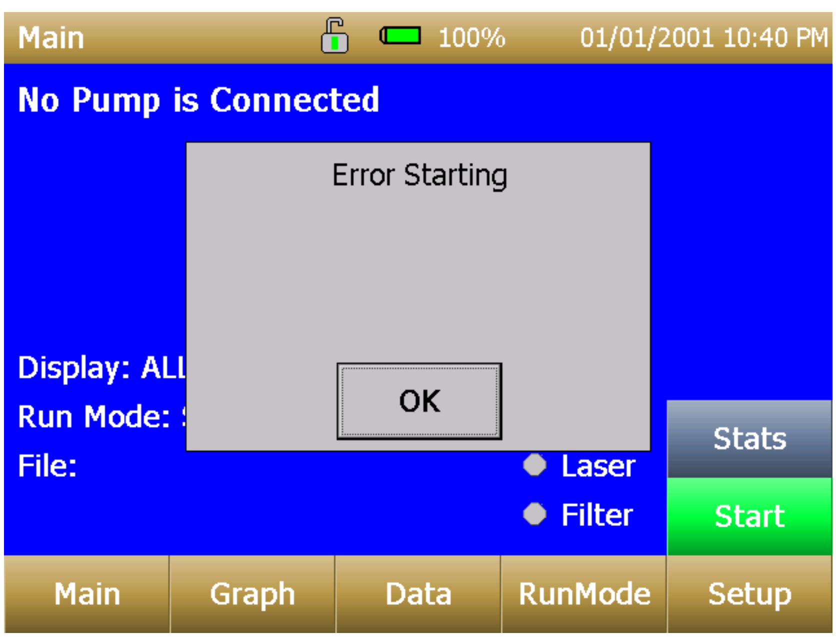
Communication errors take place under four different scenarios as follows:

1. When the unit is idle and is ***not*** connected to the External Pump Module, a warning displays on the Main screen.

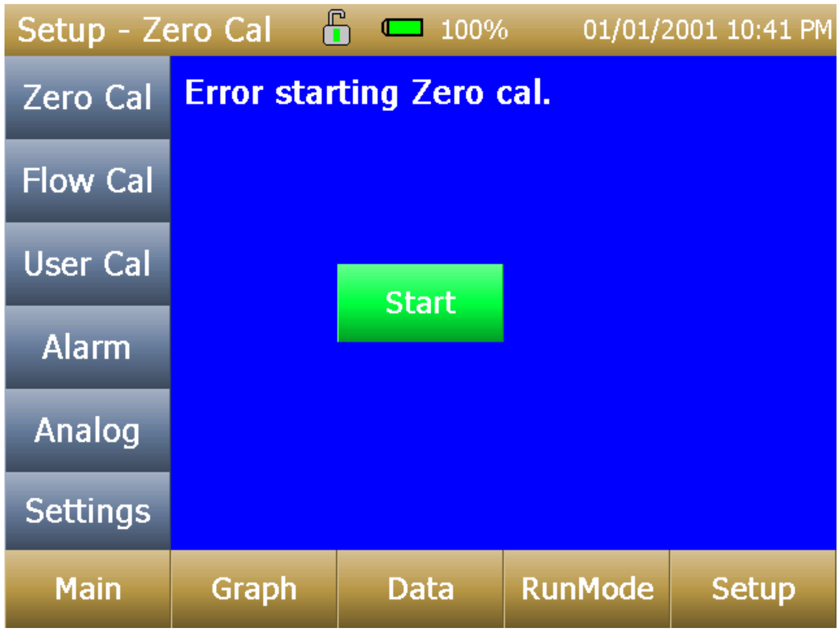


Note
"No Pump is Connected" is a sticky error. Even after the warning message, if the External Pump Module is connected to the DustTrak, the error will not disappear until the screen is refreshed. Refresh the screen by going into a different menu and returning to the Main menu.

2. When the unit is ***not*** connected to the External Pump Module and an attempt is made to start a run by selecting "Start", an error appears on the Main screen.

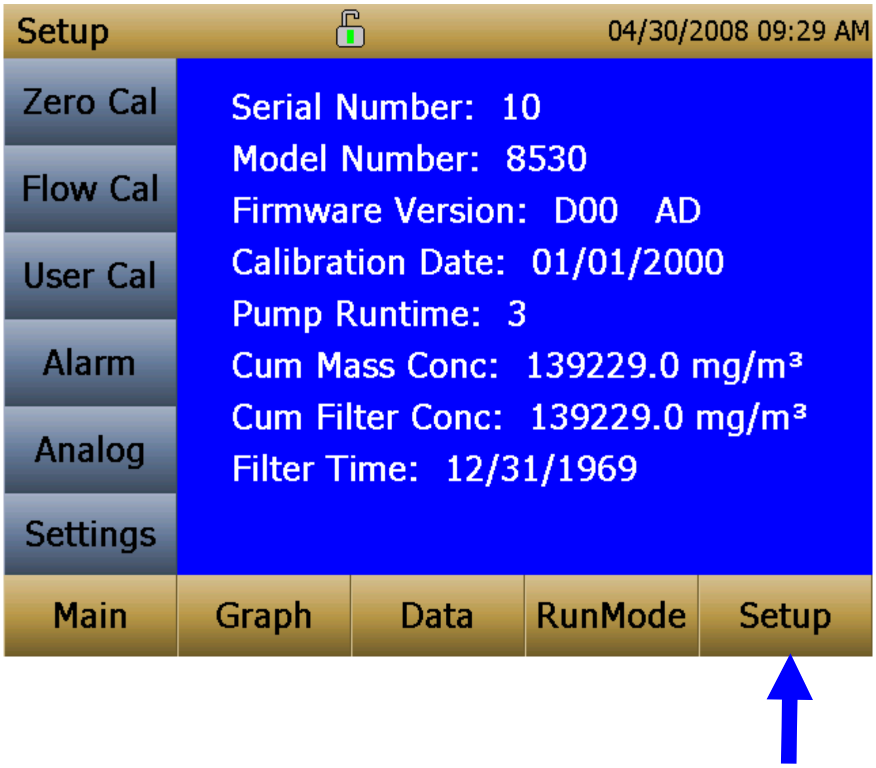


3. If the pump is ***not*** connected while attempting to perform a Zero Cal, an error appears on the Setup screen.



4. If the pump is ***not*** connected while attempting to perform a Flow Cal, an error appears on the Setup screen.

Setup Menu

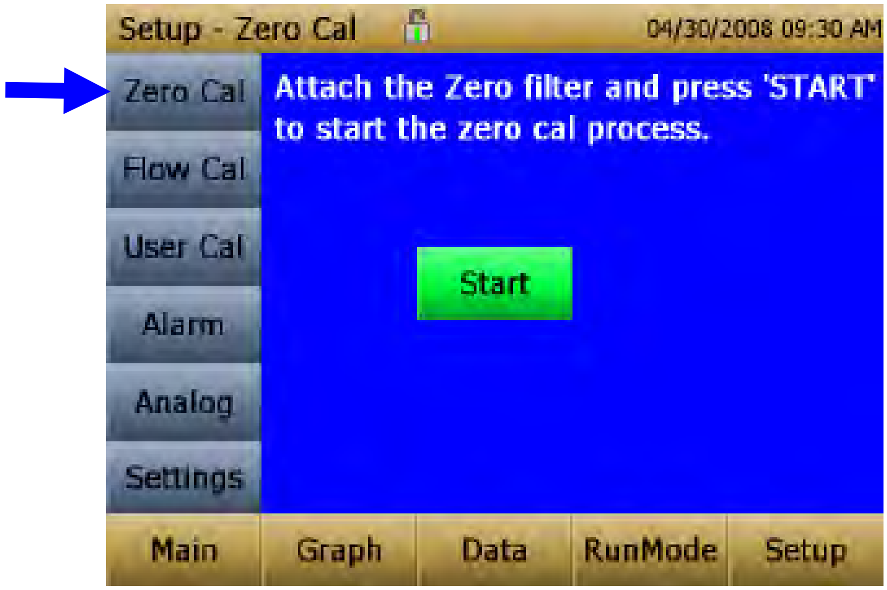


Pressing **Setup** activates the Setup Menu touchscreen buttons along the left edge of the screen. Setup is not accessible when the instrument is sampling.

The main screen of the **Setup** screen displays the following information:

Serial Number	The instruments serial number.
Model Number	The instruments model number.
Firmware Version	Instruments current version of firmware.
Calibration Date	Date of the last factory calibration.
Pump Run Time	Pump running time in hours.
Cum Mass Conc	Amount of mass run through instrument over life.
Cum Filter Conc	Amount of mass run through instrument since last filter change.
Filter Time	Date of last filter change.

Zero Cal



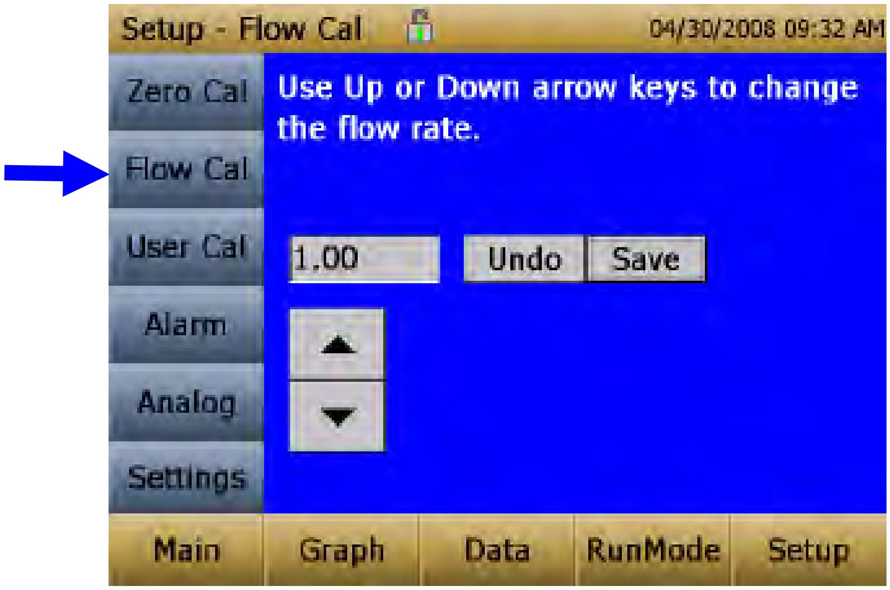
Run **Zero Cal** the first time the instrument is used and repeat prior to every use. Zero Cal requires that the zero filter be attached prior to running. Zero Cal must also be performed if the unit is reading negative concentrations. It is not possible for the DustTrak monitor to read negative concentrations. Negative concentrations are a symptom of zero drift.

Never perform a zero cal without attaching a zero filter.

1. Press Zero Cal Button
2. Attach Zero Filter
3. Press the **Start** button to start Zeroing process.
4. A count-down clock will appear indicating the time remaining. The screen with indicate “Zero Cal Complete” when done.

Remove filter after zeroing has been completed. The instrument is now zero calibrated and ready for use.

Flow Cal

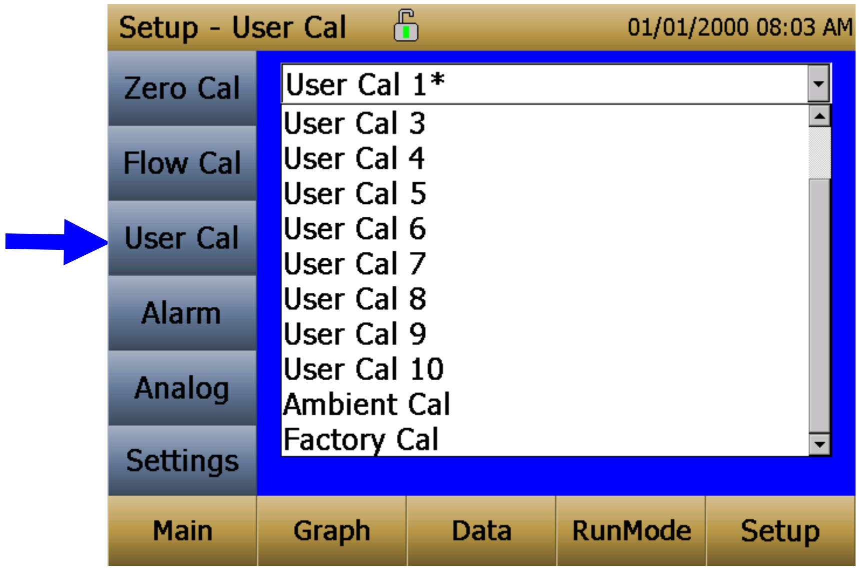


Run **Flow Cal** to change the flow set point. The flow set point is factory set to 3 L/min total flow. 2 L/min of the total flow is measured aerosol flow. 1 L/min of total flow is split off, filtered, and used for sheath flow. There is an internal ∆P flowmeter in the DustTrak DRX instrument that controls flow rate to ±5% if factory setpoint. TSI recommends checking the flows with an external flow reference meter, especially when collecting data. The pump will automatically start when entering the Flow Cal screen.

1. Attach a flow calibrator (reference flow meter) to inlet port. You may use a bubble buret, mass flow meter, dry piston or rotameter as flow measurement devices.
2. Move the arrows up or down to achieve desired flow on the reference flowmeter. Each up or down arrow will change the flow about 1%. Allow time between button presses to let pump change to the new flow rate.
3. Select **Save** once the desired flow rate is achieved. Select **Undo** to return to the factory set point.

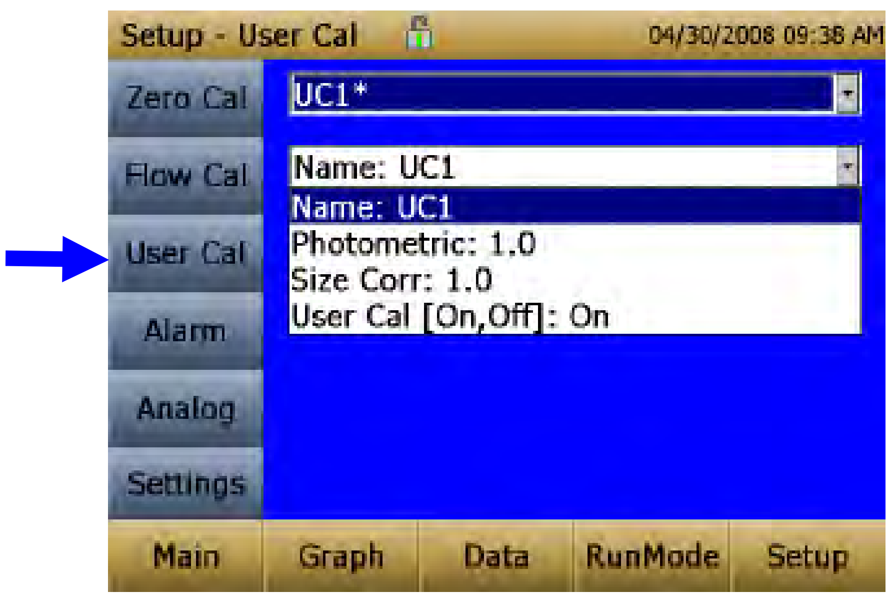
Note
The flow rate can be adjusted from approximately 1.5 to 4.0 L/min. For Model 8533/8534, the FlowCal feature allows you to re-adjust the flow rate to 3.0 L/min. While the flow rate for Model 8533/8534 is fixed at 3.0 L/min, the flow rate for Model 8530/8532 can be changed. This allows for the use of other size selective inlets like cyclones or impactors with Model 8530/8532. No size-selective inlets should be installed on the inlet of Model 8533/8534 during its normal operation.

User Cal



User Cal allows you to store and use 10 different calibration factors. In addition, there are two factory defaults, one is the “Ambient Cal” and the other is the “Factory Cal”. The “Ambient Cal” is appropriate for outdoor ambient dust or fugitive dust monitoring. The “Factory Cal” is the calibration to ISO 12103-1, A1 Arizona test dust for which a calibration certificate is provided with the instrument. The “Factory Cal” is appropriate for most workplace aerosol monitoring. The currently active user calibration is highlighted with an asterisk “*”.

Four variables can be set for each user calibration.



Name	User can rename calibration to a description name.
Photometric	Changes the factory calibration of particle signal, based on Arizona Road Dust, to actual aerosol being measured. See below for sets to set this calibration.
Size Corr	Changes the factory calibration of the particle distribution, based on Arizona Road Dust, to actual aerosol being measured. See below for sets to set this calibration.
User Cal [on,off]	Selecting **On** will activate current user calibration and deactivate the previously selected user calibration.

The Size and Photometric Calibration factors can be determine using a standard or advanced calibration method. The standard method is quick and easy to perform and works well in most situations. That method is shown below. The advanced method will give the tightest accuracy and is described in Appendix B.

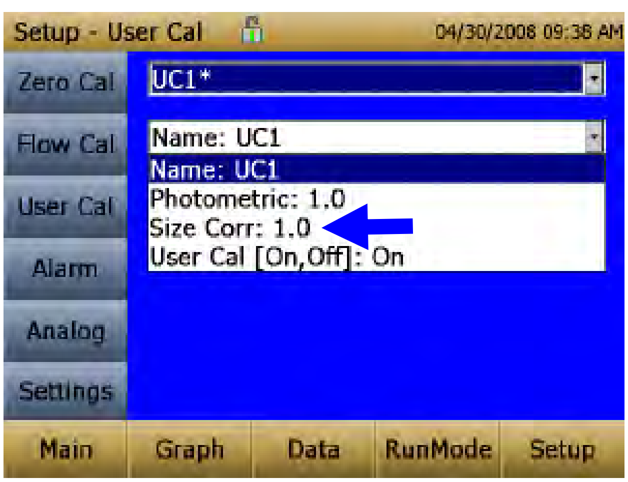
Standard Calibration Method—Size Correction Factor

The size correction factor is used to improve the relative accuracy between the 5 mass channels (PM_1, $PM_{2.5}$, Resp, PM_{10}, and Total). The instrument has been optimized in the factory calibration to standard ISO 12103-1, A1 test dust (formerly Arizona Test Dust).

Following the steps below, a size correction factor can be determined for the aerosol of interest to better optimize the 5 mass channels relative accuracy.

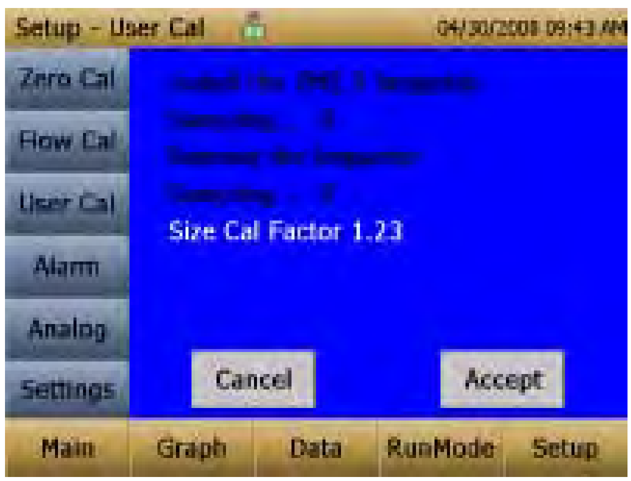
Note: *The 2.5 µm inlet impactor should be clean before performing the shape calibration. The cleaning procedure is details in the Maintenance section of this manual.*

1. Select **Size Corr** from the drop down list.

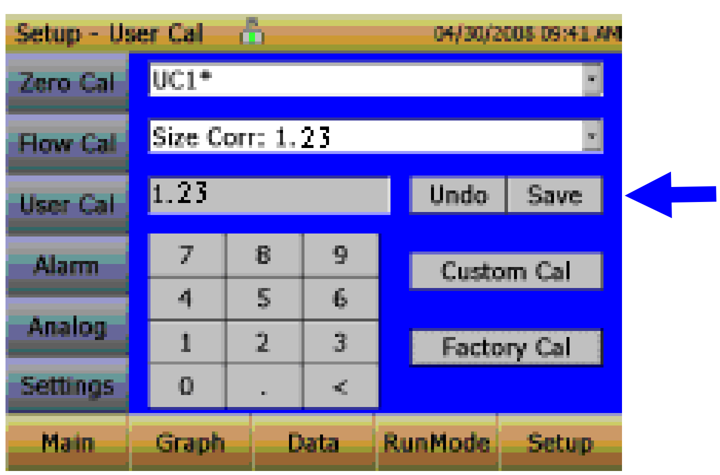


2. Press the **Custom Cal** button.

3. Follow the on screen steps to determine the size Corr. The $PM_{2.5}$ impactor is required for this step.



4. Save the calculated value.



Taking a Gravimetric Sample Using the DustTrak Monitor

When sampling with the DustTrak monitor, you can simultaneously take a gravimetric sample either for custom calibration of the DustTrak monitor or for collecting the sample on to the gravimetric filter downstream of the DustTrak monitor without a need for additional gravimetric sampling pump and filter assembly. To accomplish this, follow the instructions given below:

1. Setup the DustTrak monitor to sample how long you want the sample run time to be. The following example shows a sample for 8 hours.
2. Under RunMode menu, put the instrument in Manual Log (Manual Logging is reviewed later in this section), which will enable you to start and stop the pump at any time you choose.
3. Set the logging interval. One minute (i.e., “01:00”) is a good choice.
4. Make sure you have a preweighed 37-mm gravimetric filter cassette loaded into the DustTrak monitor. See Chapter 4, “Replacing the Internal Filters” on how to access the filter (see Figure 4-8) and replace it.

Note
Use only the conductive plastic filter cassette holder (SKC Part# 225-308).

5. Under the Setup Menu, make sure the DustTrak monitor is set to the desired flow rate. For DustTrak II Model 8530, the flows can be varied from 1.7 to 4 L/min for use with various inlet conditioners. For DustTrak DRX Model 8533, ***the flow cannot be changed.*** The flows for DustTrak II monitor can be changed by changing the default flow calibration setpoint from 1.0 to any value between 0.5 to 1.5 in the span adjustment. An external flowmeter is needed to measure the total flow. Flow can be changed by clicking on the UP or DOWN arrow keys shown below:

6. Conduct a preflow calibration on the DustTrak monitor using the same kind of sample media you will sample with. Now, attach the sample media you intend to sample with and start sampling aerosol for the desired time. After the desired run time, stop the sampling. Remove the filter from the DustTrak monitor and follow your laboratory’s criteria for

filter post weight. Conduct a post-flow calibration with the same sample media done with the pre-flow calibration and determine if these flow calibrations are within ±5% of each other. If they are, use the following to calculate the actual flow rate for the DustTrak monitor. The laboratory will need the following information to calculate mass concentration in mg/m^3:

- Total sample time in minutes.
- Flow rate—flow rate of the DustTrak monitor used for gravimetric analysis is only $^2/_3$ the total flow since $^1/_3$ of the flow is used as sheath flow.
- Total liters of air sampled = total sample time x flow rate.

7. Using this information the laboratory can determine the concentration using the following formula:

$$Concentration, \frac{mg}{m^3} = \frac{\begin{Bmatrix} Filter\ Post\ Weight\ (mg) - \\ Filter\ Pre\ Weight\ (mg) \end{Bmatrix}}{\frac{2}{3} \times \frac{\begin{Bmatrix} DustTrak^{\text{™}}\ Monitor \\ Flow\ Rate\ (L/min) \end{Bmatrix}}{1000}} \times Total\ Sample\ Time\ (min)$$

Note
The flow rate used for gravimetric analysis is only $^2/_3$ the total flow since $^1/_3$ of the flow is used as sheath flow.

8. For instructions on how to calibrate the DustTrak monitor using this data, see section below on “Determining the Calibration Factor for a Specific Aerosol”.

Standard Calibration Method—Photometric Calibration Factor

In most situations, the DustTrak monitor with its built-in data logging capability can provide very good information on how the concentration of an aerosol changes for different processes over time. Factory calibration to the respirable fraction of standard ISO 12103-1, A1 test dust is fairly representative of a wide variety of workplace aerosols. Because optical mass measurements are dependent upon particle size and material properties, there may be times in which a custom calibration would improve your accuracy for a specific aerosol.

Determining a aerosol specific photometric calibration requires that you determine a true mass concentration (e.g., gravimetric analysis) for the aerosol you want to measure. The true mass concentration is used to calculate the custom calibration factor for that aerosol. Once you have a custom calibration factor, you can reuse it each time you make measurements in the same aerosol environment.

Determining the Calibration Factor for a Specific Aerosol

The DustTrak DRX monitor is factory calibrated to the respirable fraction of standard ISO 12103-1, A1 test dust. The DustTrak monitor can be easily calibrated to any arbitrary aerosol by adjusting the custom calibration factor.

The DustTrak monitor's custom calibration factor is assigned the value of 1.00 for the factory calibration to standard ISO test dust. This procedure describes how to determine the calibration factor for a specific aerosol. Using the value of 1.00 will always revert back to the factory calibration.

To determine a new calibration factor you need some way of accurately measuring the concentration of aerosol, hereafter referred to as the reference instrument. A gravimetric analysis is often the best choice, though it is limited to nonvolatile aerosols.

To make an accurate calibration you must simultaneously measure the aerosol concentration with the DustTrak monitor and your reference instrument.

1. Zero the DustTrak DRX monitor.
2. Put the instrument in Manual Log (Manual Logging is reviewed later in this section).
3. Set the logging interval. One minute (i.e., "01:00") is often a good choice.
4. Co-locate the DustTrak DRX monitor and the reference sampler together so that they are measuring from the same area.
5. Start sampling aerosol with both instruments at the same time.

Note
Greater accuracy will be obtained with longer samples. The time you permit for sampling often depends on the reference instrument and characteristics of the measured aerosol. It may take some time to collect sufficient aerosol onto a filter cassette for accurate gravimetric analysis. Refer to instructions of your reference instrument for sampling times.

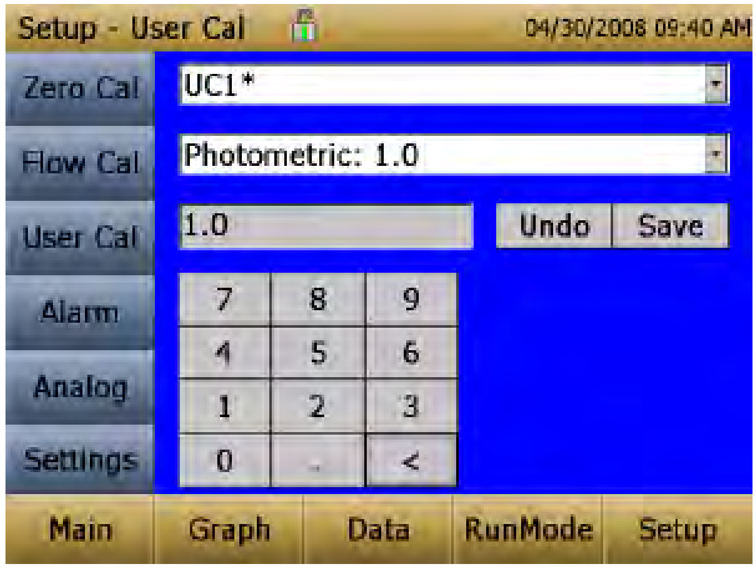
6. Stop sampling with both instruments at the same time.
7. Record the DustTrak monitor average concentration by viewing the sample average in the Data screen. (Data Screen is reviewed later in this chapter.)
8. Determine the mass concentration in mg/m^3 from your reference instrument. For gravimetric sampling this means weighing the gravimetric sample.

Note
If you used the internal gravimetric filter in the DustTrak Model 8533, the flow rate used to compute the concentration should be 2 L/min, not 3 L/min since only 2 L/min of aerosol flow reaches the filter.

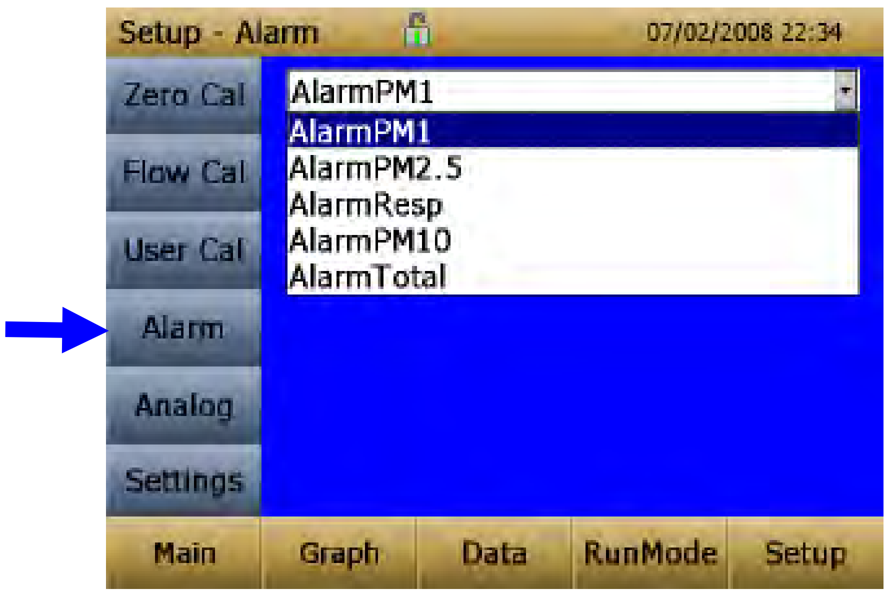
9. Compute the new calibration constant, NewCal, using the following formula:

$$\text{NewCal} = \left(\frac{\text{Reference Concentration}}{\text{DustTrak Concentration}}\right) \cdot \text{CurrentCal}$$

10. Select **Photometric** from the User Cal drop down selection and enter the NewCal factor using the onscreen controls.

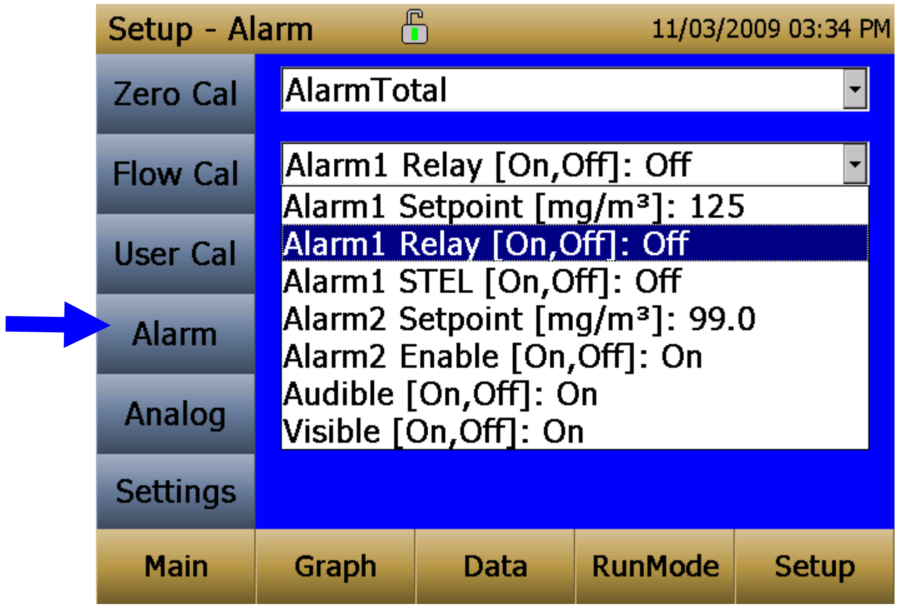


Alarm



Alarm allows you to set alarm levels on any of the 5 mass channels PM_1, $PM_{2.5}$, RESP, PM_{10} and Total. However, the alarm functioning is determined by the logging interval. The alarm will turn ON only if the average concentration over the logging interval exceeds the set point. If the logging interval is too long and the concentration exceeds the set point and stays at that level, the alarm will not turn ON until after the logging interval has passed. Likewise, the alarm will not stop until after the concentration has dropped below 5% of the threshold and after the logging interval has passed.

For each mass channel, an alarm set point level and alarm type can be set.



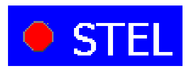
Note
The Alarm is dependent on the logging interval. For the DustTrak to alarm as soon as the Alarm Setpoint is exceeded, the logging interval must be set as low as possible (i.e., 1 second or 2 seconds). If a long test duration does not permit setting such a short logging interval, use the STEL alarm instead. The STEL is always based on 1 second concentrations and is independent of the logging interval. For more details on the STEL alarm, see section below on STEL. In Survey mode, the alarm is dependent on the time constant.

Alarm1 Setpoint [mg/m^3]	The alarm1 setpoint is the mass concentration level upon which the alarm1 is triggered. Alarm will trigger if the mass concentration, taken at the logging interval, rises above the setpoint. ***Note***: *Alarm 2 must be lower than Alarm 1 when both alarms are enabled.*
Relay1 [On, Off]	When the relay alarm is turned on, unit will close relay switch when Alarm1 level is surpassed. Relay alarm can only be linked to one mass channel at a time. Relay selection is available on the 8533 desktop model only.

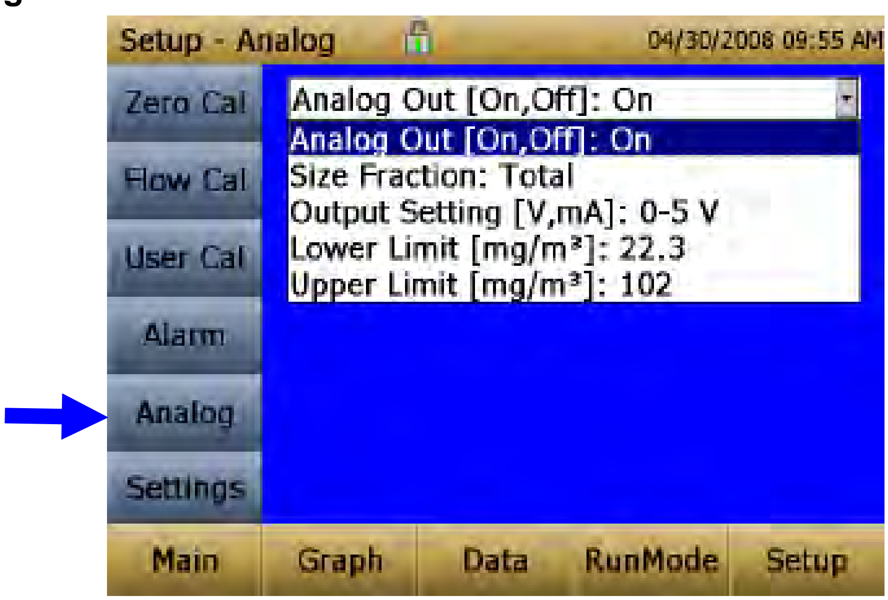
STEL 1 [On, Off]	When the STEL alarm is turned on, STEL data will be collected when Alarm1 level is surpassed. STEL alarm can only be linked to one mass channel at a time. STEL selection is available on the 8533 desktop model only. See following STEL Note.
Alarm2 Setpoint [mg/m^3]	The alarm2 setpoint is the mass concentration level upon which the alarm2 triggers. Alarm triggers if the mass concentration, taken at the logging interval, rises above the setpoint. ***Note**: Alarm 2 must be lower than Alarm 1 when both alarms are enabled.*
Alarm2 Enable [On, Off]	Enables Alarm2 to be logged and will activate the Audible or Visible alarms if they are enabled.
Audible [On, Off]	When the audible alarm is turned on, the instrument will activate internal beeper when Alarm1 or Alarm2 level is surpassed. Audible alarm can only be linked to one mass channel at a time.
Visible [On, Off]	When the visible alarm is turned on, unit will show the alarm icon (Alarm1 , Alarm 2 ) in title bar when Alarm1 or Alarm2 level is surpassed.

STEL Alarm

STEL stands for **S**hort **T**erm **E**xposure **L**imit. When a STEL alarm is selected, the instrument will inspect the data on a second by second basis, independent from the selected logging interval. If the mass exceeds the STEL limit, a STEL even triggers and the following actions will be taken.

STEL indicator	The STEL indicator  will show Red on the main screen.
Data	Data will be taken of the STEL alarm channel at a 1 minute logging interval for **15 minutes**. This data will be stored in a separate file named STEL_XXX, where XXX will be matched to the logged data file. The instrument will also continue to log the mass concentration data at the logging interval selected.
STEL Alarm repeat	If the instrument remains over the STEL limit after the 15 minute interval, or if the instrument exceeds the STEL limit later during the sample period, additional STEL files will be generated.

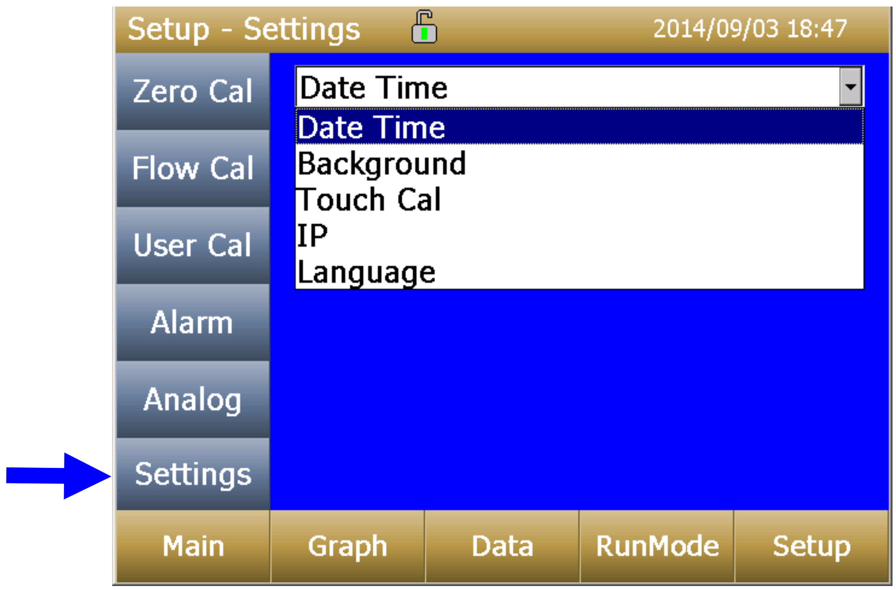
Analog



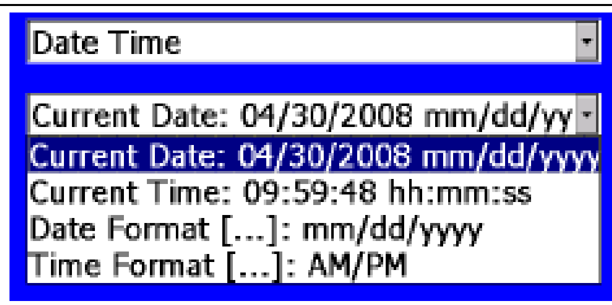
Analog setup screen sets the parameters that will drive the analog out port. Applies to the 8533 Desktop model only.

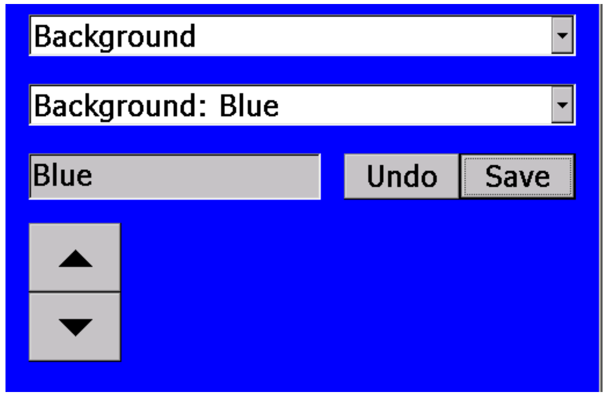
Analog out [On, Off]	Turns analog out port on.
Size Fraction	Selects the size channel that will drive the analog out.
Output Setting [V, mA]	Select between 0 to 5 V and 4 to 20 mA.
Lower Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 0 V or 4 mA.
Upper Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 5 V or 20 mA.

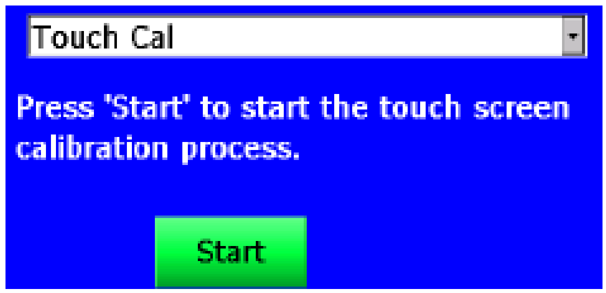
Settings

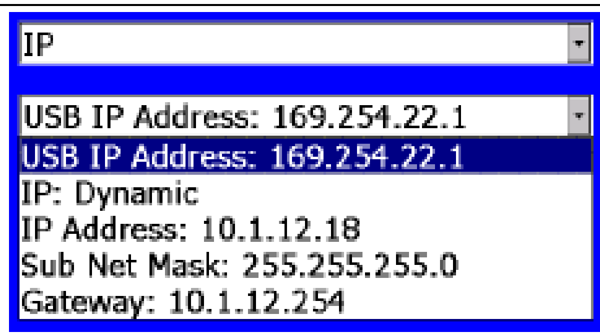


Settings screen sets basic unit parameters.

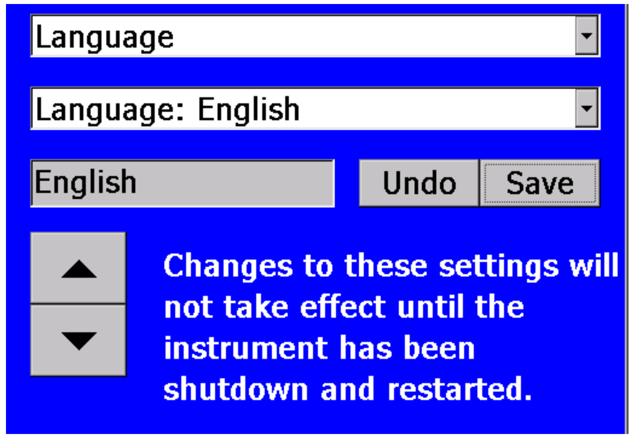
Date Time	 Sets current date, current time and date/time format. Time can set in 12 or 24 hour format. Date can be set in yyyy/dd/mm, yyyy/mm/dd or yyyy/dd/mm.

<table>
<tr><td>Background</td><td>

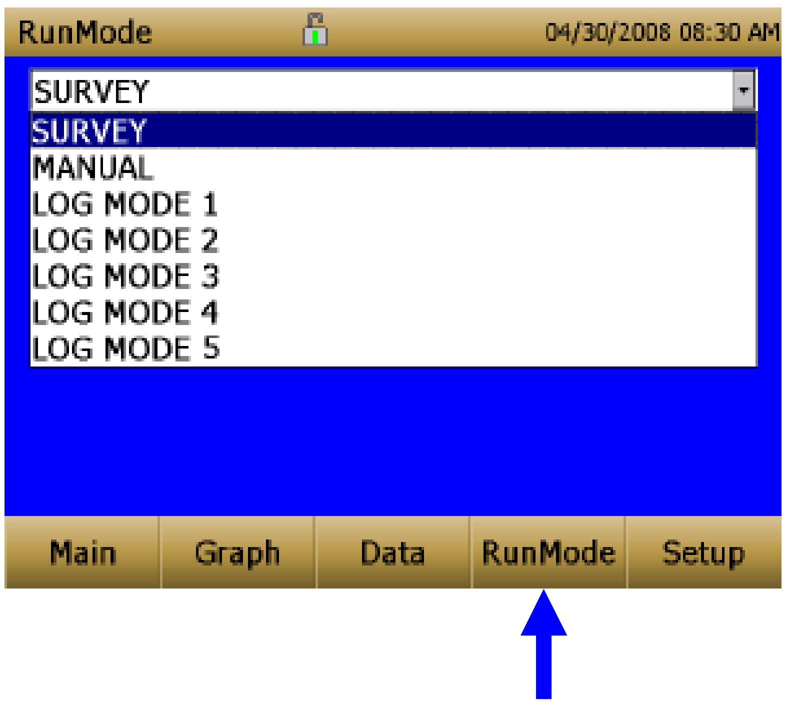
Switches between blue and white backgrounds.</td></tr>
<tr><td>Touch Cal</td><td>

Calibrates the touch cal screen.</td></tr>
<tr><td rowspan="3">IP</td><td>

USB PORT IP Address:
USB IP is the address assigned to the instrument by the NDIS driver. It is shown but cannot be changed.
Ethernet Port IP parameters:
(Model 8533 Desktop only.)
IP method can be set to static or dynamic.
For static IP, IP address, default gateway, and subnet mask can be set.
For Dynamic, The IP assigned by the network is shown. This cannot be changed.
See Note below.</td></tr>
<tr><td>IP Note</td></tr>
<tr><td>After changing the instrument to Dynamic or Static, reboot the instrument.
In Dynamic Mode, the unit will show the IP to which is assigned (after being rebooted).</td></tr>
</table>

Language	 Switches between display languages. After changing the display language, reboot the instrument.

Run Mode

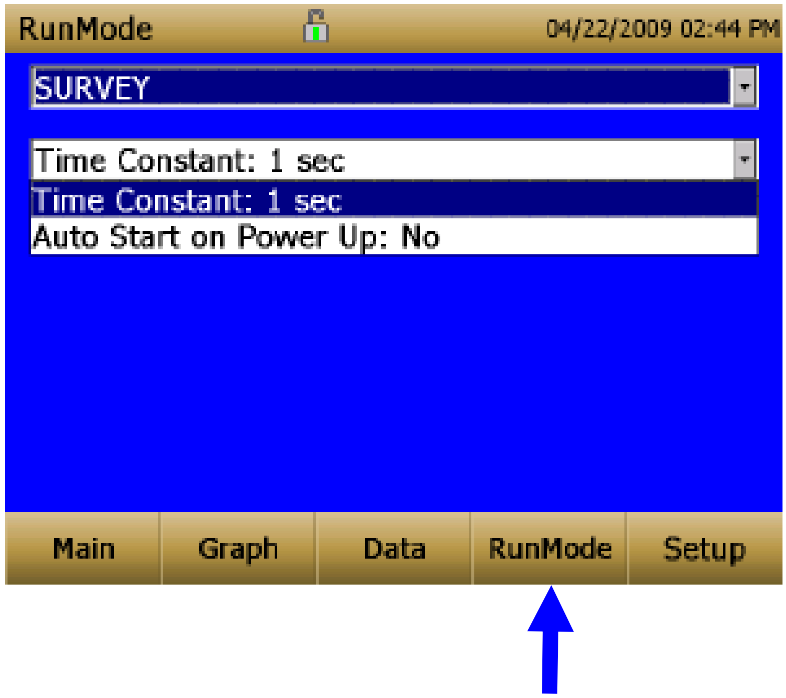


The **RunMode** tab brings up sampling mode options.

Sampling mode options include **Survey Mode**, **Manual Log**, and **Log Mode 1-5**.

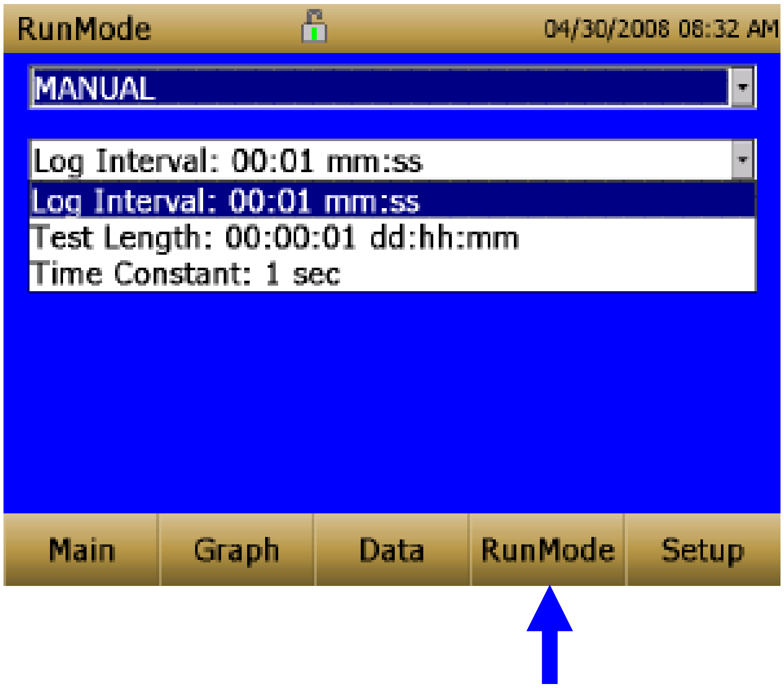
Survey	Survey Mode runs a real time, continuous active sample, but does not log data.
Manual	Manual Log sets the instrument to log data for a specified run time
Log Modes	Log Mode starts and stops the instrument at specified times, run for a specified test length, and perform multiple tests of the same length with a specified time period between tests.

Survey Mode



Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.
Auto Start on Power Up	When set to “Yes”, unit will start a measurement upon being powered on, if the unit was set to “Survey” when it was turned off. When set to “No”, the unit will be in idle when it is powered on.

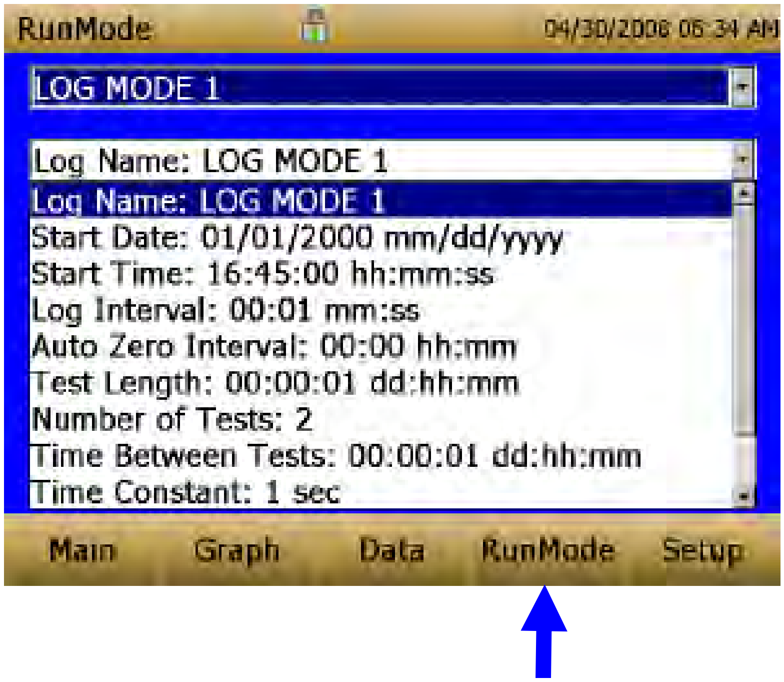
Manual Mode



Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Test Length	Test length can be set from 1 minute to the limit of the data storage.
Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.

In Manual mode, data will be stored to a file named "*Manual_XYZ*" where *XYZ* is an incrementing integer.

Log Mode (1–5)



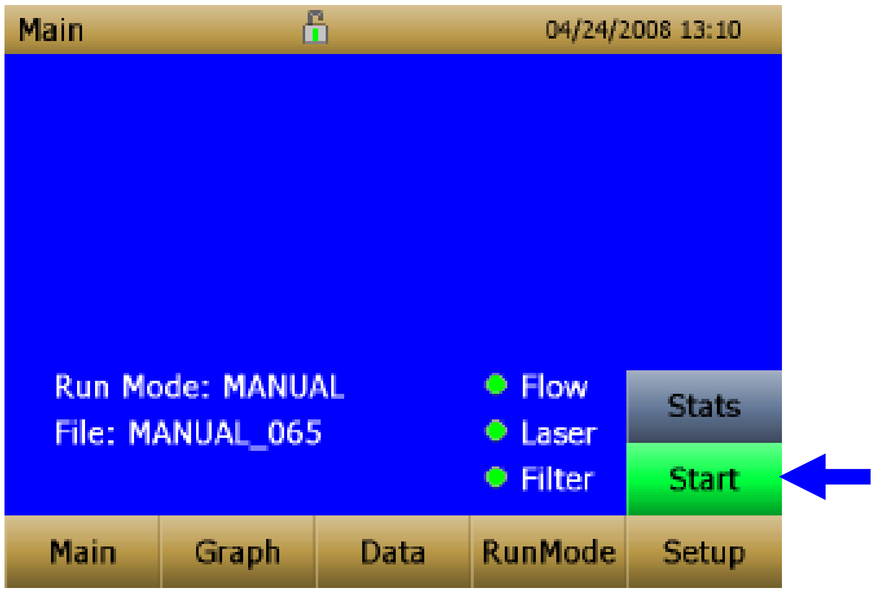
Log Name	Log Name, brings up a virtual keypad to name the Logged Data file.
Start Date	Start Date, select the date the test will start.
Start Time	Start Time, select the time the test will start.
Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Auto Zero Interval	Interval between re-zeroing the instrument using the Auto-Zero accessory. Model 8533 desktop only.
Test Length	From 1 minute to the limit of the data storage.
Number of Tests	Number of tests, 1 to 999.
Time between Tests	Time between tests, 1 minute to 30 days.
Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.
Use Start Date	Use Start Date, option to use programmed start date or by pass programmed start date.
Use Start Time	Use Start Time, option to use programmed start time or bypass programmed start time.

In Log mode, data will be stored to a file named "*LogName_XYZ*" where *LogName* is the user entered log name and *XYZ* is an incrementing integer.

Taking Mass Concentration Measurements

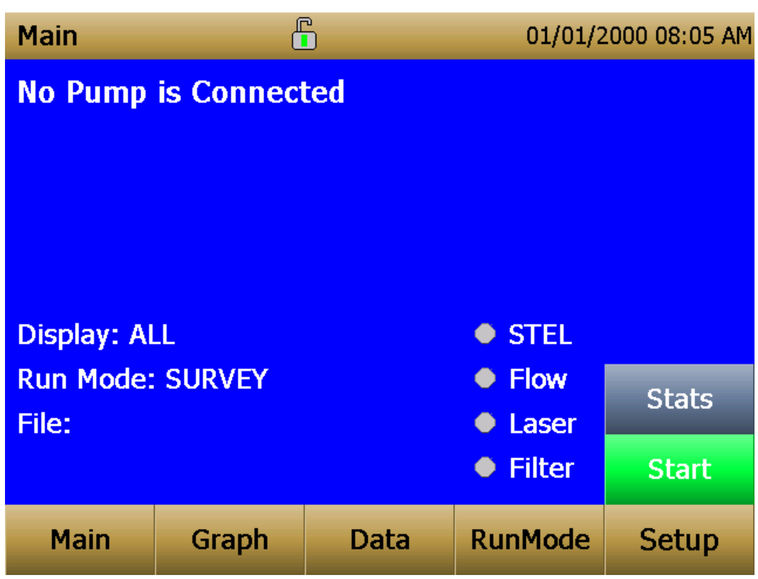
Measurements are started and controlled from the main screen.

Prior to starting a measurement the instrument should be zeroed from the **Setup** screen and the run mode should be configured and selected from the **RunMode** screen.



When the instrument is on, but not taking any mass measurements the start button will be green and instruments pump will not be running. To start taking a measurement, press the green **Start** button.

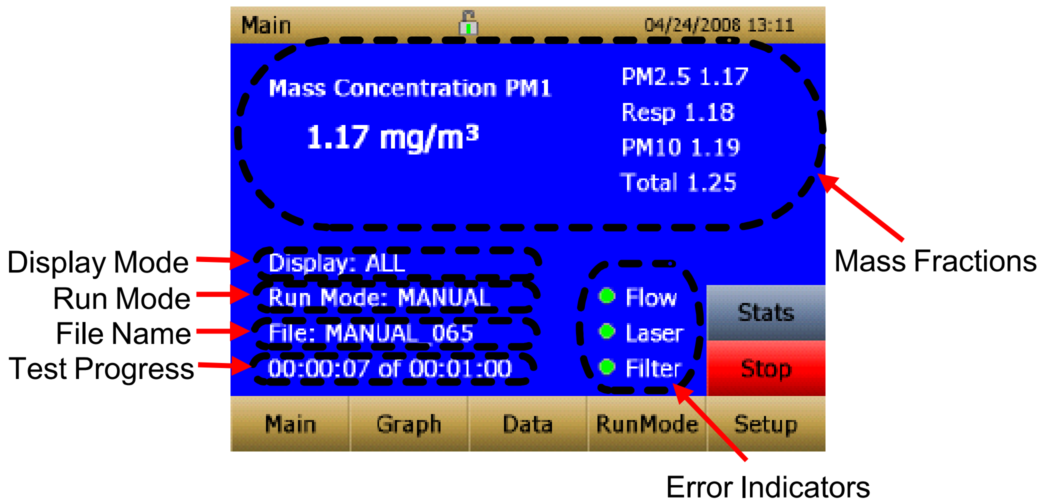
For the Model 8533EP DustTrak monitor with external pump, make sure the external pump is connected to the DustTrak monitor as described in Chapter 2. If the pump is not connected and the green start button is pressed, the DustTrak monitor will identify that the pump is not connected and a warning will be displayed as shown below:



Connect the External Pump Module to the DustTrak monitor and then try again. TSI recommends powering down the DustTrak monitor before connecting the External Pump Module to the DustTrak monitor. Connect the power cable and the flow tubing between the DustTrak monitor and the External pump module, as applicable.

While taking a measurement the screen will display the current measured mass concentration. The various regions of the screen are shown below.

Screen Regions

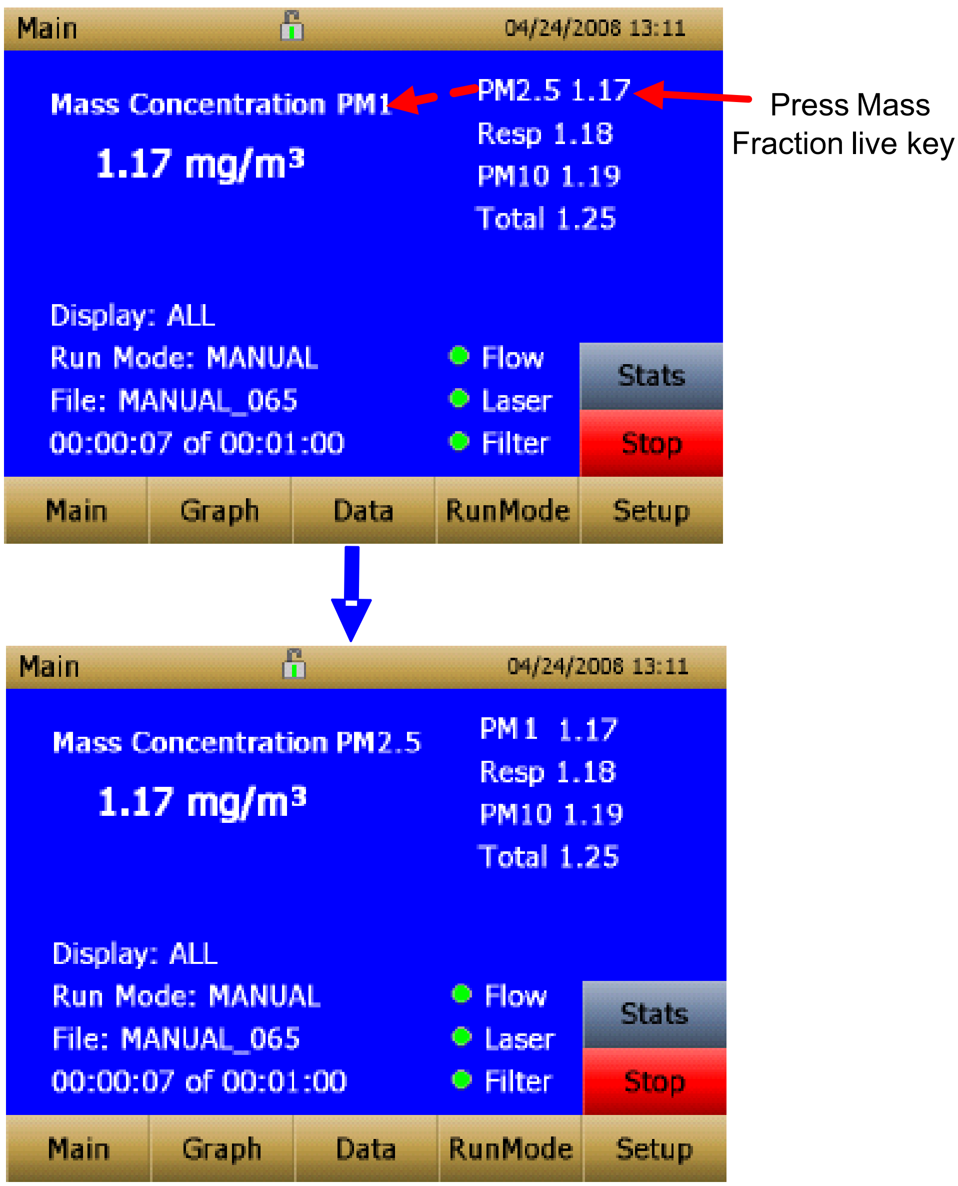


Mass Fractions Region (live keys)	Shows the size segregated mass measurements. The highlighted channel displayed in larger font on the left can be changed by touching on the screen the “measurement of most interest” on the right-hand side of the screen.
Display Mode Region (live key)	The size segregated mass fractions displayed in this area can be selected by touching in the “Display” mode region. The modes that can be selected with this live key are: **All:** PM_1, $PM_{2.5}$, Resp. PM_{10} and Total **IAQ-ENV**: PM_1, $PM_{2.5}$ PM_{10} and Total **IH**: Resp, PM_{10} and Total
Run Mode Region	Shows the run mode selected from the RunMode screen.
File Name Region	Displays the file name to which the data is currently being saved.
Test Progress Region	Shows the time-based progress of the test.

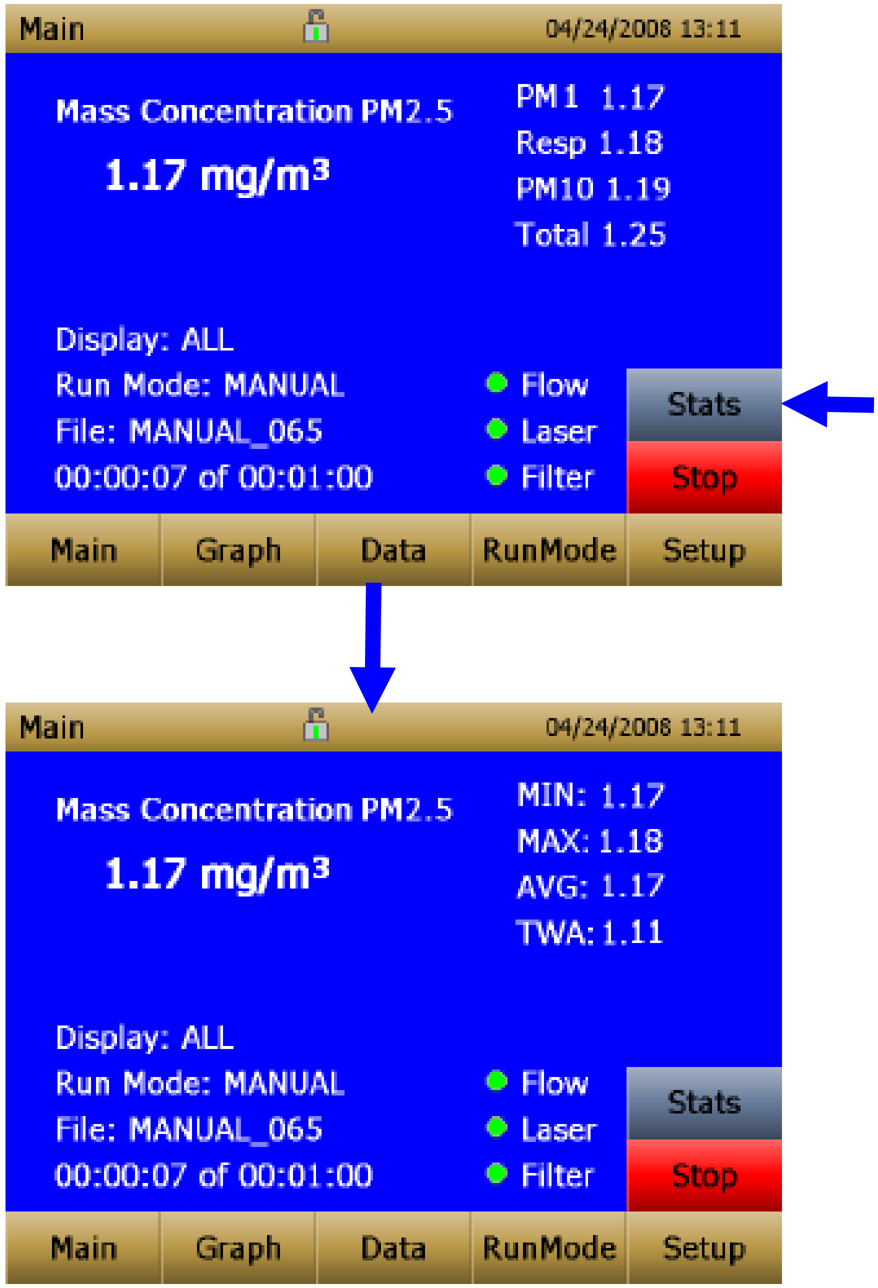
Error Indicator Region	Shows the current stats of the instrument Flow: Status of the flow control Laser: Status of the Laser Filter: Status of the Filter See Chapter 5, "Troubleshooting," to resolve any of these error conditions.

Stats

The Stats button shows the statistics of the highlighted channel. To use the stats feature, first select the channel of interest so it is highlighted in large font on the left of the screen.



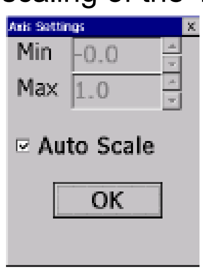
Next, press the Stats button to show the statistics for the highlighted size channel.

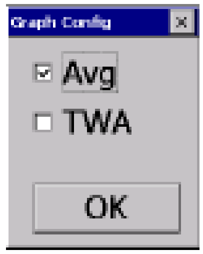


Graphing

During sampling, pressing the **Graph** button displays current readings in graphical form.

- During Survey Mode, five (5) minutes of running real-time data is displayed graphically.
- During Logging Mode, the entire log test time is displayed on the graph.

Time Display	Pressing the **Time** x-axis label on the graph screen switches between **Time (s)**, **Time (abs)**, and **Time (rel)**. **Time (s):** Elapsed time from first logged point (log interval) to the last logged point (test length). **Time (rel):** Relative time from zero to last logged point (test length – log interval). **Time (abs):** Absolute time from first logged point (test start + log interval) to last logged point (test stop).
Scale Display	Pressing in the Scale Display area will bring up a dialog that will allow changing between auto scaling and user scaling of the Y-axis. 

Data Label	Pressing the data label will toggle between PM_1, $PM_{2.5}$, Resp, PM_{10} and Total size segregated mass fractions.
Data Region	Pressing the data region will bring up a dialog to show TWA or Average lines.  **TWA:** Will show a secondary line on the graph showing the time weighted average of the data. This line will not show if test time is less then 15 minutes. **Average:** Show a secondary line on the graph of the running average of the data.

In Graphing Mode, pressing **Main** returns the instrument to the Main Screen display.

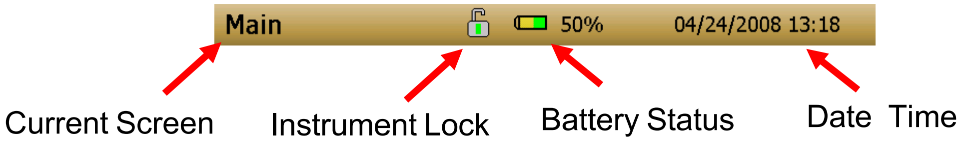
Viewing Data

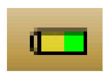
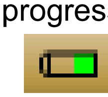
The **Data** button opens a list of data files for viewing.

Select File	Press the arrows on the right side of the screen to scroll up or down to the data file to be viewed.
Data Statistics	Statistics on the selected file ○ File Name ○ Size Channel ○ Sample Average ○ Sample TWA ○ Sample Maximum Reading ○ Sample Minimum Reading ○ Number of Data Points in the File
Channel Button	Toggles between the mass fraction channels PM_1, $PM_{2.5}$, Resp, PM_{10} and Total.
Save All Button	Downloads data to a USB thumb drive. The USB thumb drive must be attached to the USB host port. Data is saved as a .csv file that can be viewed in Microsoft® Excel® spreadsheet software.
Delete Button	Deletes the currently highlighted file.
Delete All Button	Deletes all the files stored on the instrument.
Graph Button	Data can also be viewed in graphical form by pressing the **Graph** button while the data file is highlighted.

Title Bar

The Title Bar shows common instrument information.



Current Screen	Title of the current screen that is being displayed.
Instrument Lock	Icon shows if the instrument touchscreen is in a unlocked or locked condition. Unlocked:  Locked:  To lock the touchscreen controls, touch the “lock” icon, immediately followed by three (3) quick touches on the current screen (**Main)** word along the top tool bar. Repeat the process to unlock the screen.
Battery Status	Show the current % life of the battery and show if the battery is currently being charged: Charging:  (unfilled portion of the icon is filled yellow as well as animated to indicate that the charging is in progress) Not Charging:  (unfilled portion of the icon transparent)
Date and Time	Indicates the instruments current date and time.
Alarm	If the instrument is in a alarm status a alarm icon  will appear in the title bar.

Chapter 4

Maintenance

The DustTrak DRX aerosol monitor can be maintained in the field using the instructions below. Additionally, TSI recommends that you return your DustTrak DRX monitor to the factory for annual calibration. For a reasonable fee, we will quickly clean and calibrate the unit and return it to you in “as new” working condition, along with a Certificate of Calibration. This “annual checkup” helps ensure that the DustTrak DRX monitor is always in good operating condition.

WARNING

There are no user-serviceable parts inside this instrument. The instrument should only be opened by TSI or a TSI approved service technician

Maintenance Schedule

The DustTrak DRX Aerosol Monitor requires maintenance on a regular basis. Table 4–1 lists the factory recommended maintenance schedule.

Some maintenance items are required each time the DustTrak monitor is used or on an annual basis. Other items are scheduled according to how much aerosol is drawn through the instrument. For example, TSI recommends cleaning the inlet sample tube after 350 hours of sampling a 1 mg/m^3 concentration of aerosol. This recommendation should be pro-rated according to how the instrument is used. 350 hours at 1 mg/m^3 is the same amount of aerosol as 700 hours at 0.5 mg/m^3 or 175 hours at 2 mg/m^3, etc.

Table 4–1. Recommended Maintenance Schedule

Item	Frequency
Perform zero check	Before each use.
Clean inlet	350 hr. at 1 mg/m^3*
Clean 2.5 μm calibration impactor	Before every use.
Replace internal filters	350 hr. at 1 mg/m^3* or when indicated by the main screen filter error indicator.
Return to factory for cleaning and calibration (For 8533EP, TSI recommends that both the DustTrak monitor and the External Pump Module be returned to TSI)	Annually
Replace the internal HEPA filters in the External Pump module	Annually

*Pro-rated, see discussion above.

The DustTrak monitor keeps track of the accumulated amount of aerosol drawn through it since its last cleaning. When the internal filter replacement is due, the filter error indicator will turn from green to red.

TSI recommends you perform a zero check prior to each use for the DustTrak monitor and certainly before running any extended tests, and after the instrument experiences a significant environmental change. Examples of significant environmental changes would be ambient temperature changes that exceed 15°F (8°C) or moving from locations with high aerosol concentrations to low concentrations.

Zeroing Instrument

1. Attach the zero filter to the inlet of the instrument.

Figure 4-1: Attach Zero Filter to Inlet

2. Follow zero calibration instructions detailed in the operations section of this manual,

Cleaning the Inlet

The inlet should be cleaned based on the schedule in Table 4–1.

1. Turn the DustTrak monitor off.
2. Unscrew the inlet nozzle from the instrument (Figure 4-2).

Figure 4-2: Unscrew Inlet Nozzle

3. Clean the inlet port. Use a cotton swab to clean the outside of the inlet port. The swabs can be dampened with water or a light solvent (e.g., isopropanol). Clean the inside of the sample tube by using a small brush, along with a light solvent. Dry the tube by blowing it out with compressed air, or let it air-dry thoroughly.

Note
Be *careful* not to blow particles into the DustTrak monitor inlet port.

Figure 4-3: Do NOT Blow into Instrument

4. Screw (hand-tighten) inlet back into instrument.

Cleaning 2.5 µm Calibration Impactor

The calibration impactor should be cleaned prior to every use, using it to perform a Standard Calibration (size correction) on the instrument, as described in the Operations section.

1. Unscrew Impactor. Check O-ring on the impactor base.
2. Clean outside and inside of Impactor and the impactor plate using a clean brush and a light solvent. Dry impactor parts by blowing it out with compressed air, or let it air-dry thoroughly.
3. Apply 2 drops of oil (included) to the impactor plate. Do ***not*** over-fill impaction plate.

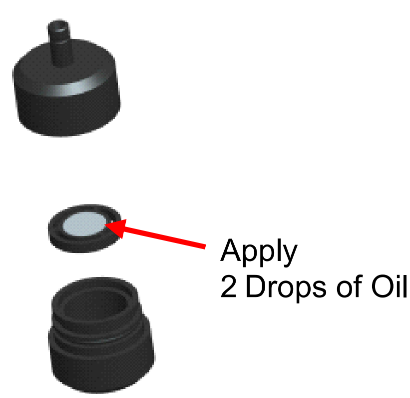


Figure 4-4: Apply 2 Drops of Oil to Impactor Plate

4. Screw (hand-tighten) impactor back together.

Replacing the Internal Filters

Replace the internal filters based on the schedule in Table 4–1 or when the filter indicator on the main screen changes to red.

1. Turn the instrument off.
2. Remove old filters from the instrument.

Handheld Model

a. Use the enclosed filter removal tool (PN 801668) tool to unscrew the two filter caps located on the bottom of the instrument.

b. Pull the old filters out of the two filter wells. If filter wells are visibly dirty, blow out with compressed air.

Figure 4-5: Pull Filters Out of Two Filter Wells (Handheld Model)

c. Put two (2) new filters into the filter wells and screw filter caps back into place.

Note
Replacement filters were shipped with the new instrument. Order additional filters from TSI under PN 801666.

Desktop Model

a. Open filter access door on the back of the instrument.

b. Use the enclosed filter removal tool (PN 801668) to unscrew the filter cap.

c. Pull out single cylindrical filter from filter well. If filter well is visibly dirty, blow out with compressed air.

Figure 4-6: Pull out Single Cylindrical Filter from Filter Well (Desktop Model)

d. Put a new filer (P/N 801673) back into filter well and screw filter cap back into place.

e. Open blue retention clip by pinching ends inward and pushing down.

Figure 4-7: Open Blue Retention Clip

f. Remove 37-mm filter cassette by pulling downward and outward.

Figure 4-8: Remove 37-mm Filter Cassette

g. Open filter cassette using enclosed tool PN 7001303.

Figure 4-9: Open Filter using Enclosed Tool

h. Remove screen mesh from filter cassette and blow out using compressed air. Blow in reverse direction to remove captured particulate.

i. Replace mesh in filter cassette and press halves together. Ensure filter has been fully closed. The filter tool PN 7001303 can be used to ensure the filter is fully closed.

Figure 4-20: Replace Mesh in Filter Holder

j. Place filter cassette back into position and close blue retaining clip. Make sure retaining clip snaps back into place.

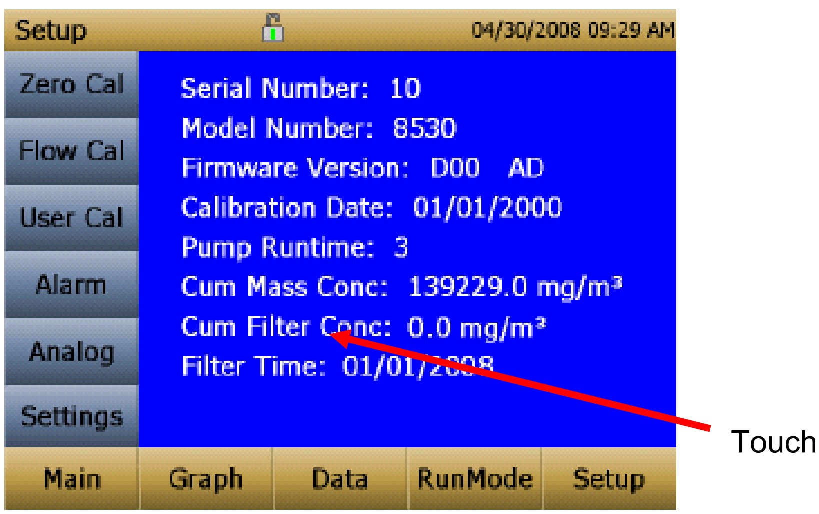
Notes
Replacement filters (HEPA and 3-mm Filter Cassette with mesh filter) were shipped with the new instrument. Order additional filters from TSI under PN 801673. TSI ***does not*** supply any filter media for the filter cassette. Any commercially available 37-mm filter media may be used with the DustTrak II or DRX desktop instruments to collect gravimetric reference samples.

3. **It is important to reset the instruments filter counter after replacing filters. Resetting the counter will clear the filter error condition shown on the main screen.** Reset the counters by the following:

   a. Turn on the instrument.

   b. Press the **Setup** button to go into the setup screen.

   c. Touch the **Cum Filter Conc:** (live key) to reset the aerosol mass.



   d. *Replace user serviceable filters?* Dialog will appear. Press **OK**.

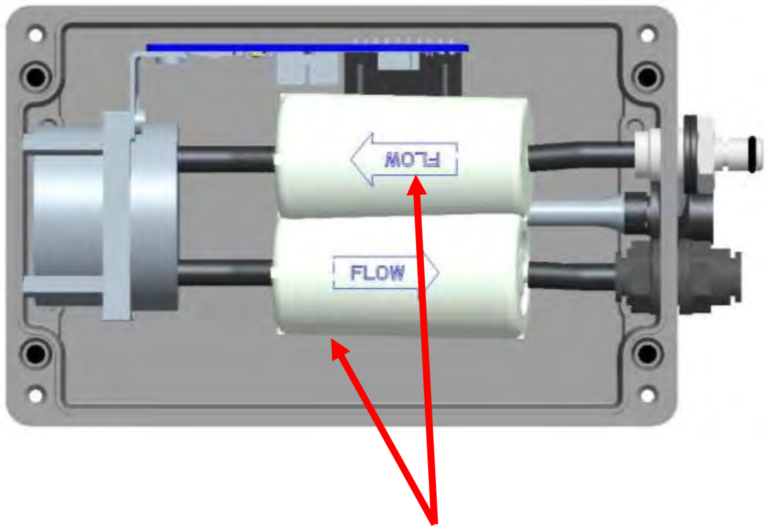
   e. *Reset filter concentration?* Dialog will appear. Press **Yes** to reset the cumulative filter concentration to zero.

   f. The Setup screen will not show zero for the **Cum Filter Concentration and** the current date for the **Filter Time**.

Replacing the Filters in the External Pump Module

The external pump module provided with Model 8533EP is designed to run continuously for about a year (8760 hours). There are two HEPA filters that protect the pump from contamination—one on the suction side of the pump and the other on the discharge side of the pump. The discharge side of the pump collects particles shedding from the vanes of the pump and will turn black over time. The HEPA filters will have to be replaced once a year.

To access the filters open the top cover of the pump module. The two HEPA filters are identified in the figure below. The two filters can be replaced by disconnecting the soft tubing between the filters, pump, and the casing connectors.



User Replaceable HEPA Filters

Caution
When replacing the HEPA filters, make sure they are oriented in the correction direction as shown in the picture above.

Storage Precautions

When storing the DustTrak monitor for more than 30 days, you should charge and remove the batteries. This prevents damage due to battery leakage.

This instrument must be stored in a location where the temperature remains between –20 and 60°C (–4 and 140°F).

Troubleshooting

The table below lists the symptoms, possible causes, and recommended solutions for common problems encountered with the DustTrak DRX monitor.

Symptom	Possible Cause	Corrective Action
Erratic zero reading	Leak	Check connections for leaks Replace zero filter
	Dirty inlet port and/or sample tube	Clean inlet port. Clean or replace tubing
	Internal filter(s) not installed properly (leaking)	Inspect internal filter wells to make certain the filters and o-rings are seated properly. Replace internal filters if necessary
DustTrak reading negative concentrations	Zero Drift	Perform Zero Cal
	Zero Cal was performed without the Zero Filter in-line	Perform Zero Cal again and make sure the Zero Filter is attached to the DustTrak inlet
Error completing Zero Cal	Too much light scatter in the optics chamber due to dust deposits	Clean the inlet nozzle. Attach the zero filter and sample for about 2 minutes. During sampling, pulse the flow going into the DustTrak monitor by intermittently plugging the zero filter. Any dust in the optics chamber will break loose during flow pulsations and will be cleared out by the pump Perform Zero Cal again. If the Zero Cal still cannot be performed, factory service may be required

Symptom	Possible Cause	Corrective Action
Run Mode Error: The start time has passed	The selected Run Mode program has "Use Start Date" selected, but the start date is prior to the current date	Correct or change the run mode program
Run Mode Error: The selected log mode will exceed the allowed number of samples	The selected Run Mode program is programmed to save more samples then is room in memory	Reduce the number of samples by reducing the test length or increasing the logging interval
Instrument runs slow	Large amount of data in memory	Large data files or many small data files will cause instrument to slow, due to need to read and display large amounts of data
No display	Unit not switched on	Switch unit on
	Low or dead batteries	Recharge the batteries or plug in the AC adapter
No touch - screen response	Instrument currently busy	The instrument will take time to open large data files and save configuration information. During this time, the instrument will not respond to additional touch-screen touches
	Instrument Touchscreen is locked	If the lock in the title bar is red, unlock the instrument following the instructions in the Chapter 3, Operation: Title Bar section of this manual
Analog output does not work	Cable/connector not correctly installed	Make sure cable connector is fully seated
	Output wired with reverse polarity	Make sure analog out (+) and analog ground (-) are wired correctly to data-logger

Symptom	Possible Cause	Corrective Action
Analog output is not in proportion to display	Analog output range in DustTrak monitor may be set incorrectly Data logger scaling factor may be set incorrectly	Check analog output setting in the Setup->Analog screen. Make sure the channel of interest is selected. Make sure that the correct output (0 to 5V, 4 to 20 mA) is selected Review the scaling factor set in the Setup-Analog screen
Alarm output does not work Alarm does not turn on correctly	Alarm function not turned on Alarm setting incorrect Alarm output wired with reverse polarity	Turn the alarm function on in the Settings->Alarm screen Check the alarm settings in the Settings->Alarm screen Make sure the logging interval and time constant are set as short as possible (30 seconds or lower) Alarm wires are polarized. Voltage input must be wired to alarm input (+)
Instrument does not store new data	Memory is full Instrument is in Survey mode	Delete or transfer historic data The instrument does not store data in survey mode. Can to manual or program log mode

Symptom	Possible Cause	Corrective Action
Flow Error is indicated on front screen	If sampling from a duct, instrument may have problems overcoming pressure differences	Attach both the input and the exhaust port into the duct
	Flow obstruction	Remove obstruction if still present. Press any key to bypass
	Internal pump failing, indicated by inability to adjust flow rate to full range	Factory service may be required
	Filter Cassette clogged or has mass loading	Replace the filter cassette. See the maintenance section of the manual
	External pump module (for Model 8533EP only) is not connected to the DustTrak monitor	Make sure both the External Pump cable and the flow tubing connector are connected to the DustTrak monitor and the External pump module. Lock the External Pump Cable in place by rotating the connector clockwise until you hear it snap in place Make sure the tubing between the DustTrak monitor and the External pump module is not kinked and is free of any sharp bends Make sure the exhaust adapter is connected to the exhaust of the DustTrak monitor Make sure the External Pump module filters are not clogged. If found dirty, replace the two HEPA filters
Laser Error indicated on front screen	Laser background is too high	Remove and clean inlet nozzle. Pay close attention to the tip of the nozzle that is inserted into the instrument to ensure it is clear of any contamination
	Laser is failing	Factory service may be required

Symptom	Possible Cause	Corrective Action
Filter Error indicated on front screen	Filters need to be replaced	Replaced the filters per instructions in the maintenance section of this manual. Make sure to reset the filter mass and date once the filters have been changed **Note**: This is only a warning. The unit will continue to operate normally until the increase in pressure drop across the filter is so high that the pump can no longer maintain the set flow rate
System Error has Occurred!	The processor did not receive the input it expected. This can also happen if the optics chamber is saturated with light, or the External Pump Cable is accidentally disconnected during the middle of sampling	Reboot the instrument. If the error does not go away, factory service is required

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Appendix A

Specifications

Specifications are subject to change without notice.

Sensor Type	90° light scattering
Range	8533 Desktop 0.001 to 150 mg/m^3 8534 Handheld 0.001 to 150 mg/m^3
Display	Size Segregated Mass Fractions for PM_1, $PM_{2.5}$, Respirable, PM_{10} and Total. All displayed
Resolution	±0.1% of reading of 0.001 mg/m^3, whichever is greater
Zero Stability	±0.002 mg/m^3 24 hours at 10 sec time constant
Particle Size Range	Approximately 0.1 to 15 µm
Flow Rate	3.0 L/min
Flow Accuracy	±5% Internal flow controlled
Temperature Coefficient	+0.001 mg/m^3 per °C
Operational Temp	0 to 50°C
Storage Temp	-20 to 60°C
Operational Humidity	0-95% RH, non-condensing
Time Constant	Adjustable 1 to 60 seconds
Data Logging	<45 days at 1 minute samples
Log Interval	1 second to 1 hour
Physical Size (HWD)	Handheld: 4.9 x 4.75 x 12.45 in. Desktop: 5.3 x 8.5 x 8.8 in. External Pump: 4.0 x 7.5 x 3.5 in.
Weight	Handheld: 2.9 lb, 3.3 lb with battery Desktop: 3.45 lb, 4.45 lb – 1 battery, 5.45 lb – 2 batteries External Pump: 3.0 lb
Communications	8533: USB (Host and Device) and Ethernet. Stored data accessible using thumb drive 8534: USB (Host and Device). Stored data accessible using thumb drive.
Power—DC	Handheld 12 VDC at 2A Desktop 24 VDC at 2.5A

Battery	8533: Up to 2 Removable Li-Ion External and Internal charging Life, 1 battery: >6.5 hours (9 hours typical for a new battery) for both internal and external pump Desktop DustTrak monitors Life, 2 battery: >13 hours 8534: 1 Removable Li-Ion External and Internal charging Life: 6 hours typical
Analog out	8533 User selectable output 0 to 5 V or 2 to 20 mA User selectable scaling
Alarm Out	8533: STEL Relay or sound buzzer Relay No latching MOSFET User selectable set point 5% deadband Connector 4-pin, Mini-DIN connectors 8534: Sound buzzer
Screen	8533: 5.7” color touchscreen 8534: 3.5” color touchscreen
Gravimetric Sampling	8533: Removable 37 mm Cartridge
EMI/RF Immunity:	Complies with Emissions Directive Standard: EN50081-1:1992 Complies with Immunity Directive Standard: EN50082-1:1992*

*ESD Shock may require instrument reboot

Appendix B

DRX Advanced Calibration

The advanced calibration method is employed to yield high size segregated mass concentration accuracy for $PM_{1.0}$, $PM_{2.5}$, Respirable and PM_{10} size fractions. It involves two gravimetric measurements to obtain PCF and SCF. The two gravimetric measurements can be done in sequence or in parallel, depending on the gravimetric sampling device availability.

Option 1: Serial Gravimetric Calibration

When you have only one set of gravimetric sampling devices, the DustTrak DRX advanced calibration can be performed in two serial steps. The experimental setup is in Figure B-1a. The calibration steps are outlined below:

Step 1: PCF Calibration

- Install a $PM_{2.5}$ impactor at the inlet of the external gravimetric filter.
- Co-locate and run the gravimetric sample and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filter.
- Calculate the $PM_{2.5}$ mass concentration ($PM_{2.5\_Grav}$) from the gravimetric filter based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.
- Read the DustTrak DRX monitor average $PM_{2.5}$ mass concentration ($PM_{2.5\_DRX}$) from the screen or through TrakPro Data Analysis Software.
- Calculate the new PCF

$$\mathrm{PCF_{New}} = \frac{\mathrm{PM_{2.5\_Grav}}}{\mathrm{PM_{2.5\_DRX}}} \times \mathrm{PCF_{Old}}\,.$$

- Update the new PCF in user calibration settings.

Step 2: SCF Calibration

- Install a PM_{10} impactor at the inlet of the external gravimetric filter.
- Co-locate and run the gravimetric sample and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filter.
- Calculate the PM_{10} mass concentration (PM_{10_Grav}) from the gravimetric filter based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.
- Read the DustTrak DRX monitor average $PM_{2.5}$ ($PM_{2.5\_DRX}$) and PM_{10} (PM_{10_DRX}) mass concentration from the screen or though TrakPro Data Analysis Software.
- Calculate the new SCF

$$SCF_{New} = \left(\frac{PM_{10\_Grav} - PM_{2.5\_DRX}}{PM_{10\_DRX} - PM_{2.5\_DRX}} \right)^{\frac{1}{3}} \times SCF_{Old}\,.$$

- Update the new SCF in user calibration settings.

Option 2: Parallel Gravimetric Calibration

When you have two sets of gravimetric sampling devices, the DustTrak DRX monitor advanced calibration can be performed in the parallel configuration as shown in Figure B-1b. The calibration steps are outlined below:

1. Install a $PM_{2.5}$ and a PM_{10} impactor at the inlet of the two external gravimetric filters, respectively.

2. Co-locate and run the gravimetric samples and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filters.

3. Calculate the $PM_{2.5}$ ($PM_{2.5\_Grav}$) and PM_{10} (PM_{10_Grav}) mass concentrations from the gravimetric filters based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.

4. Read the DustTrak DRX monitor average $PM_{2.5}$ and PM_{10} mass concentration ($PM_{2.5\_DRX}$ and PM_{10_DRX}) from the DRX screen or through TrakPro Data Analysis Software.

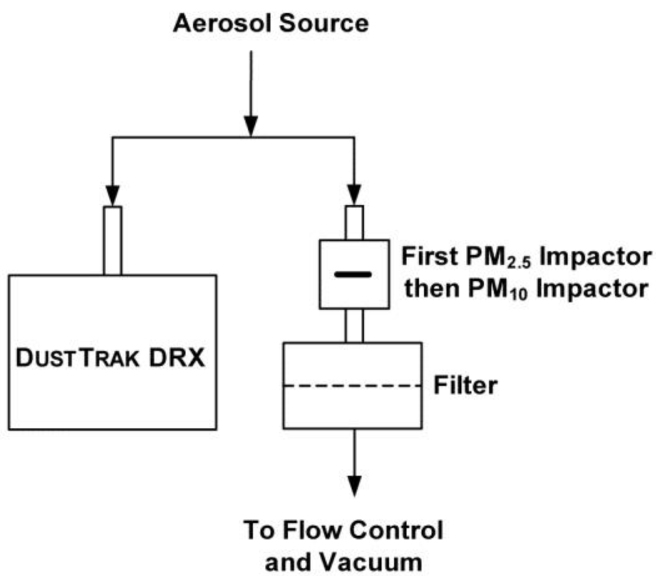
5. Calculate the new PCF

$$\mathrm{PCF_{New}} = \frac{\mathrm{PM_{2.5\_Grav}}}{\mathrm{PM_{2.5\_DRX}}} \times \mathrm{PCF_{Old}},$$

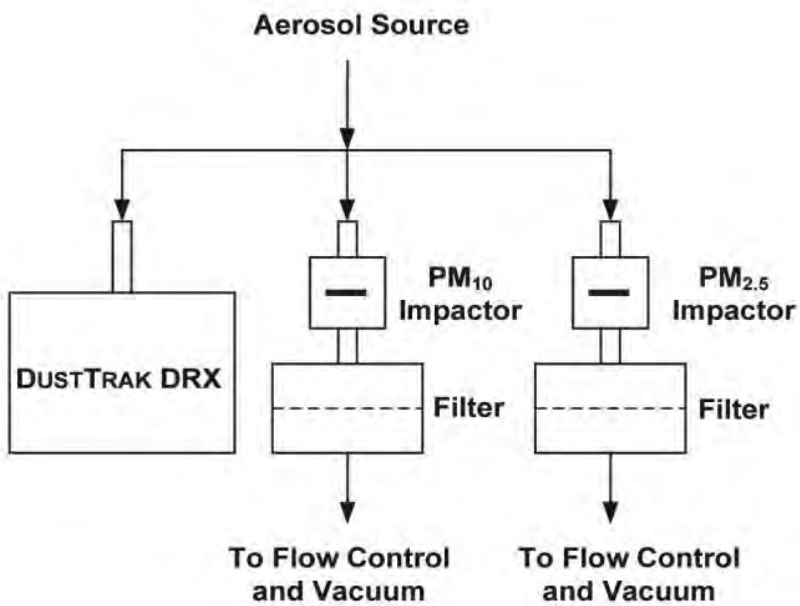
and the new SCF

$$SCF_{New} = \left(\frac{PM_{10\_Grav} - PM_{2.5\_Grav}}{PM_{10\_DRX} - PM_{2.5\_DRX}} \right)^{\frac{1}{3}} \times SCF_{Old}.$$

6. Update the new SCF and PCF in the user calibration settings.



(a)



(b)

Figure B-1: Experimental Setup for
(a) Serial and (b) Parallel Gravimetric Calibration

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Appendix C

Zero Module

The Zero Module (PN 801690) allows for automatic re-zeroing of the DustTrak Instrument during long sampling runs. The Zero Module works only with the 8533 desktop model.

Attach the AutoZero module to the main instrument in two steps.

1. Place the Zero module over the instrument's inlet and press down. The Zero module has an O-ring seal that will engage with the instrument's inlet.

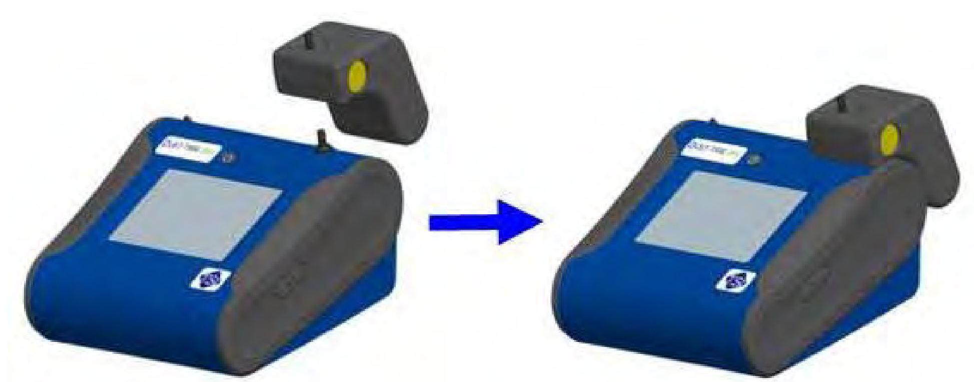

Figure C-1: Place Zero Module Over Inlet and Press Down

2. Attach the cable from the Zero module to the Zero module connector located on the back of the instrument.

Figure C-2: Zero Module Connector

The Zero Module can only be used in a program log mode. The Zero module function is controlled through these two program mode options:

Auto Zero Interval	Interval between re-zeroing the instrument using the Auto-Zero accessory.
Use Auto Zero	Select **Yes** to use the Zero Module. Select **No** to not use the Zero Module.

Important points on Zero Module operation:

- The Zero module will take 1 minute to take a zero reading. The first 45 seconds of that period is used to clear the chamber of particles. Readings from last 15 second of the period, when the chamber is cleared of particles, will be averaged to determine the Zero offset.
- The log interval, when the Zero module is activated, must be 2 minutes or greater. Data will not be recorded to the log file when the Zero module is activated.

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ATTACHMENT B

Particulate Monitoring Log

Particulate Monitoring Log
RAM for the Former Test Range Berm Area and the Cold Waste Area
National Fireworks Site, Hanover, MA

Date	Monitor Instrument Number	Sampling Location	Sampling Start Time	Weather Conditions	Detonation Time(s)	Sampling End Time	Signature of Sampler

TETRA TECH