Tronox Navajo Area Uranium Mines
Northern Abandoned Uranium Mine Region

Final
Full Year Analytical Report

Cove Air Study

February 17, 2023

TETRA TECH

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Full Year Analytical Report

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Response, Assessment, and Evaluation Services
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U.S. Environmental Protection Agency

Submitted by
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ACRONYMS AND ABBREVIATIONS

AMP	Air monitoring plan
AUM	Abandoned uranium mine
DQO	Data quality objective
ERT	Environmental Response Team
NAAQS	National Ambient Air Quality Standard
NAREL	National Analytical Radiation Environmental Laboratory
NNAQCP	Navajo Nation Air Quality Control Program
NTUA	Navajo Tribal Utility Authority
PAL	Project action limit
$PM_{2.5}$	Particulate matter less than 2.5 micrometers in diameter
QAPP	Quality assurance project plan
Ra-226	Radium-226
Ra-228	Radium-228
RPD	Relative percent difference
SCF	Standard cubic foot
SCFM	Standard cubic foot per minute
Tetra Tech	Tetra Tech, Inc.
Th-230	Thorium-230
Th-232	Thorium-232
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (USEPA) tasked Tetra Tech, Inc. (Tetra Tech) to develop an air monitoring plan (AMP) for collecting air sampling data in the Cove area within the Northern Abandoned Uranium Mine (AUM) Region of the Navajo Nation. This effort is referred to as the Cove Air Study. Tetra Tech team members iiná bá and Environmental Restoration Group, Inc. provided local experience, logistics, and radiation assessment experience. This work was assigned under Task Order 0012 of the Response, Assessment, and Evaluation Services contract (EP-S9-17-03).

Five sampling locations were selected to evaluate potential exposure to residents in the Cove area, which is downwind of the AUMs in the nearby Lukachukai Mountains. Air samples were collected weekly during the effort and analyzed for radionuclides, metals, and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$).

This report summarizes the sample results and meteorological data collected over a 57 week-long sampling event between February 10, 2020, and June 21, 2022. The weeks of sampling covered in this report are referred to as "Events" and are numbered sequentially from 1 to 57 despite the gap of over a year between Events 7 and 8 and about 2 months between Events 44 and 45.

During development of the AMP for the Cove Air Study and following USEPA guidance, project action limits (PAL) for metals and $PM_{2.5}$ were identified in the quality assurance project plan prepared before sampling started. PALs represent the concentrations of contaminants in air sampled above which risk is added for people living or working in the area.

The sampling results for the study were:

- No samples collected had a result above the PAL for radionuclides, metals, or $PM_{2.5}$. This indicates that:
  - Risk from exposure to the air sampled during this time period for each individual radionuclide and metal studied does not exceed the upper end of the EPA risk management range for excess cancer risk of 1E-06 to 1E-04 or a noncancer hazard quotient of 0.1, and
  - $PM_{2.5}$ concentrations did not exceed the National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$.
- Meteorological data showed the predominant wind direction during the sampling events was from the southwest with frequent periods of wind from the northeast. Because no previous meteorological data are available, determining whether the observed meteorological data are typical or atypical is not possible.

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) tasked Tetra Tech, Inc. (Tetra Tech) to develop an air monitoring plan (AMP) for collecting air sampling data in the Cove area within the Northern Abandoned Uranium Mine (AUM) Region of the Navajo Nation. This effort is referred to as the Cove Air Study. Tetra Tech team members iiná bá and Environmental Restoration Group, Inc. provided local experience, logistics, and radiation assessment experience. This work was assigned under Task Order 0012 of the Response, Assessment, and Evaluation Services contract (EP-S9-17-03).

Five sampling locations were selected to evaluate potential exposure to residents in the Cove area, which is downwind of the AUMs in the nearby Lukachukai Mountains. Samples were collected weekly during the effort and analyzed for radionuclides, metals, and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$).

Project work was performed in accordance with the AMP finalized on January 8, 2020 (Tetra Tech 2020). The AMP contains appendices with a sampling and analysis plan, quality assurance project plan (QAPP), health and safety plan, and site-specific data management plan. The technical portion of the sampling and analysis work followed the requirements in the sampling and analysis plan and QAPP. The QAPP appendix was revised and finalized on June 11, 2021 (Tetra Tech 2021).

This report summarizes the sample results and meteorological data collected over a 57 week-long sampling event between February 10, 2020, and June 21, 2022. The weeks of sampling covered in this report are referred to as “Events” and are numbered sequentially from 1 to 57 despite the gap of over a year between Events 7 and 8 and about 2 months between Events 44 and 45.

2.0 FIELD SAMPLING

Five stations in or near Cove, Arizona, were sampled weekly for radionuclides, metals, and $PM_{2.5}$ using air samplers provided by the USEPA Environmental Response Team (ERT):

- Cove Chapter House station
- Cove Day School station
- Cove water tower station
- Residential station
- Navajo Tribal Utility Authority (NTUA) pump station (which served as the reference location)

The station locations are shown on Figure 1. Tables 1 and 2 summarize the sampling dates of each event and the latitude and longitude coordinates for each station.

Sampling began in February 2020 with the goal of sampling for a full year. However, after 7 weeks, the sampling effort was temporarily paused because of COVID-19 restrictions. The process of recalibrating the air samplers began in February 2021, and sampling restarted in May 2021. In late January 2022, sampling was paused for about 2 months because many of the radionuclide samplers were not operational. Replacement samplers were acquired and mobilized to the field, and sampling restarted in March 2022 for 3 more months.

2.1 RADIONUCLIDE SAMPLING

Radionuclide samples were collected using F&J Specialty Products DH-100V samplers. The AMP specified samples be collected at a flow rate of 15 standard cubic feet per minute (SCFM) for at least 98.1 hours (4.1 days) to reach a sampling volume of 88,290 standard cubic feet (SCF) and achieve the desired reporting and detection limits.

Because of the remote sampling location, the sampling team only mobilized to the site once a week to collect samples from the previous week and restart the samplers. Consequently, the radionuclide samplers were set up for a 6.5-day collection time and a flow rate of 10 SCFM. Therefore, the nominal sampling volume was 93,600 SCF, resulting in slightly lower nominal reporting and detection limits than the AMP specified. This configuration was used through Event 44. The new samplers were configured with flow rates of 15 SCFM. Therefore, the nominal sampling volume for Events 45 through 57 was 140,400 SCF, giving even lower nominal reporting and detection limits.

Table 1 summarizes the radionuclide data obtained for each sampler for each week of sampling. During the 2021 and early 2022 sampling events, some of the radionuclide samplers stopped working because of power outages or equipment failures and, in some cases, would not restart for the following week of sampling. When this occurred, the samplers were returned to USEPA ERT for repair.

For quality control, the AMP specified that one blank sample be collected and analyzed weekly, and one duplicate sample be collected every other week using an extra sampler located adjacent to the primary sampler at the same station. However, in practice, the duplicate for radionuclide analysis could not always be collected because of equipment failures. Section 3.3 discusses the frequency and results for the quality control samples collected.

2.2 METALS AND $PM_{2.5}$ SAMPLING

Metals and $PM_{2.5}$ samples were collected using BGI PQ200 samplers. The AMP specified that samples would be collected at a flow rate of 16.7 standard liters per minute over a 24-hour sampling period, resulting in a nominal 24 standard cubic meter sample volume to achieve the desired detection limits. To standardize collection, the samplers were set up to begin collection at midnight on Friday morning and finish sampling at midnight on Friday night.

Table 2 summarizes metals and $PM_{2.5}$ data obtained for each sampler for each week of sampling. Metals samples were collected during each week of sampling with no sampler interruptions. However, because of COVID-19 restrictions, samples for Event 7 were not collected until long after the sample holding times. Because of the method requirements for conditioning of the sampled filters within 30 days after initial conditioning, these samples were not submitted for analysis.

For quality control, the AMP specified one blank sample be collected and analyzed weekly, and one duplicate sample be collected every other week using an extra sampler located adjacent to the primary sampler at the same station. Section 3.3 discusses the results for the quality control samples collected.

2.3 METEOROLOGICAL STATION DATA

A meteorological station was procured and installed by Navajo Nation Air Quality Control Program (NNAQCP) personnel at the Cove Chapter House station. This station was used to collect data on wind speed and direction, temperature, relative humidity, precipitation, and solar radiation.

Meteorological data were collected for the following periods:

- March 6, 2020, at 2:00 PM local time through April 17, 2020, at 11:00 AM local time
- March 9, 2021, at 2:00 PM local time through June 21, 2022, at 10:00 AM local time.

The meteorological station collected both hourly and daily data; however, for the purposes of this report, only the hourly data were used.

3.0 RADIONUCLIDE RESULTS

This section summarizes the analytical methods, field sample results, and field quality control sample results for radionuclides from the Cove Air Study.

3.1 RADIONUCLIDE ANALYTICAL METHODS

Samples were analyzed for the following analytes by the National Analytical Radiation Environmental Laboratory (NAREL) using the indicated analytical methods:

- Thorium-230 (Th-230) and thorium-232 (Th-232) using method NAREL TH-EICHROM
- Uranium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238) using method NAREL U-EICHROM
- Radium-226 (Ra-226) using method NAREL RA-07-EC
- Radium-228 (Ra-228) and gamma spectroscopy using method NAREL GAM-01
- Gross alpha and gross beta using USEPA method 900.0

For the gamma spectroscopy method NAREL GAM-01, NAREL reported results for all individual radionuclides detected. These included results for Ra-226 and U-235 in addition to other radionuclides not specified in the QAPP for analysis by gamma spectroscopy. NAREL indicated in the laboratory reports that potential spectral interference and other problems possibly associated with the determination of the activity of certain radionuclides result in greater uncertainty in the activities reported by this method for those radionuclides than for other commonly reported radionuclides. NAREL also recommended that for this method and the radionuclides discussed, including Ra-226 and U-235, the results should be used only as a qualitative means of indicating presence of these radionuclides and not as a quantitative measure of their concentration. Therefore, the results for Ra-226 and U-235 by the gamma spectroscopy method are not summarized in this report although they have been uploaded into the project Scribe database. Results for Ra-226 and U-235 are instead reported for the isotope-specific methods used for these radionuclides. In this report, only results for Ra-228 are reported from the gamma spectroscopy method.

3.2 RADIONUCLIDE FIELD SAMPLE RESULTS

The radionuclide results for all QAPP analytes are summarized in Table 3 and Table 4. The results are also summarized for Ra-226, U-234, and U-238 in chart form on Figure 2 through Figure 4. These tables list the project action limits (PAL) as defined in the QAPP, as well as alternate PALs. The PALs listed in the QAPP were based on a target cancer risk of 3E-04 and a target hazard quotient of 0.1. USEPA is currently making decisions based on a target cancer risk of 1E-04 and a target hazard quotient of 0.1. Therefore, this report uses alternate PALs based on these target levels. Each figure shows the detected results by sampling station and event, the alternate PAL, and the maximum reporting limit for all samples in which the radionuclide was not detected.

No radionuclide concentration in any sample exceeded the PAL or alternate PAL. The lack of exceedances of these PALs indicates that risk from exposure to the each individual radionuclide studied in the air sampled during this time period does not exceed the EPA risk management range for excess cancer risk of 1E-06 to 1E-04.

3.3 RADIONUCLIDE FIELD QUALITY CONTROL RESULTS

Field blanks and field duplicates were collected to assess data quality as outlined in the QAPP. The data validation team did not qualify sample results based on field quality control results.

During several events, sample volumes were low or no samples were collected because of technical problems with the FJ100 samplers used for radionuclide sampling. These samplers were removed from service, sent back to USEPA ERT for servicing, and then returned to the field after repair.

Field blank results for radionuclides are summarized in Table 5. One field blank was collected during each week of sampling except Event 20 when no radionuclide samples were collected because the samplers would not restart. Several radionuclides were detected in one or more field blanks at concentrations not meeting the QAPP data quality objective (DQO) of the detected concentration being below the minimum detectable concentration:

- Ra-226, Th-230, Th-232, U-234, U-238, gross alpha, and gross beta were detected in most or all field blanks at concentrations above the minimum detectable concentration or minimum detectable activity. The concentrations or activities detected were generally near the low end of the range of detected concentrations or activities for field samples.

Field duplicate results for radionuclides where both results were detected are listed in Table 6. The QAPP specified collection of one field duplicate every other week, but the sampling equipment failures reduced the field duplicates collected. A total of 20 field duplicates were collected; however, during Event 12, the field duplicate had insufficient volume, so only 19 field duplicates with valid data for both pairs were collected. Field duplicates were collected weekly for radionuclides between Events 45 and 57 to compensate for the missing field duplicates earlier in the project, but the QAPP goal of 26 field duplicates could not be reached.

The relative percent difference (RPD) did not meet the QAPP DQO of 20 percent for radionuclides in the following cases (the sample results for these duplicate pairs should be considered estimated):

- For gross alpha, seven duplicate pairs had RPDs exceeding 20 percent (from Events 8, 10, 48, 53, 54, 55, and 56) with a maximum RPD of 66 percent.
- For gross beta, five duplicate pairs had RPDs exceeding 20 percent (from Events 1, 10, 46, 56, and 57) with a maximum RPD of 113 percent.
- For Ra-226, four duplicate pairs had RPDs exceeding 20 percent (from Events 49, 50, 56, and 57) with a maximum RPD of 49 percent.
- For Th-230, the duplicate pair for Event 53 had an RPD exceeding 20 percent (24 percent).
- For Th-232, three duplicate pairs had RPDs exceeding 20 percent (from Events 53, 54, and 56) with a maximum RPD of 30 percent.

- For U-238, four duplicate pairs had RPDs exceeding 20 percent (from Events 49, 50, 53, and 54) with a maximum RPD of 40 percent.

3.4 RADIONUCLIDE RESULT QUALIFICATIONS

The data validation team rejected nine Ra-226 results. Rejected data were not reported in the electronic data deliverables but were summarized in the data validation reports. The rejected data were:

- Sample results for all radionuclide analytes for the following 32 samples did not attain a sampling volume between 75 and 125 percent of the intended nominal sample volume (93,600 SCF for Events 1 through 44, and 145,080 SCF for Events 45 through 57):
  - Residential station: Events 10, 11, 12 (field duplicate), 13, and 31
  - Cove Day School station: Events 10, 11, 12, 13, 30, 31, and 46
  - Cove water tower station: Events 10, 13, 30, 32, and 49
  - Cove Chapter House station: Events 17, 18, 19, 32, 39, 40, 41, and 49
  - NTUA pump station: Events 5, 8, 10, 11, 12, 32, and 41
- Sample results for Ra-226 in nine samples were rejected based on poor spectral resolution:
  - Residential station: Event 10
  - Cove Day School station: Events 7 and 10
  - Cove water tower station: Event 7
  - Cove Chapter House station: Event 7
  - NTUA pump station: Events 5 and 11
  - Field blank sample: Events 9 and 11

Other qualifications were applied by the data validation team for a variety of reasons, including field blank results. Some results with reported activity were changed to nondetects or qualified as estimated with a high bias based on the field blank results. The data are used as recommended by the data validation team.

4.0 METALS AND $PM_{2.5}$ RESULTS

This section summarizes the analytical methods used for metals and $PM_{2.5}$ sampling, and the field sample results and field quality control sample results for metals and $PM_{2.5}$.

4.1 METALS AND $PM_{2.5}$ ANALYTICAL METHODS

Samples were analyzed for metals and $PM_{2.5}$ by Enthalpy Analytical, LLC. Metals were analyzed using USEPA method IO-3.5, and $PM_{2.5}$ was analyzed using USEPA method IO-3.1 and following 40 *Code of Federal Regulations* Part 50.

4.2 METALS AND $PM_{2.5}$ FIELD SAMPLE RESULTS

The metals and $PM_{2.5}$ results are summarized in Table 7 and Table 8 and shown on Figure 5 through Figure 12. These tables list the PALs as defined in the QAPP, as well as alternate PALs. The QAPP PALs were based on a target cancer risk of 3E-04 and a target hazard quotient of 0.1. USEPA is currently making decisions based on a target cancer risk of 1E-04 and a target hazard quotient of 0.1. Therefore, this report uses alternate PALs based on these target levels. Each figure shows the detected results by sampling station and event, the alternate PAL, and the maximum reporting limit for all samples in which the constituent was not detected.

No metal or $PM_{2.5}$ concentration in any sample exceeded the PAL or alternate PAL. The lack of exceedances of these PALs indicates that risk from exposure to each individual metal studied in the air sampled during this time period does not exceed the EPA risk management range for excess cancer risk of 1E-06 to 1E-04 or a hazard quotient of 0.1, and that the National Ambient Air Quality Standard (NAAQS) standard for $PM_{2.5}$ was not exceeded in any sample.

4.3 METALS AND $PM_{2.5}$ FIELD QUALITY CONTROL RESULTS

Field blanks and field duplicates were collected to assess data quality as outlined in the QAPP. The data validation team did not qualify sample results based on field quality control results.

Field blank results for $PM_{2.5}$ and metals are summarized in Table 9. One field blank was collected during each week of sampling. $PM_{2.5}$ and several metals (barium, lead, selenium, and vanadium) were detected in one or more field blanks. Detections met the QAPP DQO of the detected concentration being below the reporting limit with the following exceptions:

- $PM_{2.5}$ was detected in 3 of 56 field blanks at concentrations above the reporting limit of 0.042 micrograms per cubic meter for Events 8, 20, and 29. The concentrations detected were approximately a factor of 10 or more below all detected results for the same weeks of sampling for Events 8 and 20, indicating the $PM_{2.5}$ results for these events are likely not significantly impacted by blank contamination. However, the concentrations detected for Event 29 were within a factor of 5 of the detected results for field samples, indicating that some positive bias may have been observed for those samples. These samples are not likely false positives but should be considered estimated with a possible positive bias.
- Barium was detected in 5 of 56 field blanks at concentrations above the reporting limit of 0.00083 micrograms per cubic meter for the samples from Events 11, 14, 39, 50, and 53.

The field blank result was close to the maximum concentration detected for each of these weeks, indicating the results may be false positives from blank contamination.

Field duplicate results for $PM_{2.5}$ and metals where both results were detected are listed in Table 10. For metals and $PM_{2.5}$, 28 field duplicates were collected. The RPD for field duplicate pairs were calculated when the analyte was detected in both the original and the field duplicate sample. The RPD did not meet the QAPP DQOs of 25 percent for $PM_{2.5}$ and 20 percent for metals in the following cases:

- For barium, 12 of the 20 duplicate pairs had RPDs exceeding 20 percent (from Events 5, 10, 18, 20, 24, 26, 34, 36, 38, 45, 53, and 55) with a maximum RPD of 112 percent. The results for these samples were close to the reporting limit. These samples should be considered estimated.
- For lead, 5 of the 11 duplicate pairs had RPDs exceeding 20 percent (from Events 18, 24, 30, 42, and 44) with a maximum RPD of 75 percent. The results for these samples were close to the reporting limit. These samples should be considered estimated.
- For vanadium, 1 duplicate pair had an RPD of 30 percent (from Event 49). The results for this sample were close to the reporting limit. This sample duplicate pair should be considered estimated.
- For $PM_{2.5}$, 11 of the 24 duplicate pairs had RPDs exceeding 25 percent (from Events 2, 5, 8, 10, 12, 14, 24, 28, 36, 40, and 44) with a maximum RPD of 99 percent. These samples should be considered estimated.

To summarize:

- Field blank results may indicate false positives for barium results in a few samples from Events 11 and 14.
- Field duplicate results for several metal and $PM_{2.5}$ results are considered estimated based on precision not meeting the QAPP DQOs.

5.0 METEOROLOGICAL DATA

Meteorological data were collected using a Campbell Scientific Meteorological Station at the Cove Chapter House station using a CR1000 data logger. The data are summarized in this report for each sampling event. The data fields collected were:

- Date and time of the observation
- Sequential record number
- Temperature in degrees Celsius
- Relative humidity in percent
- Barometric pressure in millimeters of mercury (however, the Navajo Nation Environmental Protection Agency indicated this sensor was not operational, so pressure data are not summarized in this report)
- Rainfall in inches
- Solar radiation in Webers per square meter
- Wind speed using two separate averaging methods (scalar averaging and vector averaging) in miles per hour
- Wind direction (using scalar averaging and vector averaging) in degrees
- Standard deviation of the wind direction (for both the scalar and vector averaging methods) in degrees

Both daily and hourly summary data were downloaded from the meteorological station by NNAQCP. For the purposes of this report, only the hourly data were used. The sampling periods were generally as follows:

- Radionuclide samplers were started manually around noon on Tuesday and ran for 6.5 days. For this report, the data were tabulated from noon on the start of the sampling day through the midnight before collection.
- Metals and $PM_{2.5}$ samplers were started up automatically at midnight on Thursday evening and stopped automatically 24 hours later at midnight on Friday evening. For this report, the data were tabulated from midnight to midnight on these days.

For the radionuclide samples, individual sample start and stop times varied slightly. However, for the purposes of this report and study, these differences are minor. Full meteorological data are available for more detailed analysis if necessary.

Data collection from the meteorological station did not begin until partway through Event 4. Therefore, meteorological data are not available for the first three sampling events. Although some data are available for Event 4, meteorological summary data are not presented for Event 4 because of the high uncertainty associated with averaging only about half the sampling period.

5.1 METEOROLOGICAL DATA SUMMARY TABLES

Table 11 summarizes the meteorological data for the 57 radionuclide sample collection events. The table shows the expected general increase in average temperature between the spring and summer. The average relative humidity and average total solar radiation also increased during this period. Average wind speed ranged from 1.5 to 5.1 meters per second for scalar averaging and from 1.3 to 4.8 meters per second for vector averaging with higher average wind speeds observed in the spring months. The weekly average wind directions ranged from 179 to 258 degrees for scalar averaging and from 178 to 257 degrees for vector averaging.

Table 12 summarizes the data for the 57 metals and $PM_{2.5}$ sample collection events. The trends observed in Table 11 were also seen generally in Table 12 except for more variability in wind data, which would be expected from the shorter sampling periods. The wind speed was particularly high during Events 9, 49, and 51.

5.2 WIND ROSE PLOTS

Table 11 and Table 12 summarize wind speed and wind direction. However, for wind direction, wind rose plots also provide a helpful visual indication of the data. Wind rose plots were generated using WRPLOT View software version 8.0.2 and are presented in Figure 13 for the radionuclide sampling events and Figure 14 for the metals and $PM_{2.5}$ sampling events. As noted above, complete data were not available for the first 4 weeks of sampling in 2020, so wind roses are not presented for those weeks of sampling.

The wind roses show the frequency of specific wind direction and wind speeds. The directions shown are the directions from which the wind is coming. As illustrated by the wind roses, the predominant wind direction during the sampling events was from the southwest, but there were also frequent periods where the wind direction was from the northeast and occasional periods where the wind direction was from other directions. The variability of wind directions appears higher for the metals and $PM_{2.5}$ sampling events, which is not surprising since these samples are collected over a 24-hour period (compared with 6.5 days for the radionuclide samples).

6.0 DATA USABILITY

The QAPP identified USEPA as the party that would prepare the usability assessment; this section provides information that will assist in that assessment (Tetra Tech 2021). Data usability is based on the precision, accuracy, representativeness, comparability, completeness, and sensitivity of the methods used.

6.1 PRECISION

Precision was assessed using field duplicate pairs, laboratory control samples, and laboratory control sample duplicate pairs. Laboratory duplicate pairs cannot be analyzed because of the nature of the air filters.

Laboratory control sample and laboratory control sample duplicate pair precision was evaluated during data validation against QAPP criteria and generally met criteria. Data were qualified as estimated as necessary.

As noted in Section 3.3 and Table 6, field precision for radionuclides was generally good. In a total of 73 duplicate pair results, both results were detected. For these pairs, the RPD ranged from 0 to 113 percent with an average of 19 percent. Of these 73 pairs, 49 met the QAPP criteria of 20 percent for radionuclides and 24 did not. The data validation did not qualify data based on field duplicate RPD criteria from the QAPP, but for the 24 duplicate pairs that did not meet criteria, the reported results should be considered estimated.

As noted in Section 4.3 and Table 10, field precision for metals was generally good. In a total of 35 duplicate pair results, both results were detected. For these pairs, the RPD ranged from 0 to 112 percent with an average of 29 percent. Of the 35 pairs, 17 met the QAPP criteria of 20 percent for metals and 18 did not. The data validation did not qualify data based on field duplicate RPD criteria from the QAPP, but for the 18 duplicate pairs that did not meet criteria, the reported results should be considered estimated.

As noted in Section 4.3 and Table 10, field precision for $PM_{2.5}$ was generally very good. In a total of 24 duplicate pair results, both results were detected. For these pairs, the RPD ranged from 0 to 99 percent with an average of 31 percent. Of the 24 pairs, 13 met the QAPP criteria of 25 percent for $PM_{2.5}$ and 11 did not. The data validation did not qualify data based on field duplicate RPD criteria from the QAPP, but for the 11 duplicate pairs that did not meet criteria, the reported results should be considered estimated.

For metals, post-digestion matrix spikes can also be used to assess precision. However, that assessment has not been performed as part of this limited usability assessment. Generally, criteria were met for these criteria and data were qualified as appropriate by the data validation.

6.2 ACCURACY

Accuracy was assessed for radionuclides, metals, and PM2.5 using method blanks and field blanks. Method and field blanks generally met criteria for metals. Method blanks generally met criteria for radionuclides, but field blanks frequently exceeded the criteria. When criteria were not met, data were qualified as nondetect (U) or estimated with a high bias (J+) during validation as appropriate based on the concentration in the blanks and field samples.

Accuracy can also be assessed for radionuclides, metals, and $PM_{2.5}$ using laboratory control samples and for metals using inductively coupled plasma mass spectrometry tuning data, post-digestion spike samples, and inductively coupled plasma interference check samples. However, these assessments have not been performed as part of this limited usability assessment. Generally, criteria were met for these criteria and data were qualified as appropriate by the validation team.

6.3 REPRESENTATIVENESS

The representativeness of the dataset includes two aspects: the spatial representativeness of the sampling, and the temporal representativeness.

The spatial representativeness for air samples is based on two factors. The first is whether the locations sampled are representative of the receptors to be evaluated for risk by USEPA. The second is whether those receptors are adequately covered by the stations selected or, in other words, whether the wind direction during the study period provided enough opportunity to detect airborne particulate blowing from the AUMs to the stations.

The first aspect of spatial representativeness is assured as all sampling stations are located within the bounds of the Cove Chapter except for the NTUA pump station, which was intended to serve as the reference location. The second aspect of spatial representativeness was evaluated based on the wind direction measured over the sampling period. Figure 15 shows the Cove area including the location of the sampling stations and AUMs in the Lukachukai Mountains to the southwest of Cove. This figure also shows a wind rose. The wind rose shows the wind direction was predominantly from the AUMs to Cove during the time periods sampled.

The temporal representativeness for air samples is also based on two factors. The first is whether the sampling period covers an adequate period of time. The second is whether the sampling period occurred during a time when meteorological conditions were typical for the area.

The first aspect of temporal representativeness was evaluated by assessing against the QAPP goals, which were to collect data for a full year. Although the 57 week-long sampling events represent more than the goal of 52 weeks, gaps in the study because of COVID-19 (between Events 7 and 8) and equipment-related delays (between Events 44 and 45) occurred. Table 13 summarizes the representativeness of the data by showing the number or samples collected in specific seasons and months. For this table, the number of events with data for any Cove station during a particular month or season are combined. Although some variation between the coverage for seasons occurred, at least 20 samples were collected in each season. Spring was the season with the most samples collected and generally had the highest wind speeds.

The second aspect of temporal representativeness was evaluated by comparing wind speeds, wind directions, $PM_{2.5}$ concentrations, and metals concentrations for periods where some or all radionuclide data were missing against the periods where data were obtained. Figure 16 through Figure 24 show the values for various wind parameters and contaminants of potential concern concentrations for each event against the number of stations with radionuclide data during that event:

- Figure 16 shows averaged hourly vector wind speed.
- Figure 17 shows the maximum hourly vector wind speed.
- Figure 18 shows averaged hourly vector wind direction.
- Figure 19 shows averaged $PM_{2.5}$ concentration.
- Figure 20, Figure 21, Figure 22, Figure 23, and Figure 24 show averaged arsenic, barium, molybdenum, lead, and vanadium concentrations, respectively. Only detected concentrations were averaged, so some events do not appear in some figures. Other metals were not plotted because of very low detection frequency.

In summary, temporal representativeness within the time period collected was good. Sampling events missing data from one or more stations were generally not those with higher wind speeds, different wind directions, or higher $PM_{2.5}$ or metals concentrations. However, the metals and $PM_{2.5}$ sampling periods were shorter than the radionuclide sampling periods, so the data from these periods are not completely representative of each other.

6.4 COMPARABILITY

Samples were collected following standard procedures and the project QAPP and, as such, are expected to be comparable to data collected using similar equipment and procedures. The laboratories used followed standard methods, and the data generated are expected to be comparable to data generated by laboratories following similar standard methods.

6.5 COMPLETENESS

The completeness of the dataset was evaluated in several ways. The most basic is to assess the criteria in the QAPP, which specified collection of four samples per week from Cove for 52 weeks (208 field samples) along with one reference location sample per week (52 samples), one field blank each week (52 field blanks), and one field duplicate every other week (26 field duplicates). The values below consider how many events had data where data were collected and not rejected for insufficient volume during data validation:

- Radionuclides:
  - A total of 134 valid samples were collected in Cove for a percent completeness of 134/208 or 64 percent.
  - A total of 35 valid samples were collected from the reference location for a percent completeness of 35/52 or 67 percent.
  - A total of 52 valid field blanks were collected for a completeness of 100 percent.
  - A total of 19 valid field duplicates were collected for a completeness of 73 percent.
- Metals and $PM_{2.5}$:

- All field samples and field blanks were collected for each of the 57 events except Event 7,for a completeness of 98 percent for each type.
- Field duplicates were collected for 30 events for a completeness of 100 percent.

6.6 SENSITIVITY

Reporting limits for all samples met the QAPP sensitivity goals based on the PALs for the project. Reporting limits were also below the alternative PALs described in Sections 3.2 and 4.2 for all analytes in all samples.

7.0 REFERENCES

Tetra Tech, Inc. (Tetra Tech). 2020. "Northern Agency Tronox Mines, Cove Air Study, Air Monitoring Plan." January 8.

Tetra Tech. 2021. "Appendix B: Quality Assurance Project Plan." In the "Northern Agency Tronox Mines, Cove Air Study, Air Monitoring Plan." Revision 1. June 11.

FIGURES

Figure 1. Air Sampling Station Locations

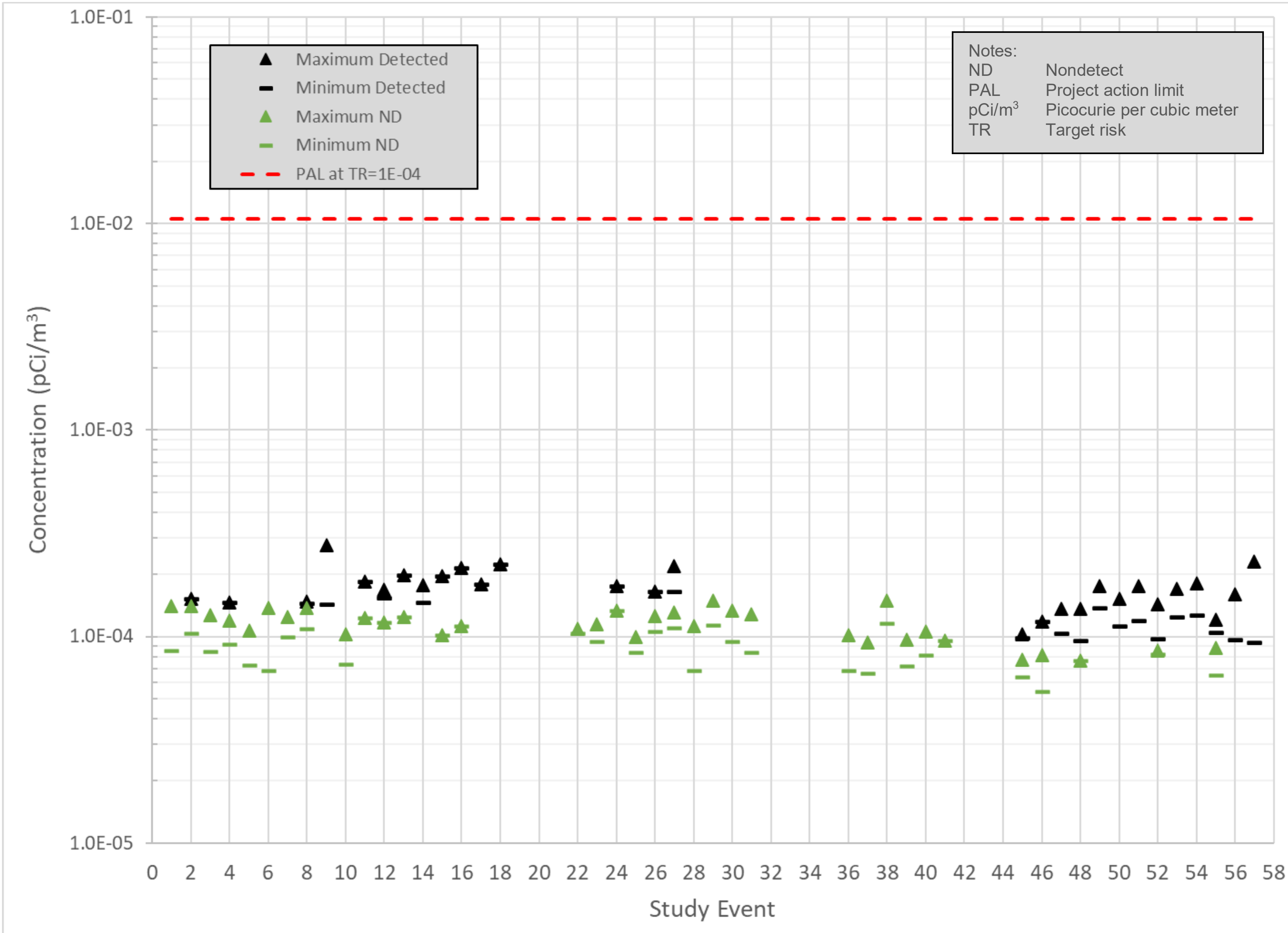


Figure 2. Radium-226 Results

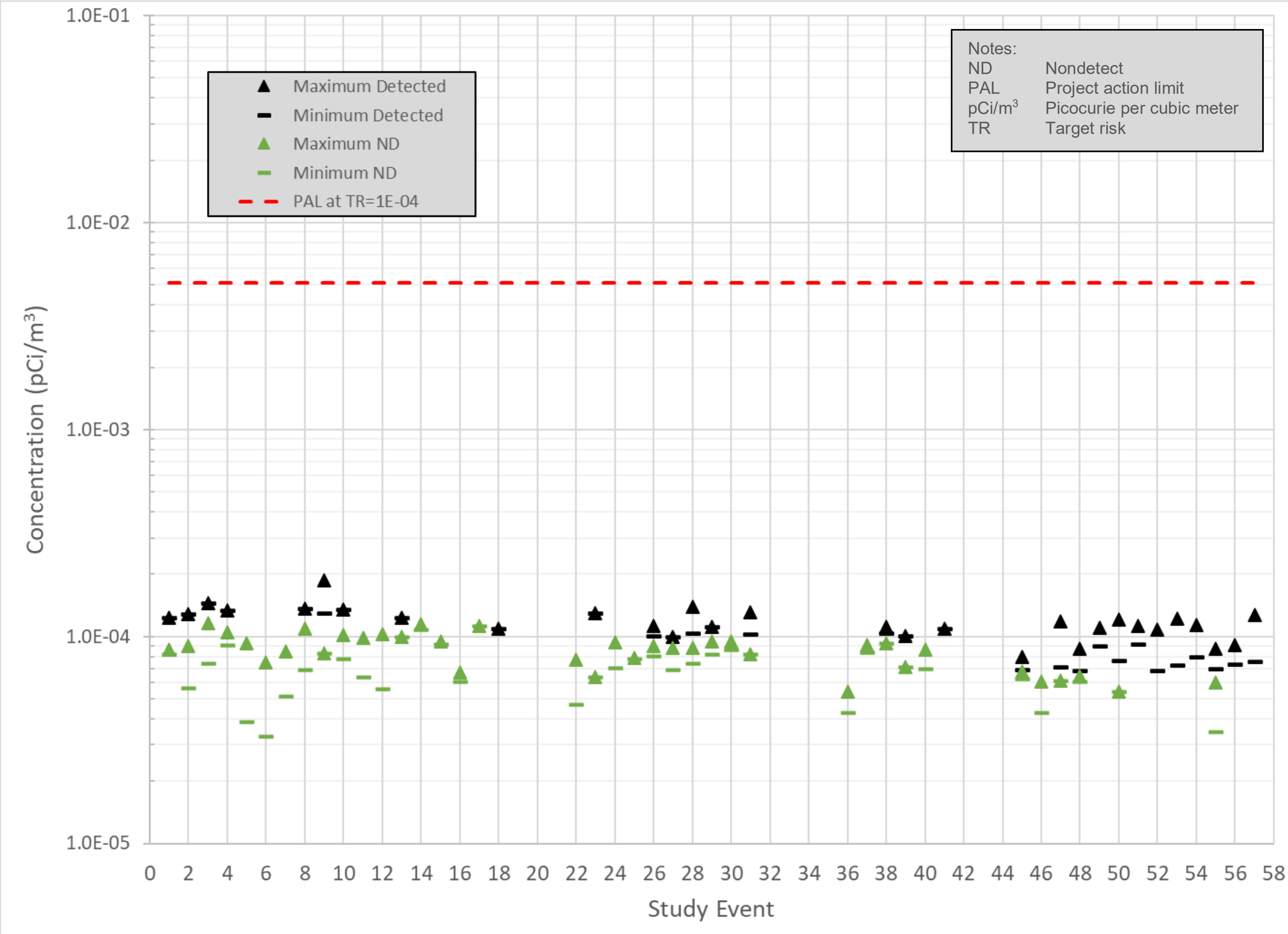


Figure 3. Uranium-234 Results

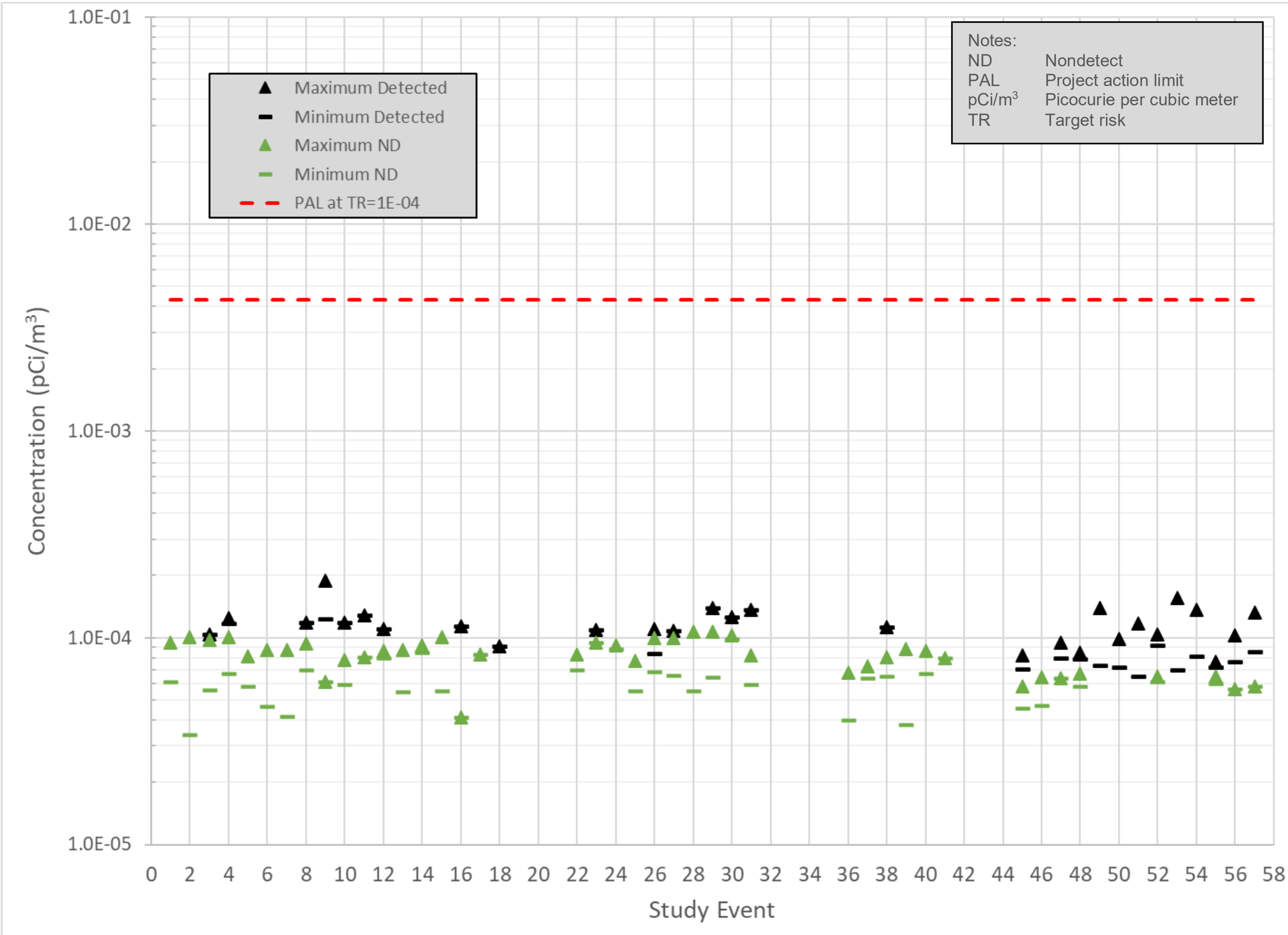


Figure 4. Uranium-238 Results

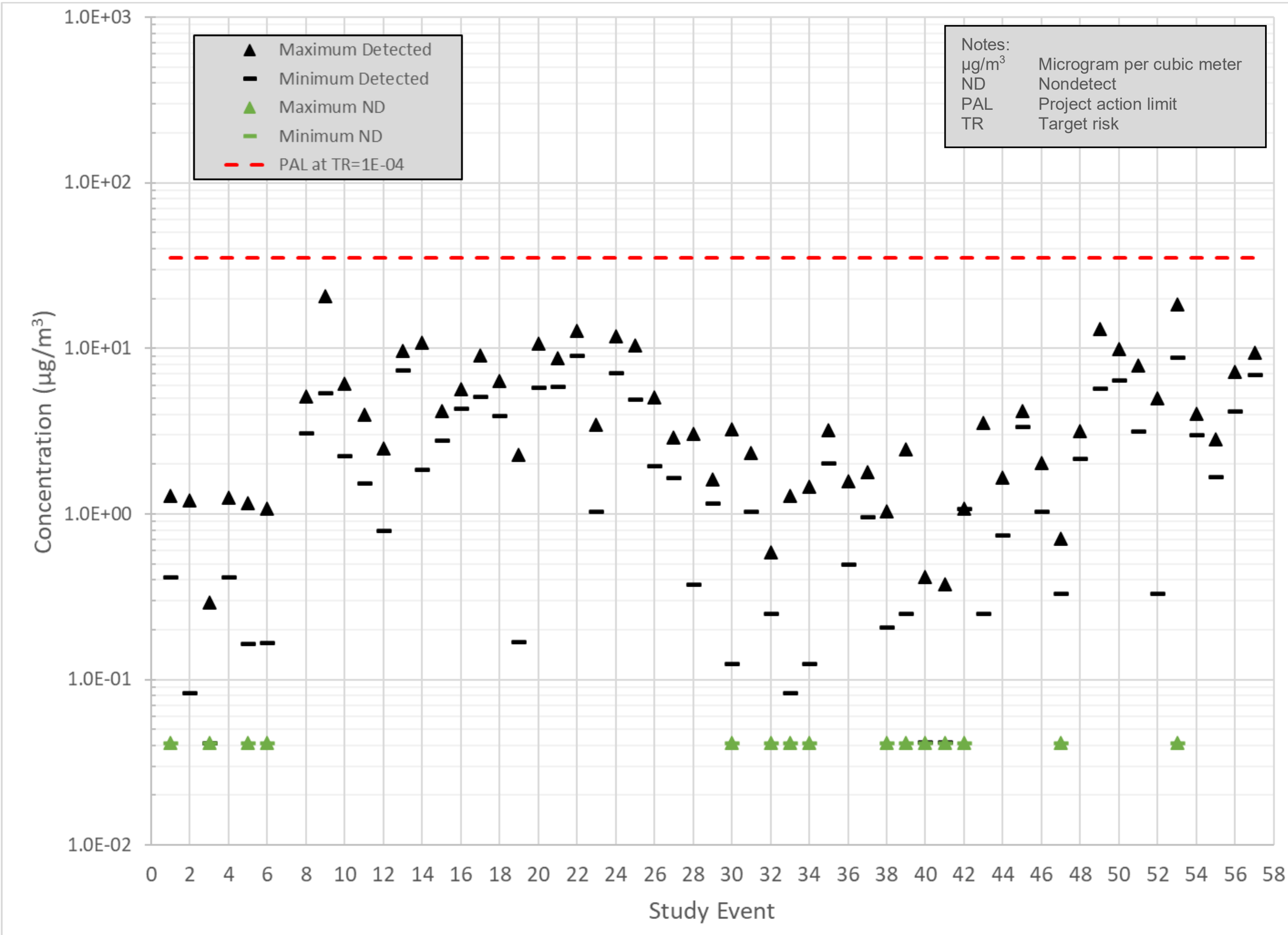


Figure 5. $PM_{2.5}$ Results

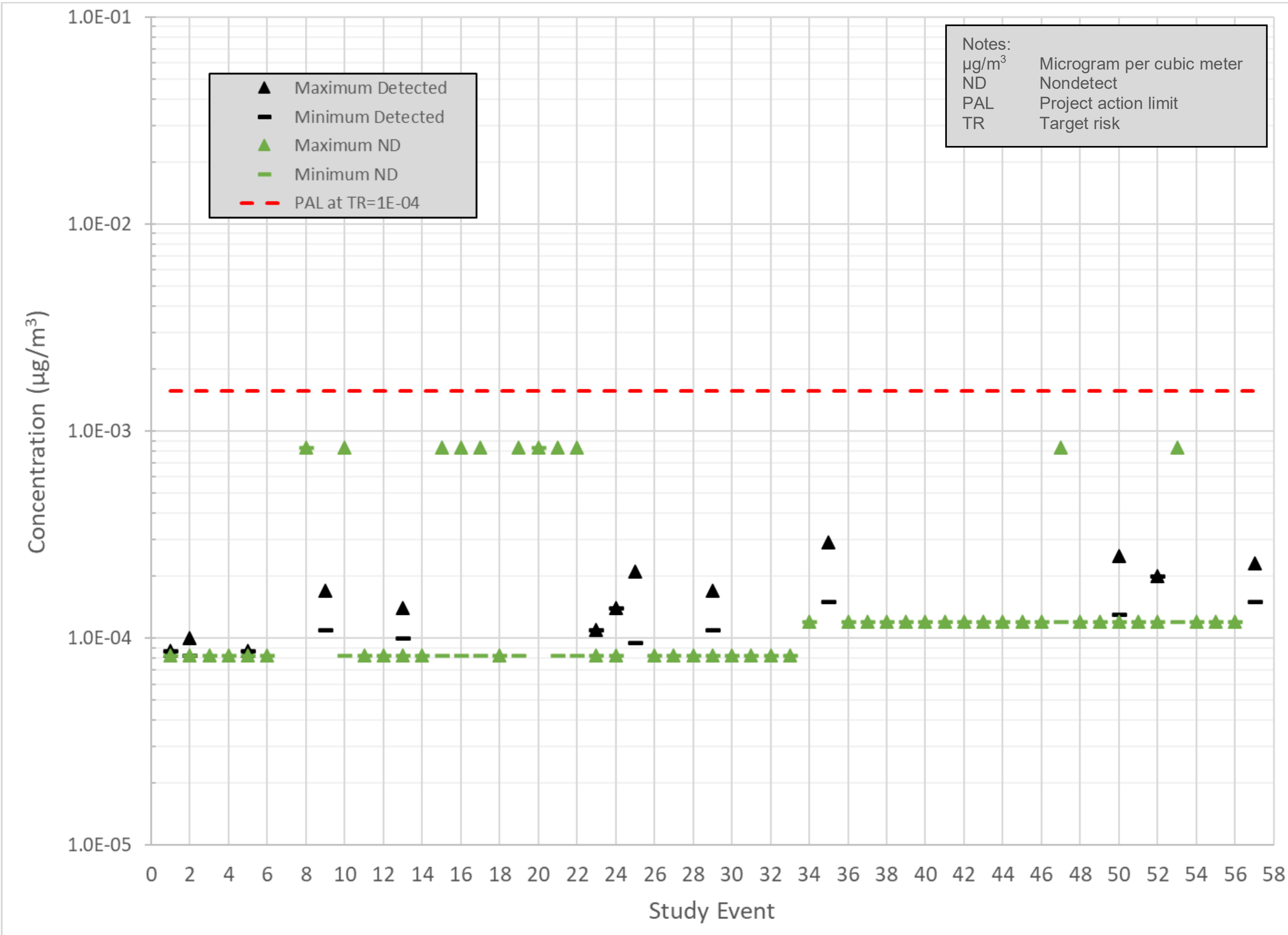


Figure 6. Arsenic Results

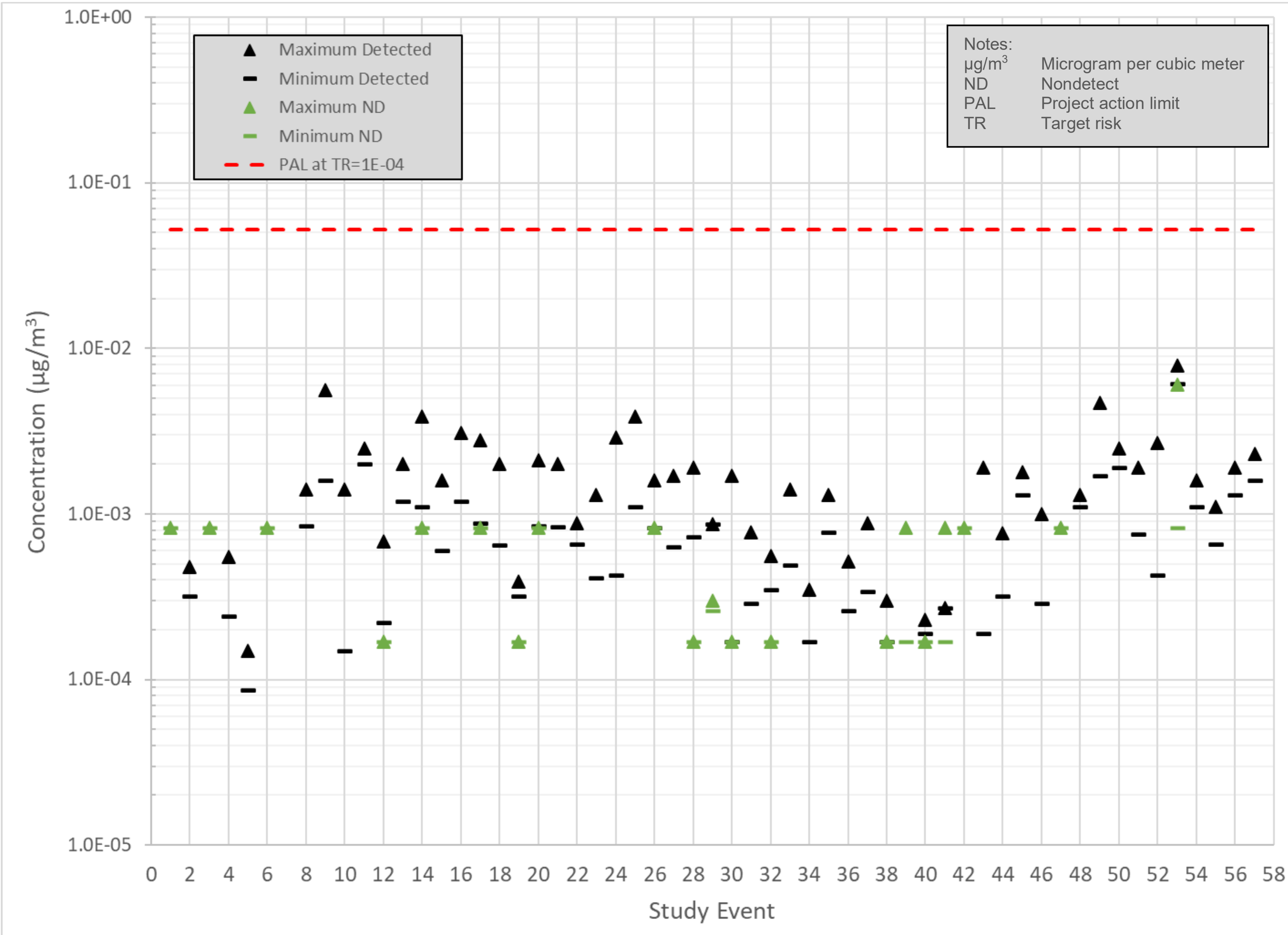


Figure 7. Barium Results

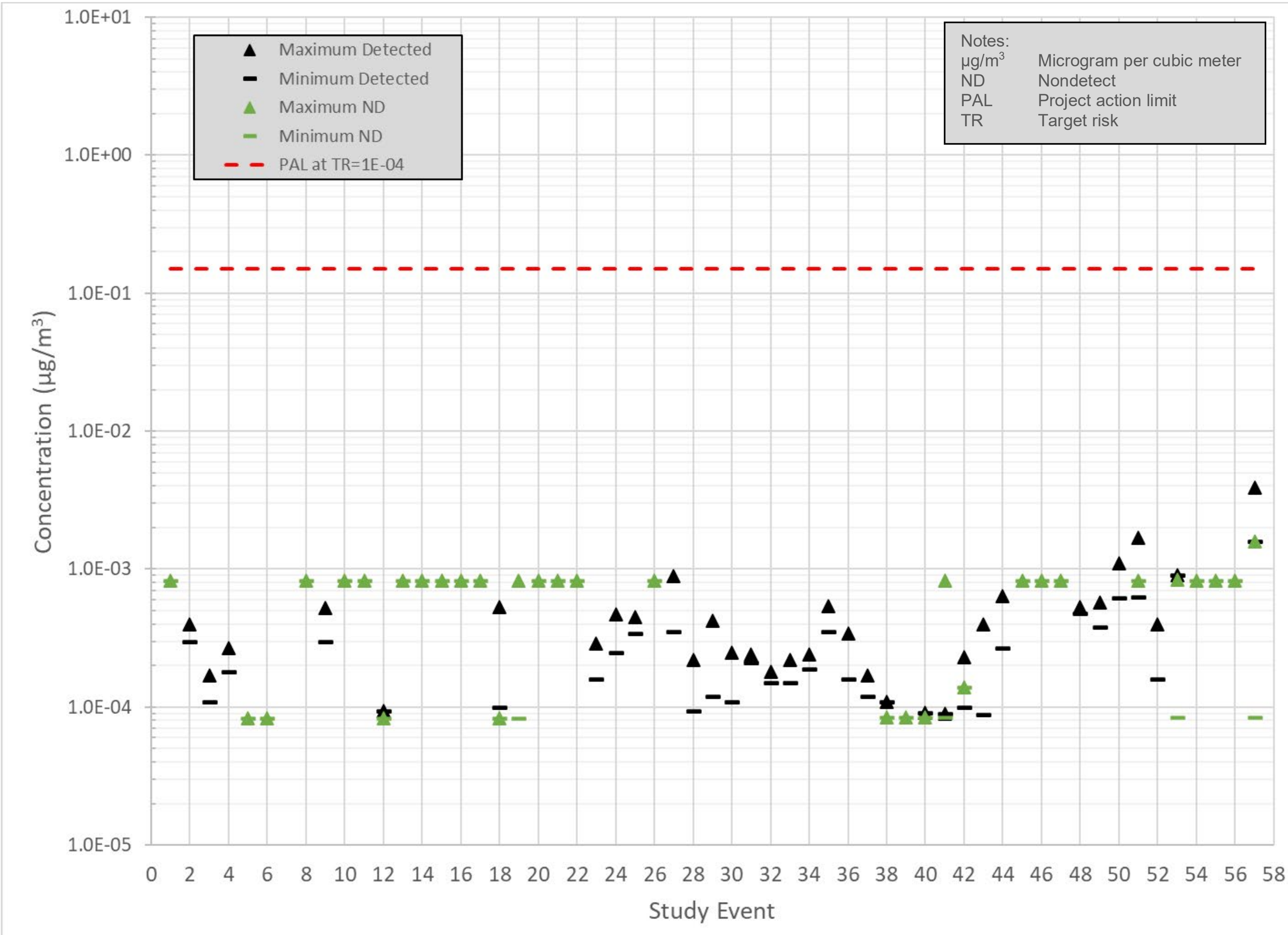


Figure 8. Lead Results

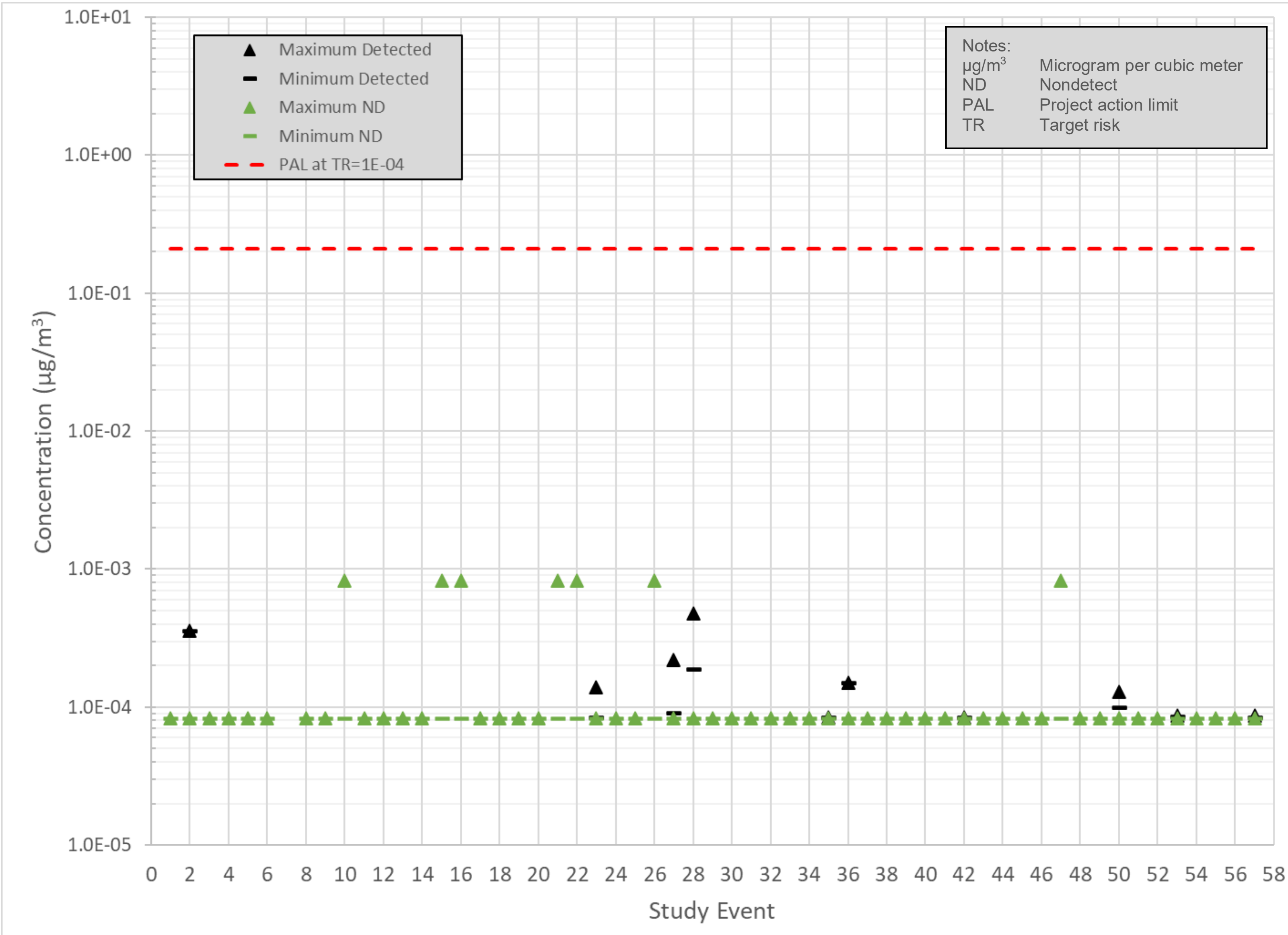


Figure 9. Molybdenum Results

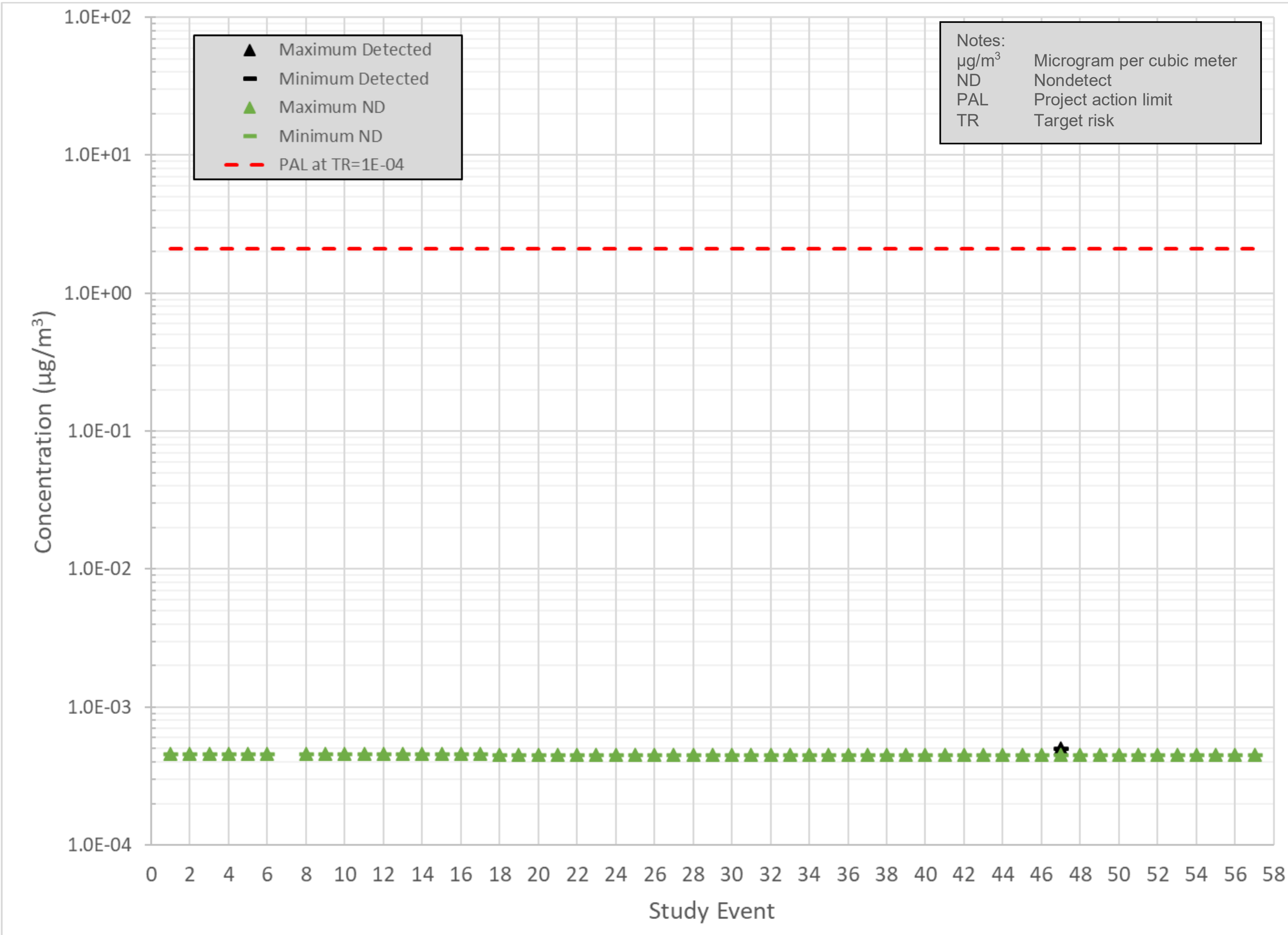


Figure 10. Selenium Results

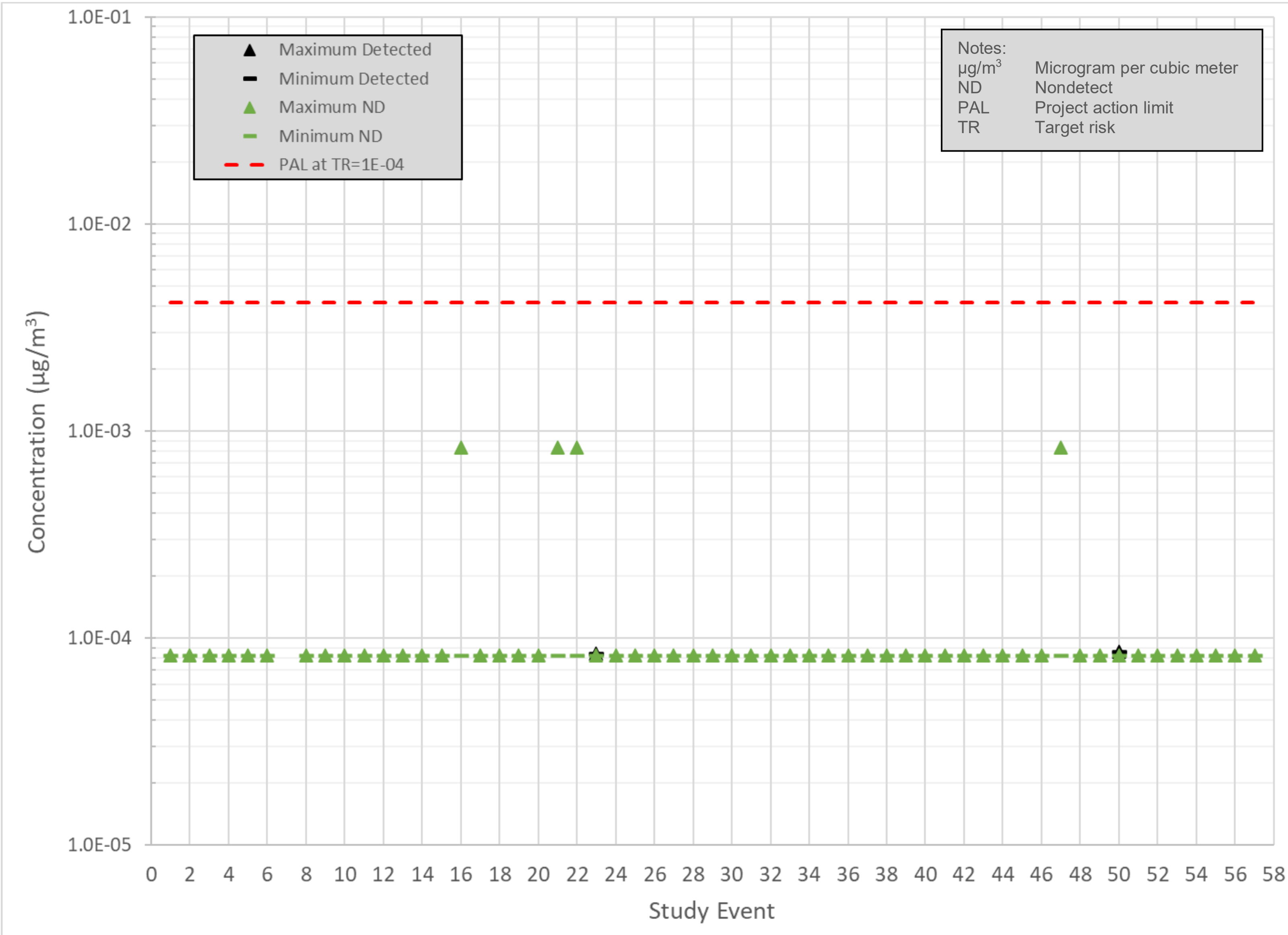


Figure 11. Uranium Results

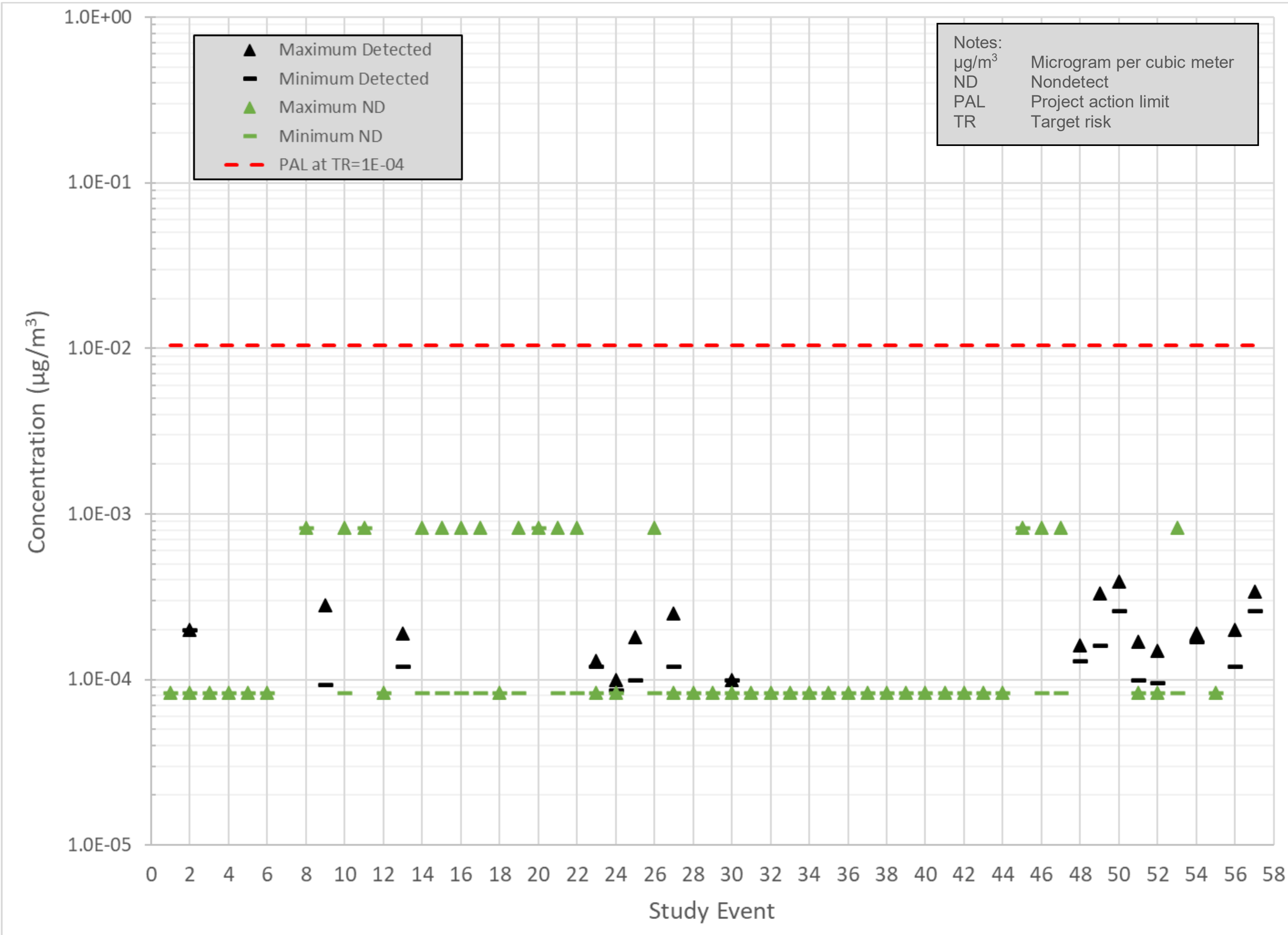


Figure 12. Vanadium Results

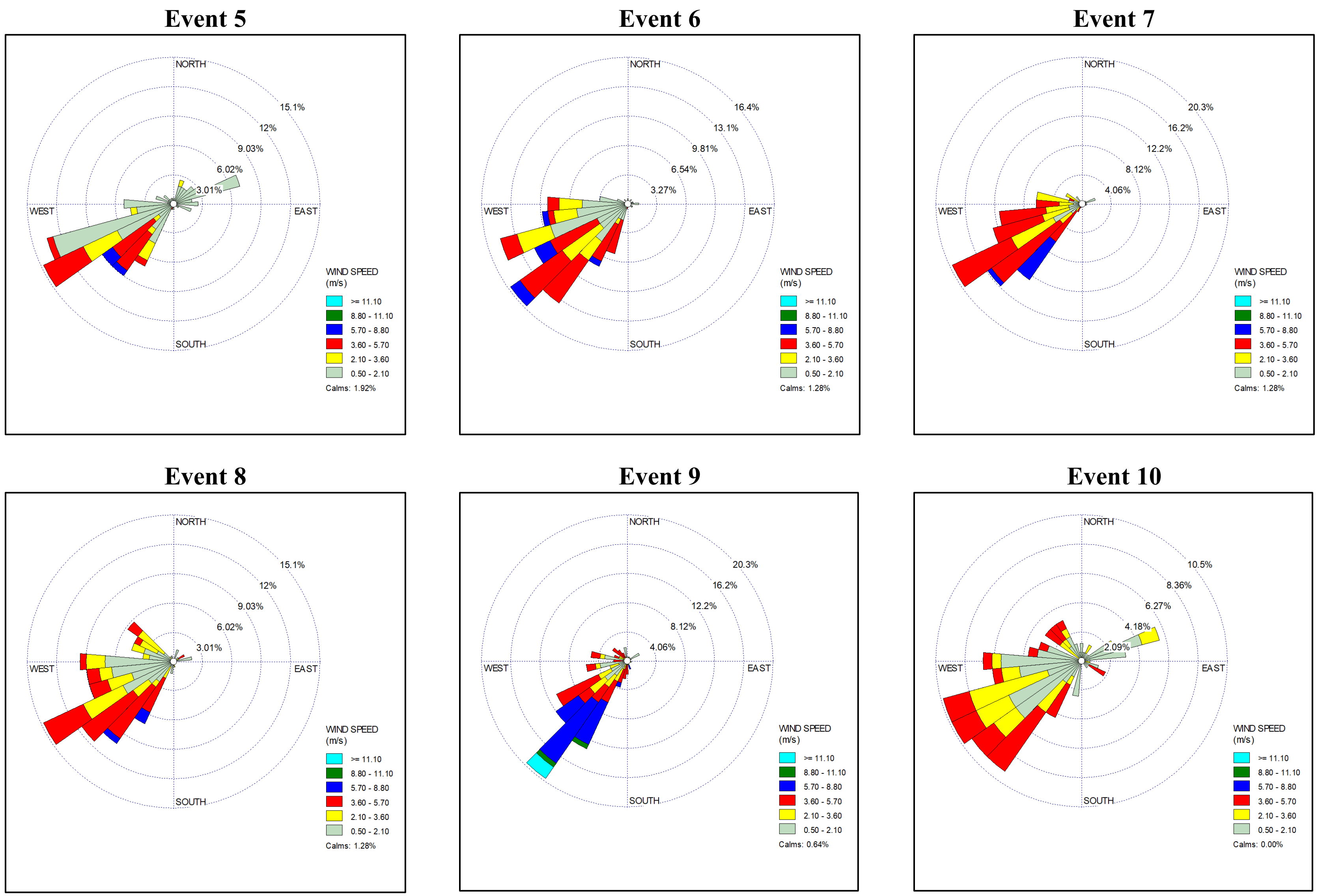


Figure 13. Wind Roses, All Radionuclide Sampling Events

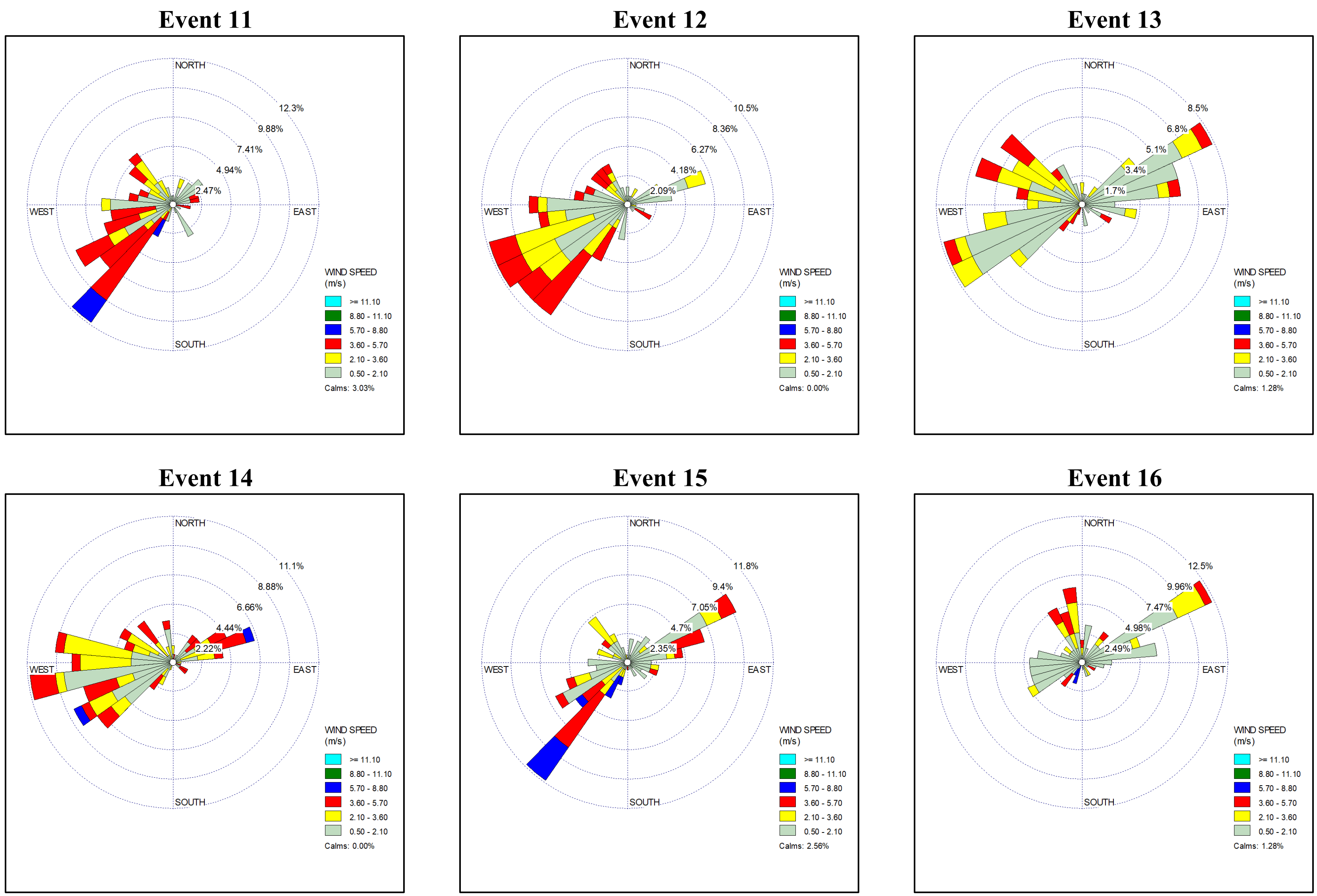


Figure 13. Wind Roses, All Radionuclide Sampling Events (Continued)

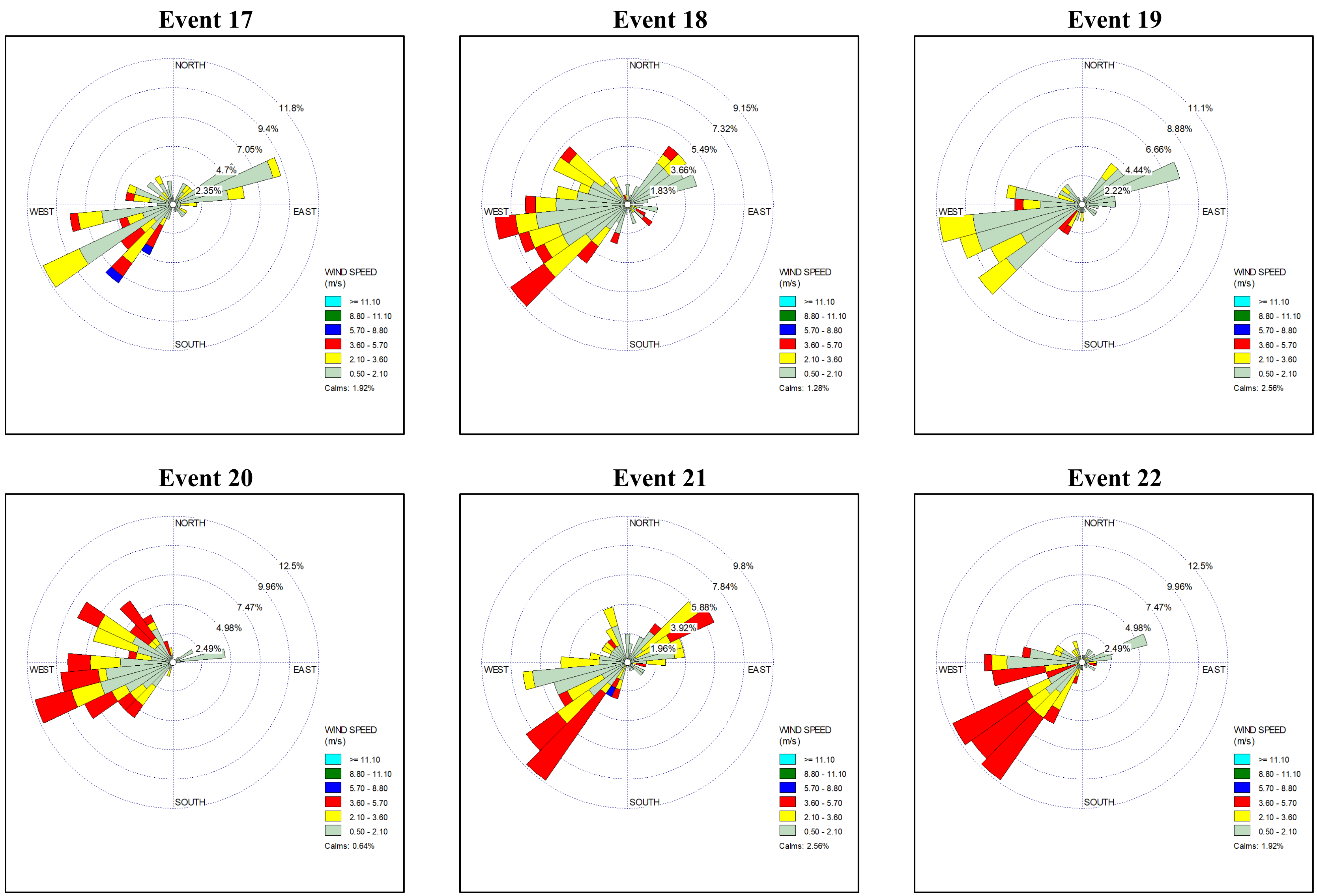


Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

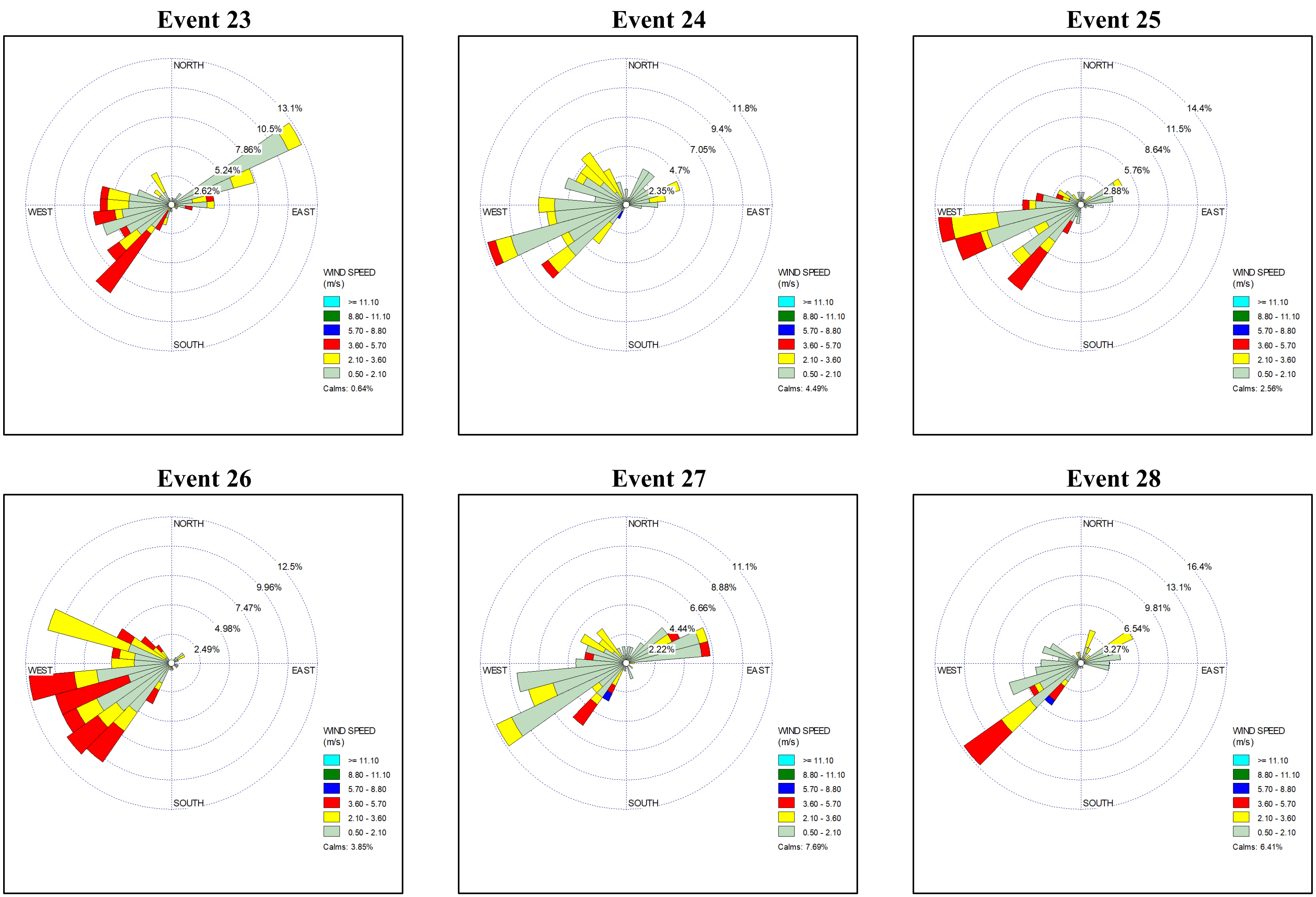
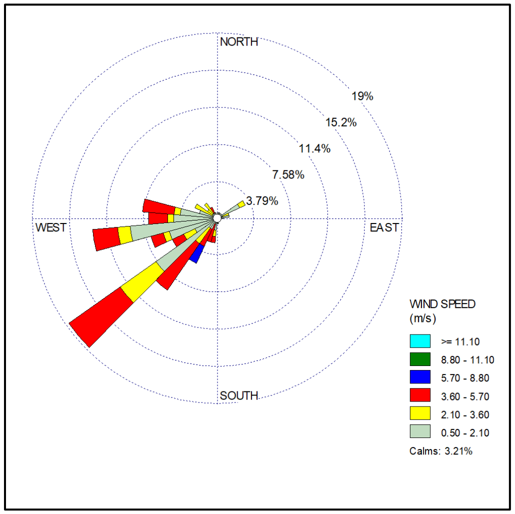


Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

Event 29



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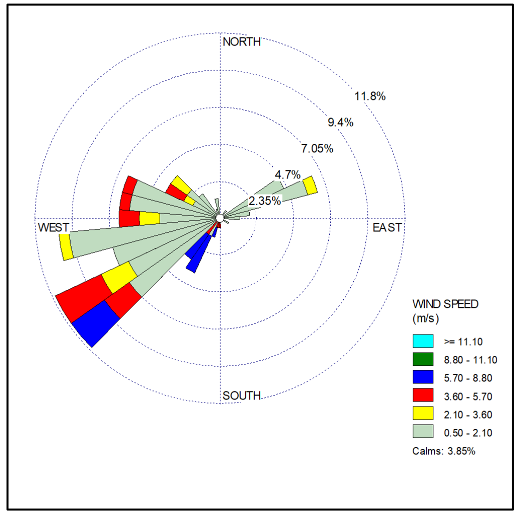

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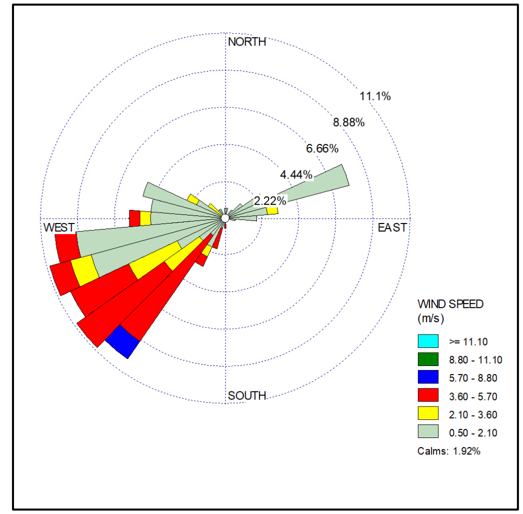

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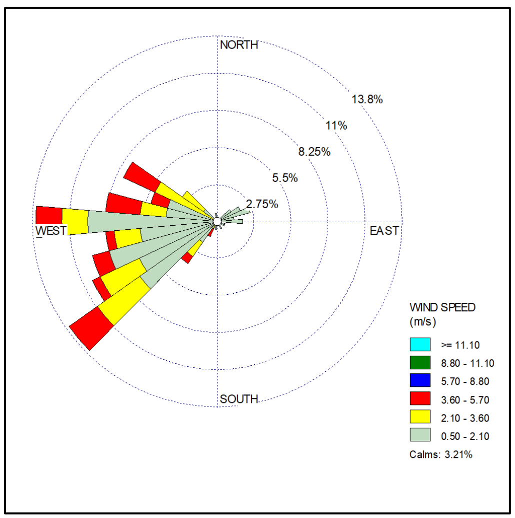

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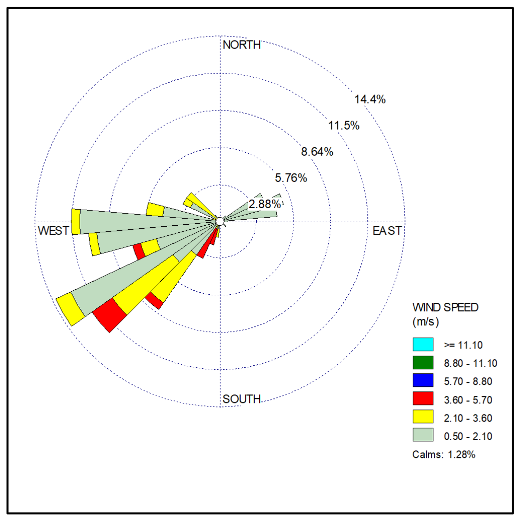

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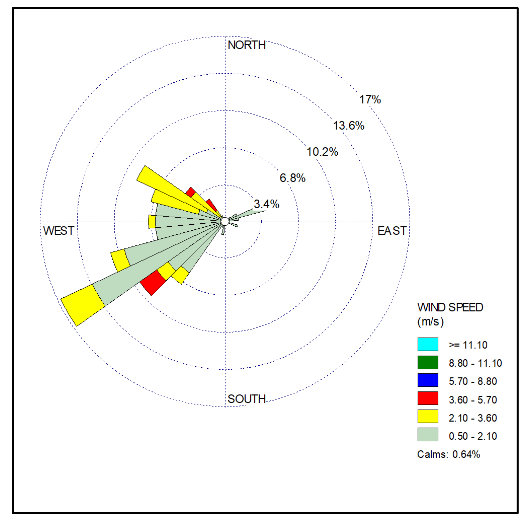

Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

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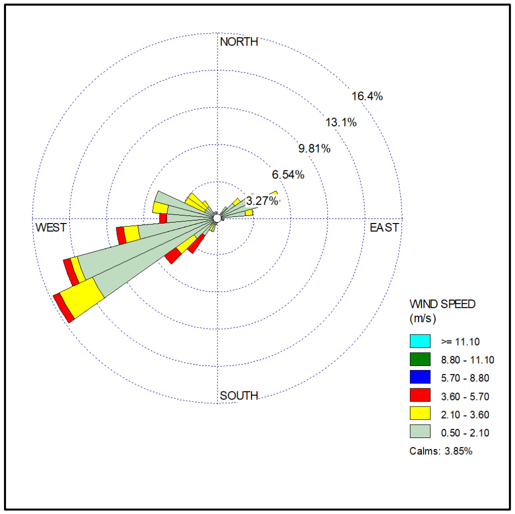

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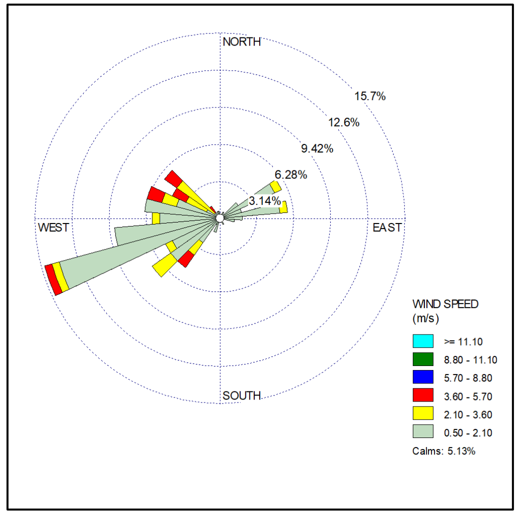

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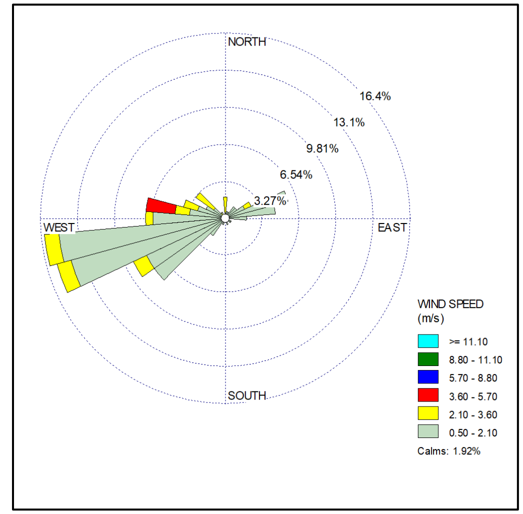

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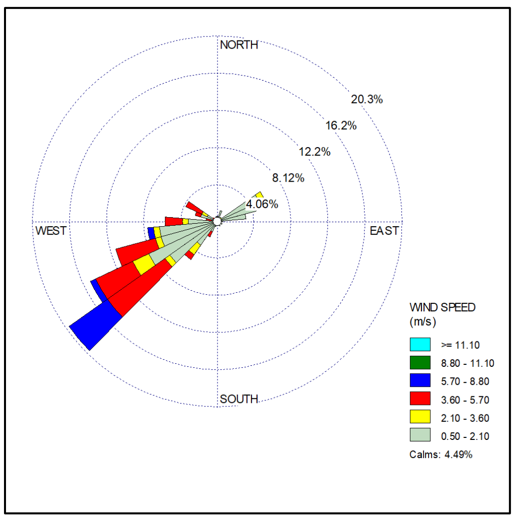

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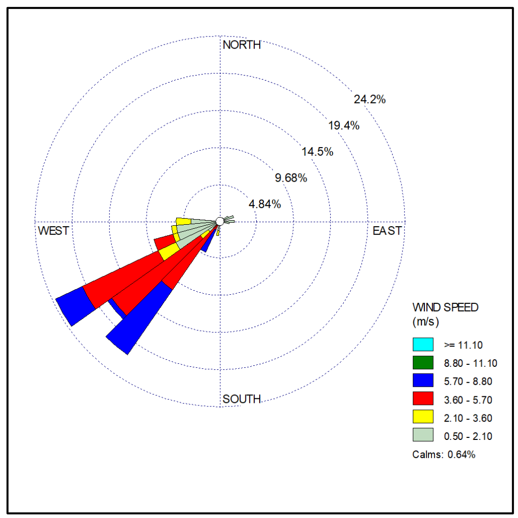

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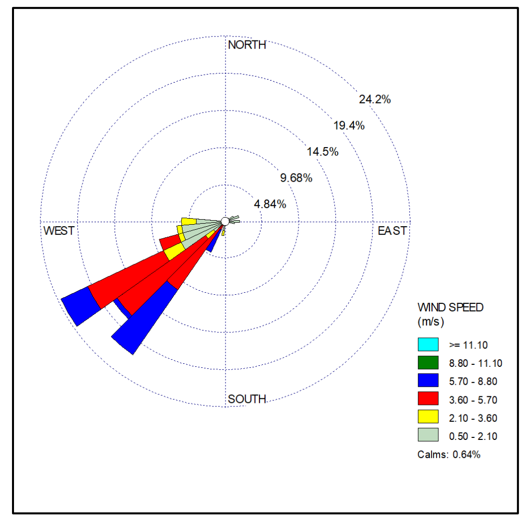

Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

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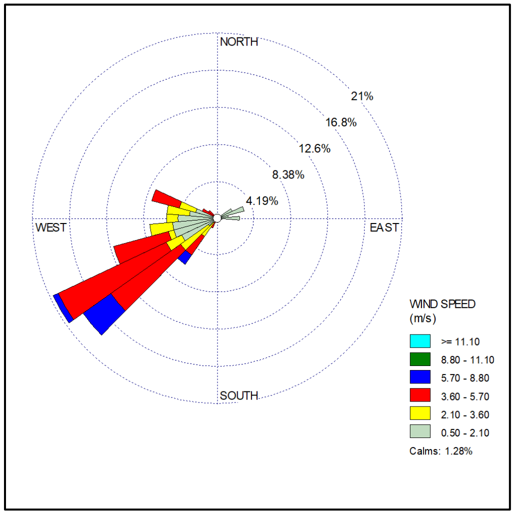

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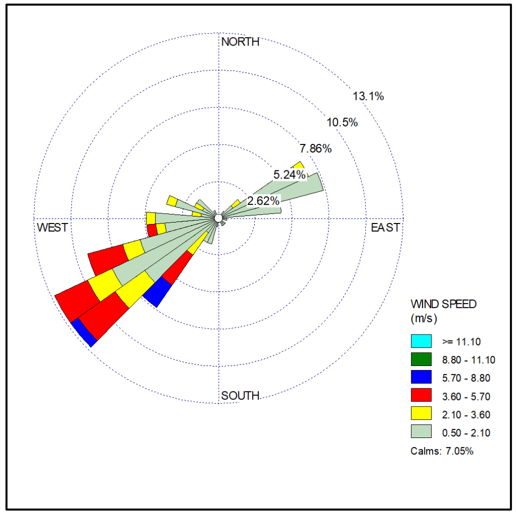

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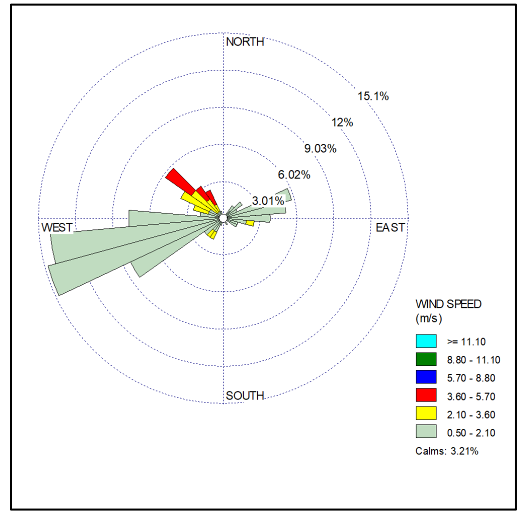

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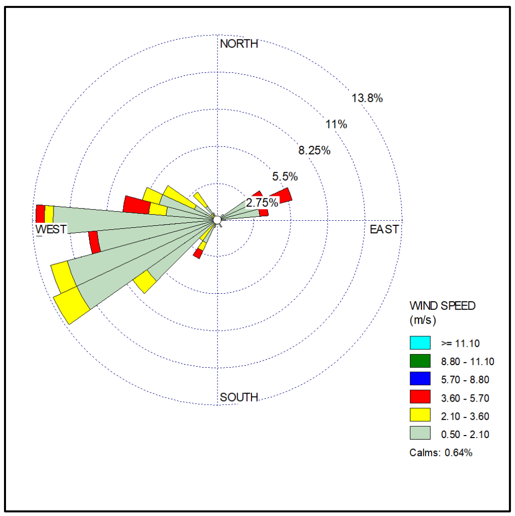

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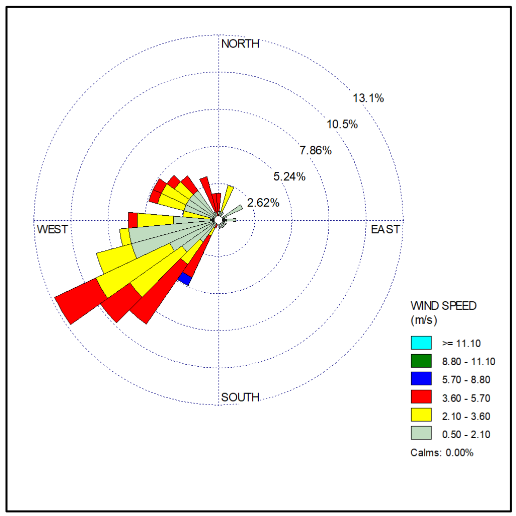

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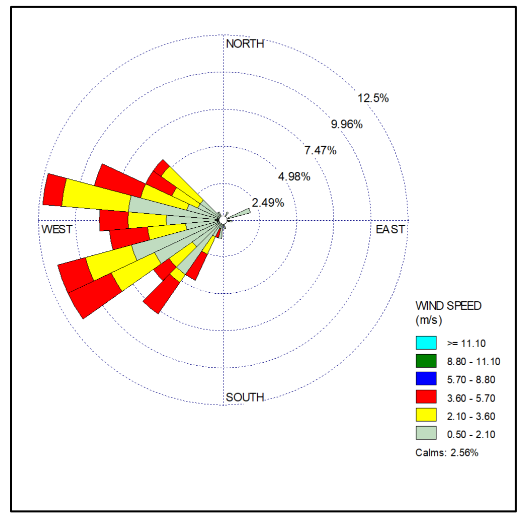
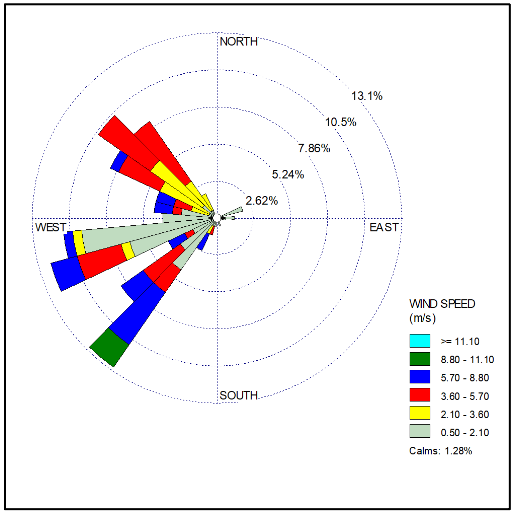


Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

Event 47



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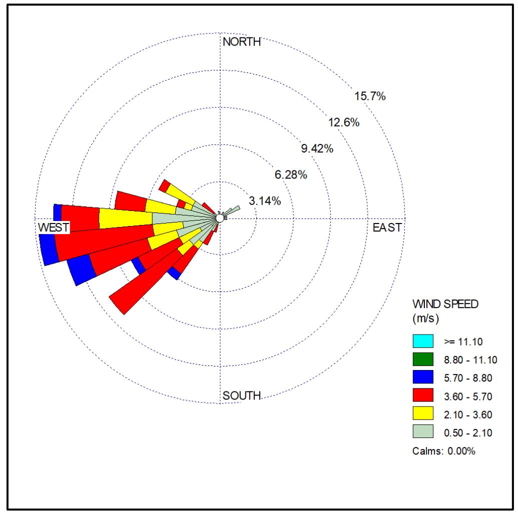

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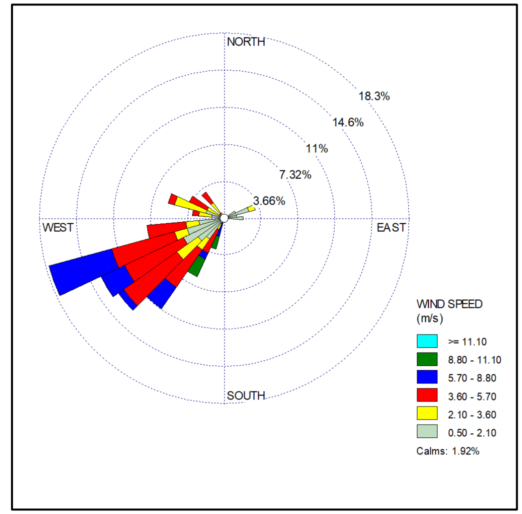

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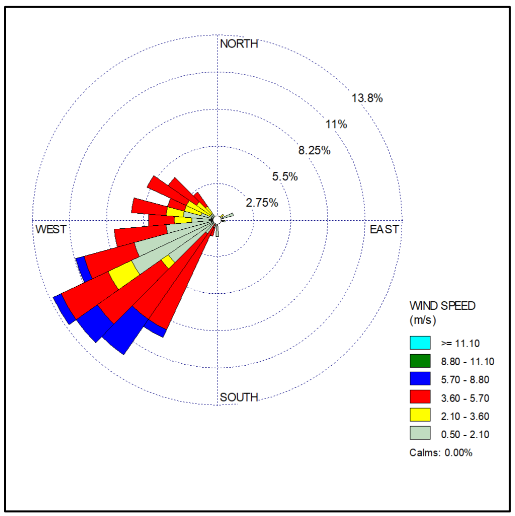

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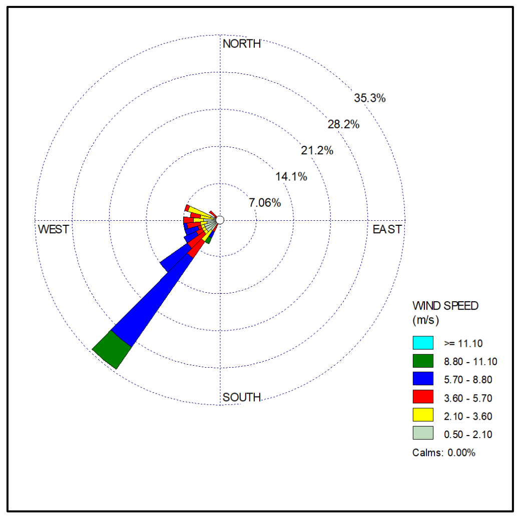

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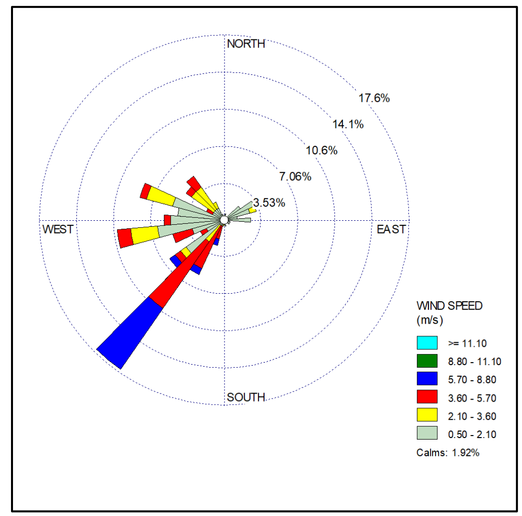
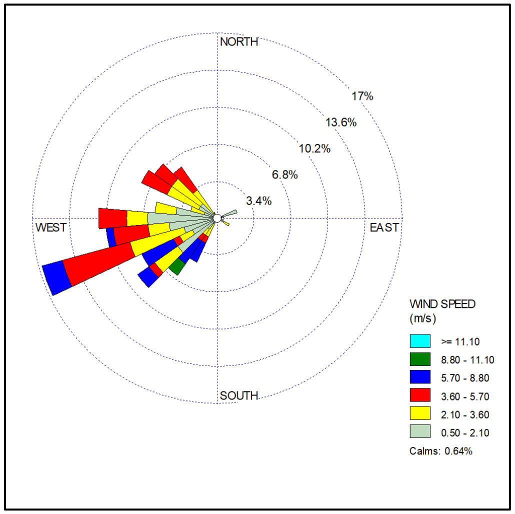


Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

Event 53



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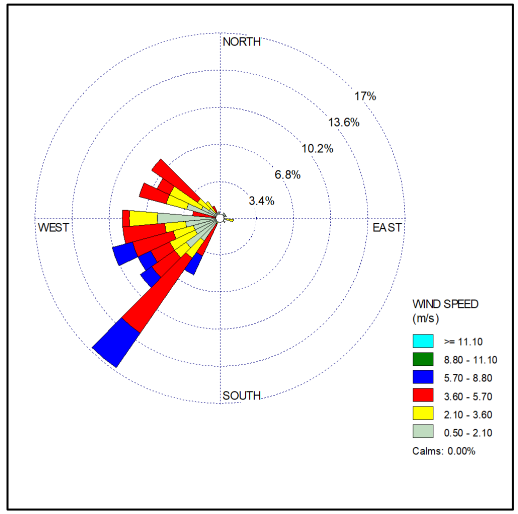

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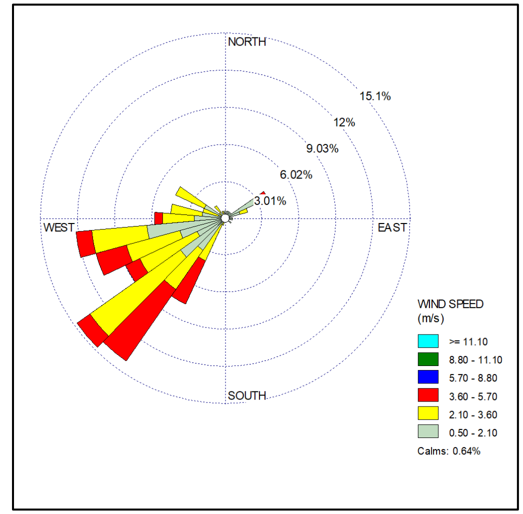

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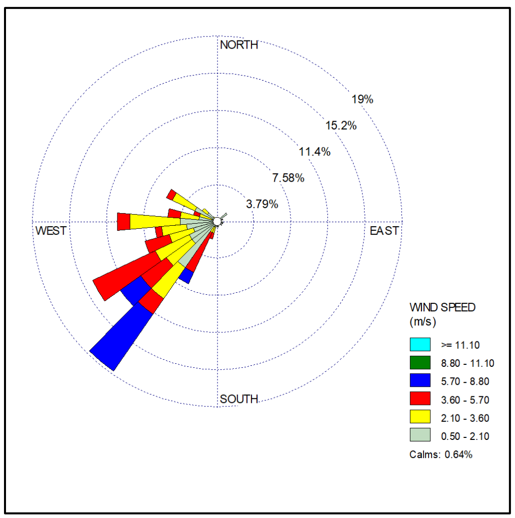

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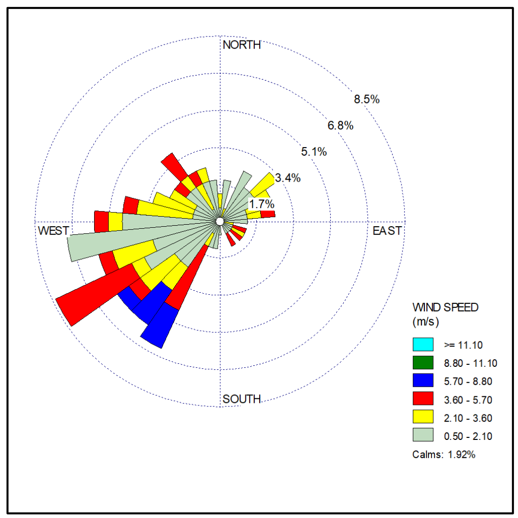

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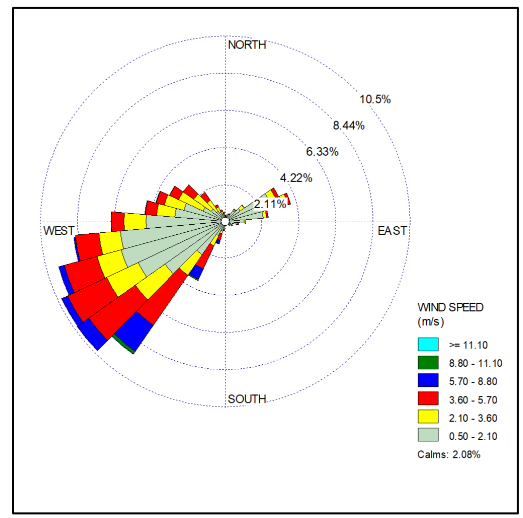


Figure 13. Wind Roses, Radionuclide Sampling Events (Continued)

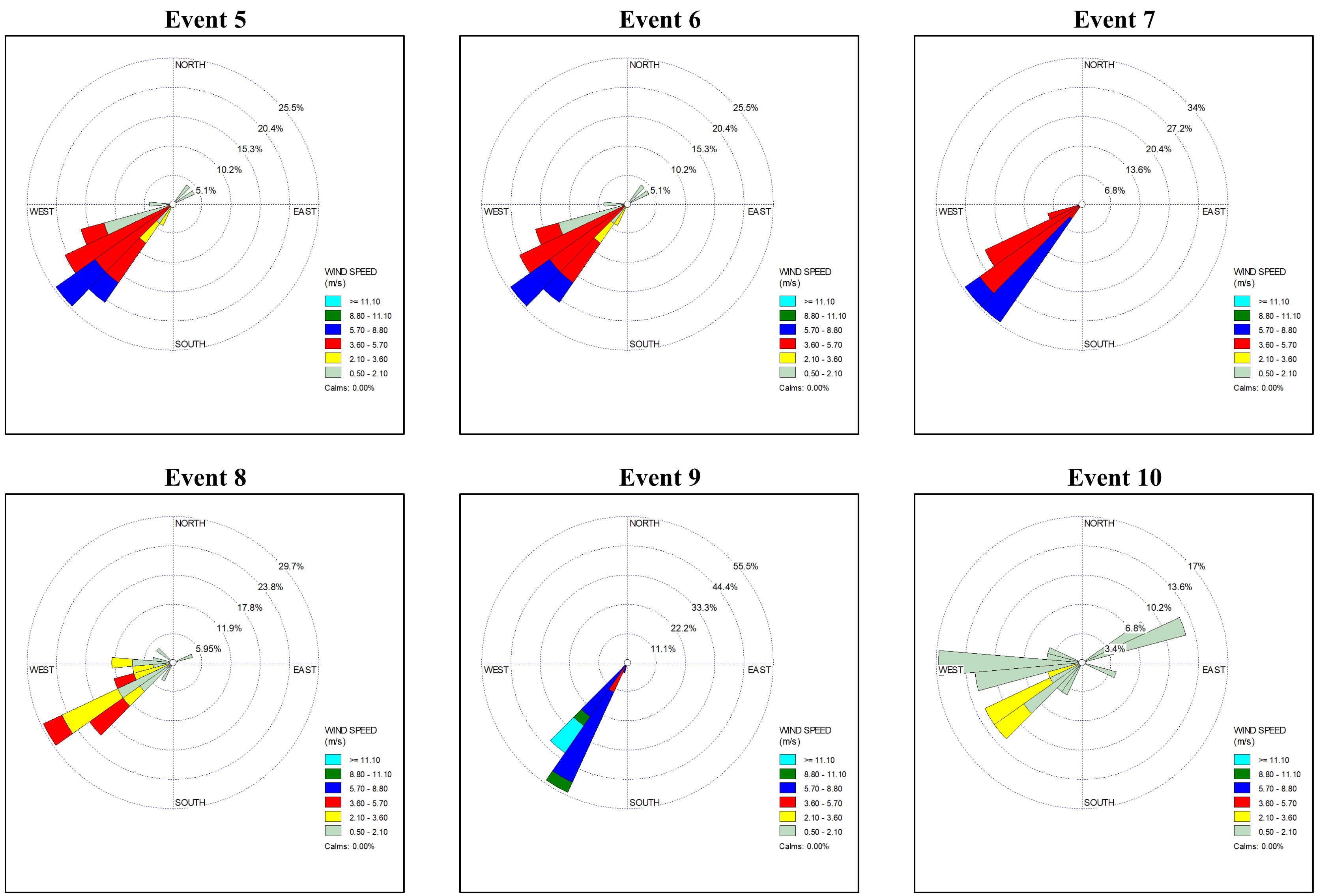


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events

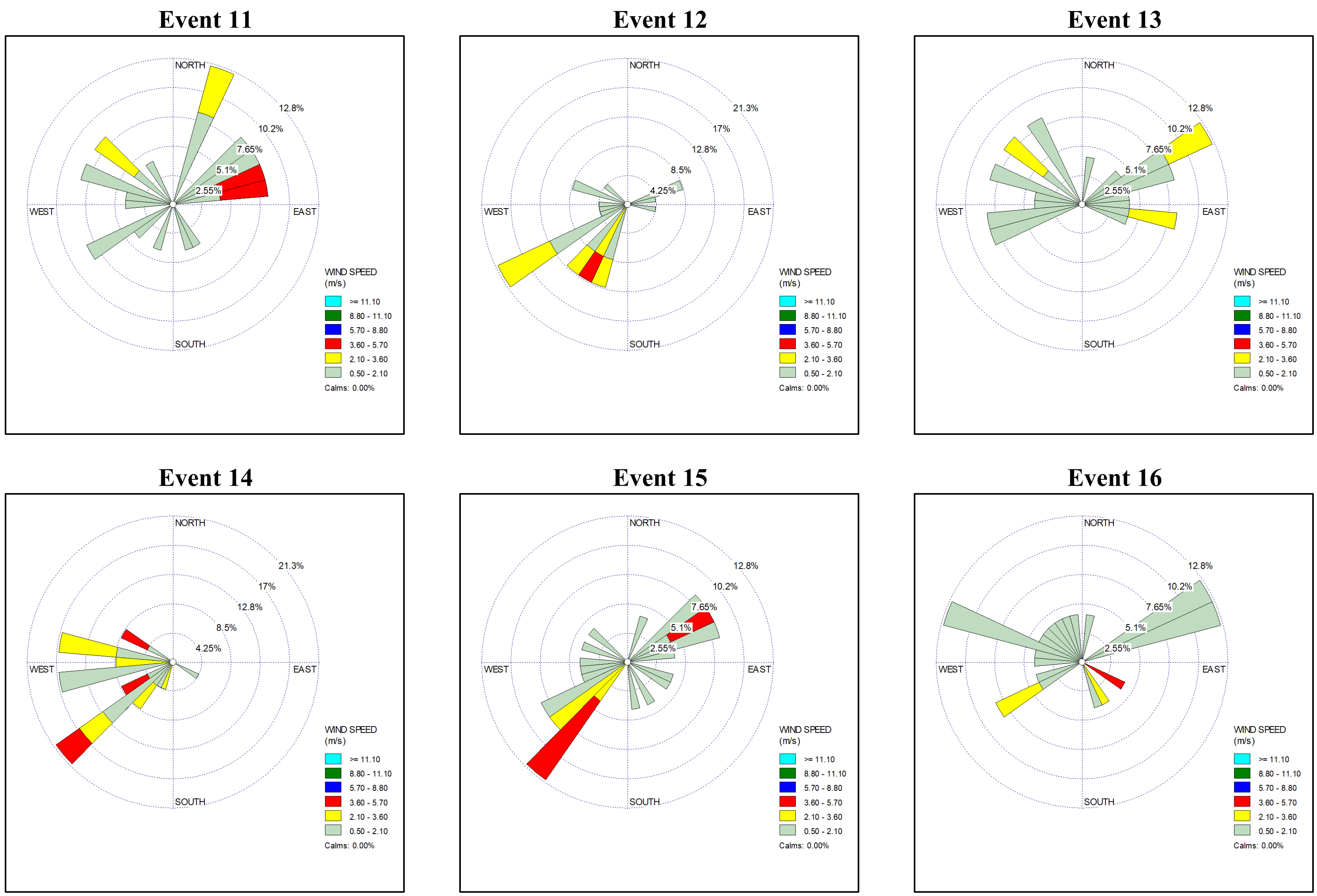
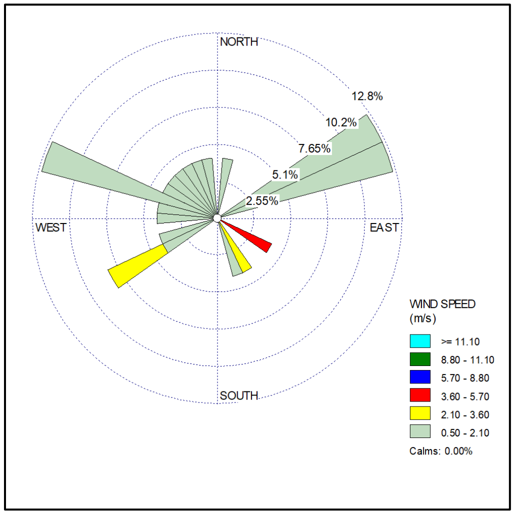


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

Event 17



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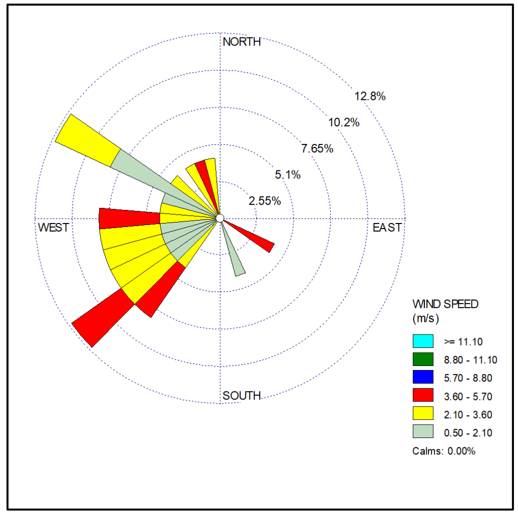

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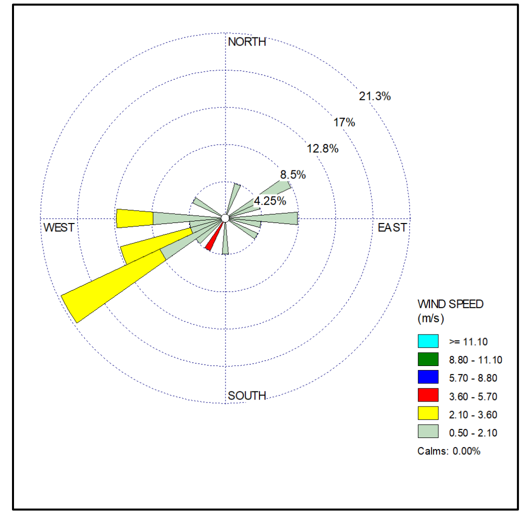

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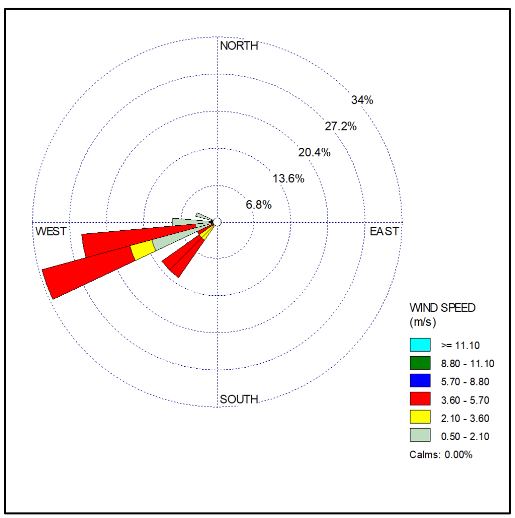
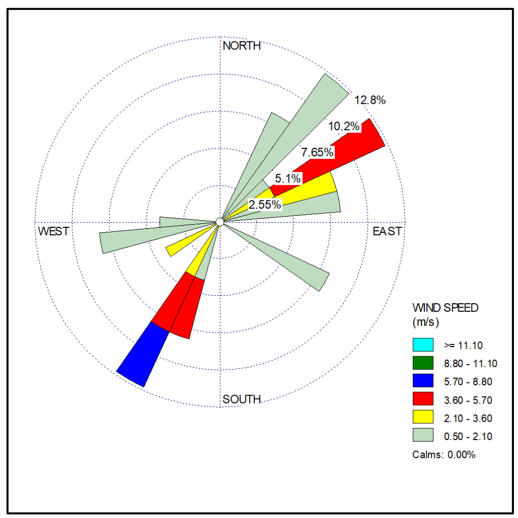




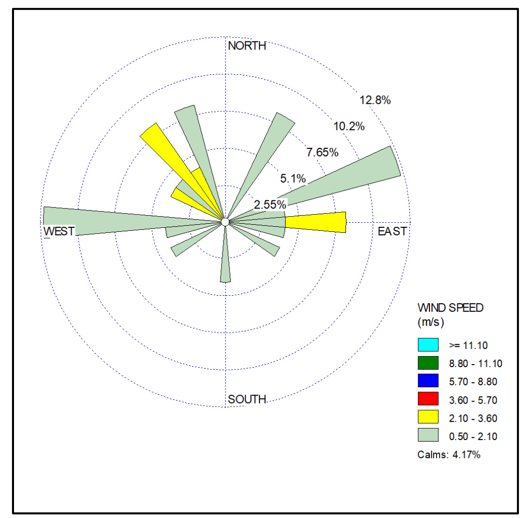
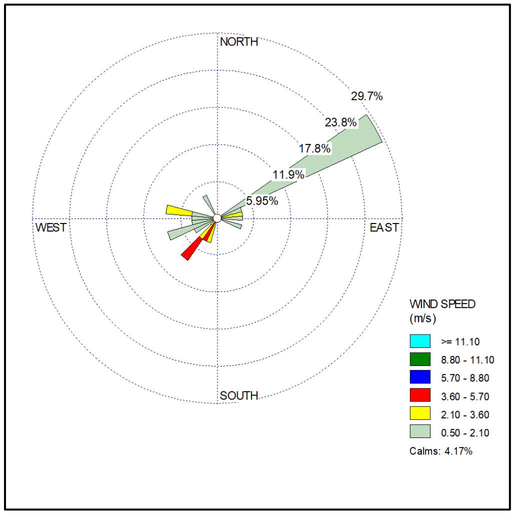


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

Event 23



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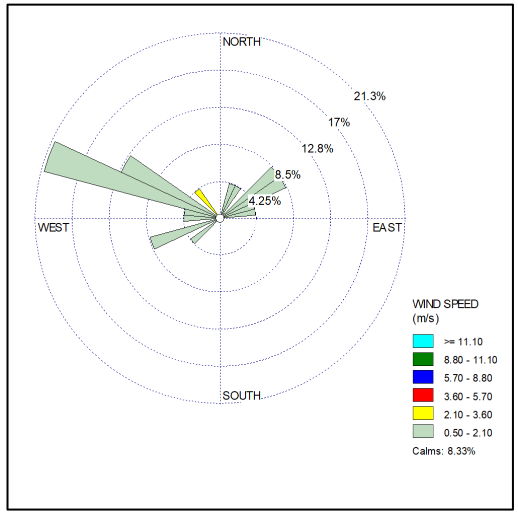

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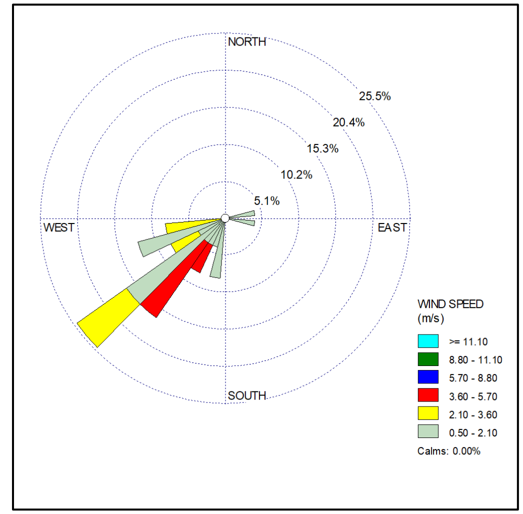

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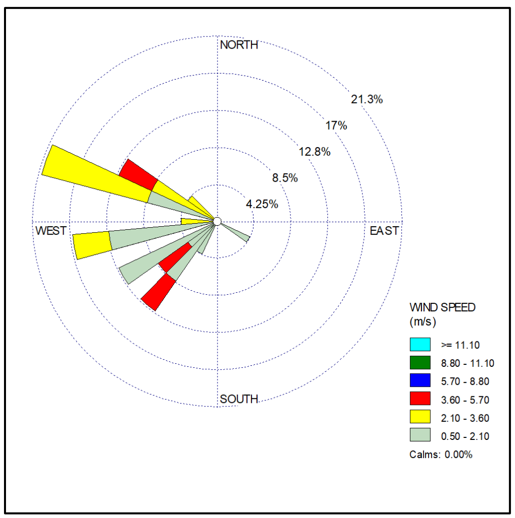

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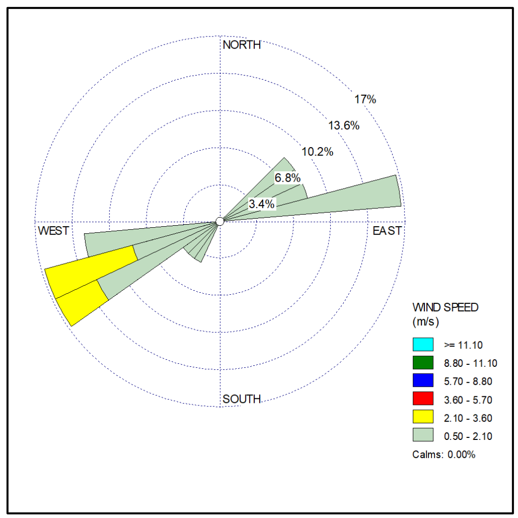

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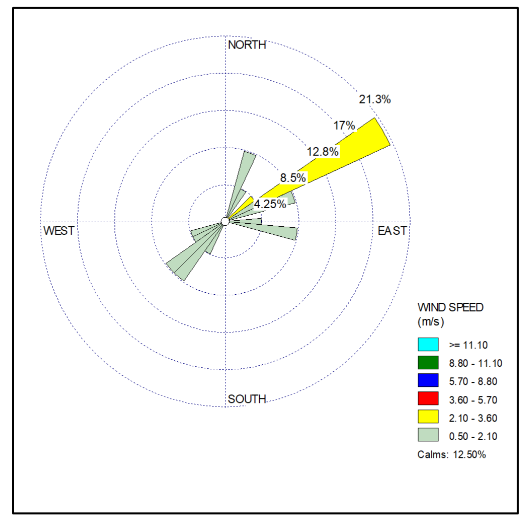


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

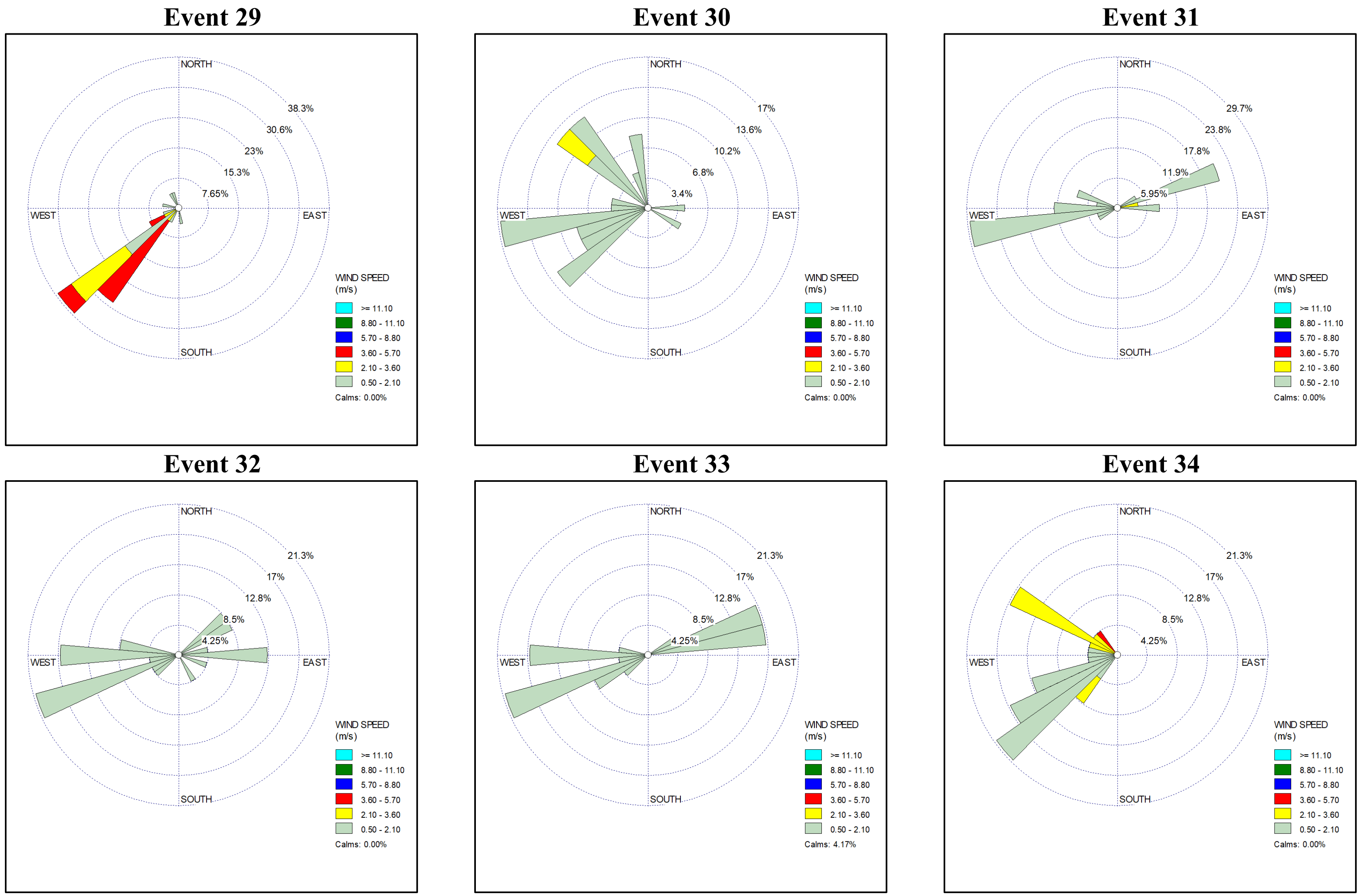


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

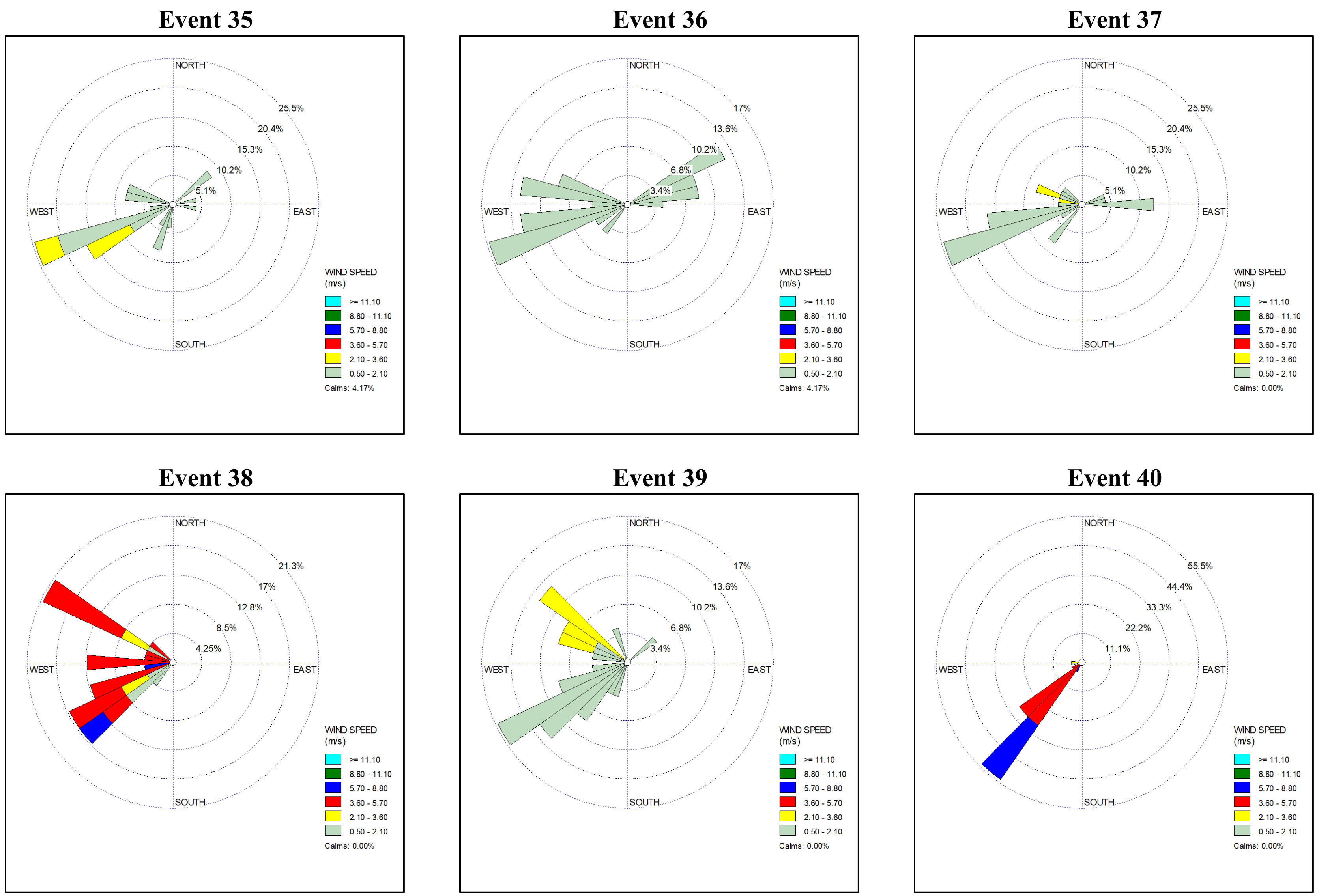


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

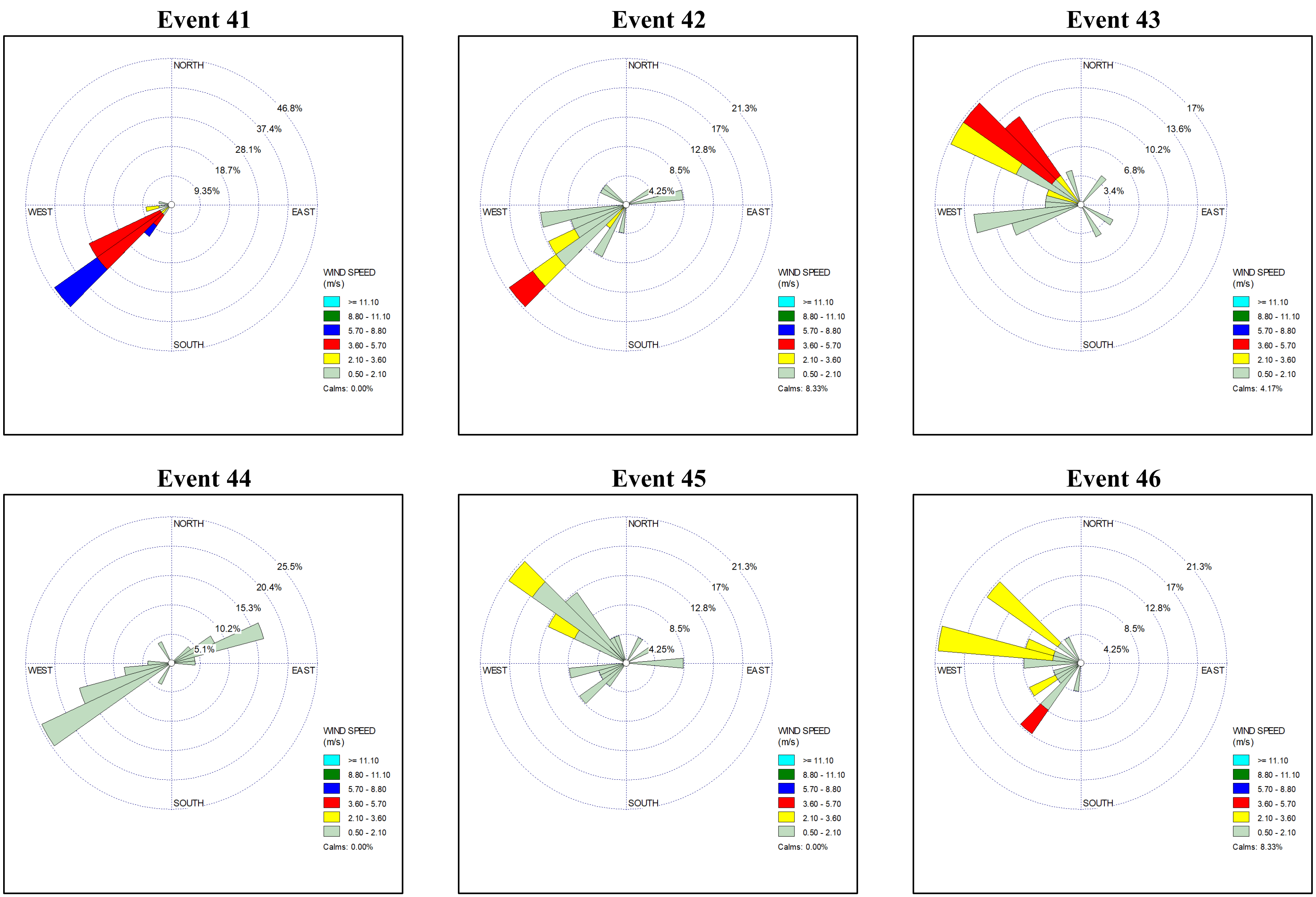


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

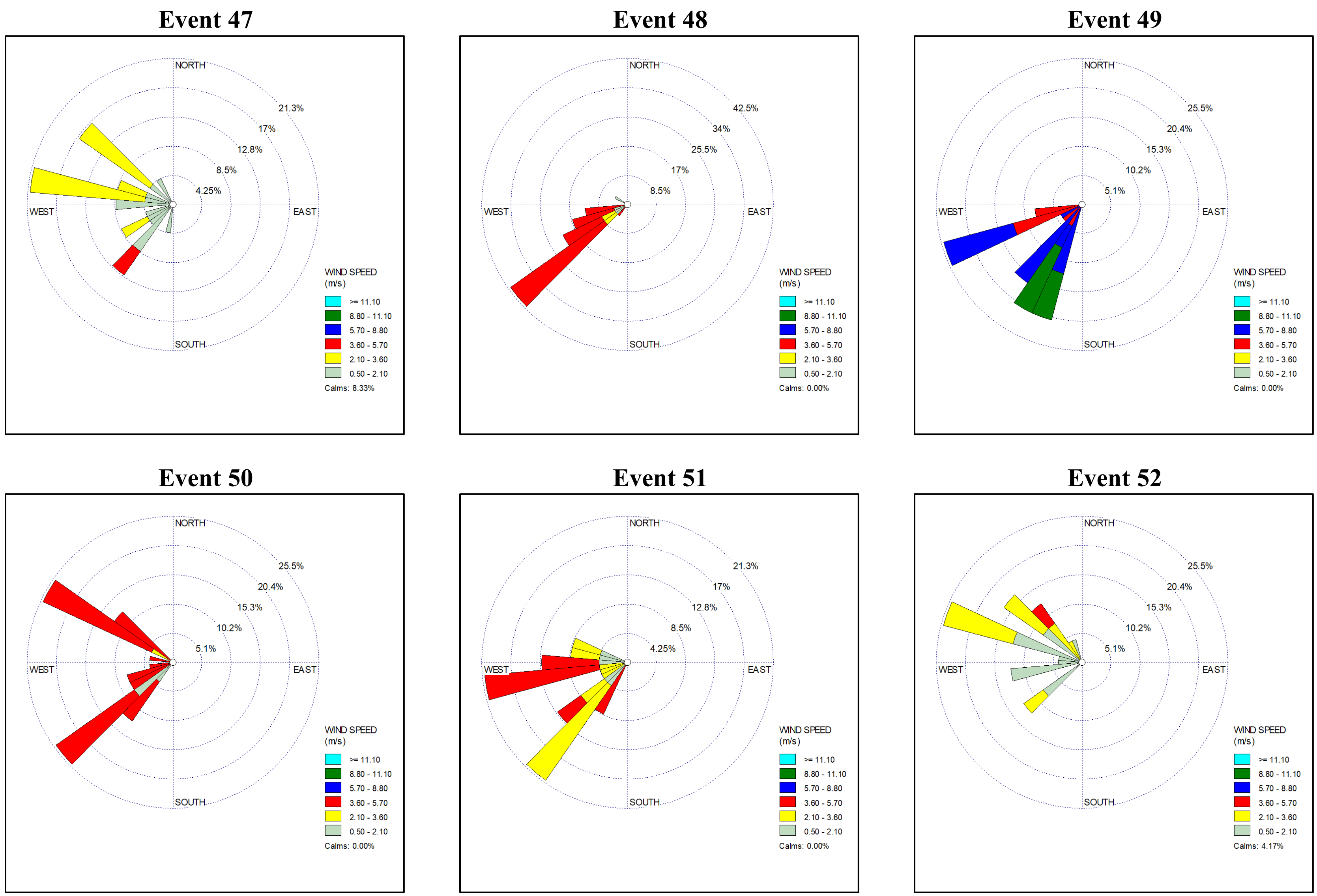
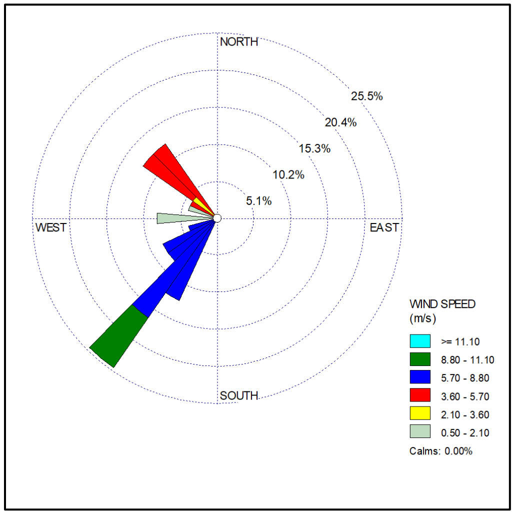


Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

Event 53



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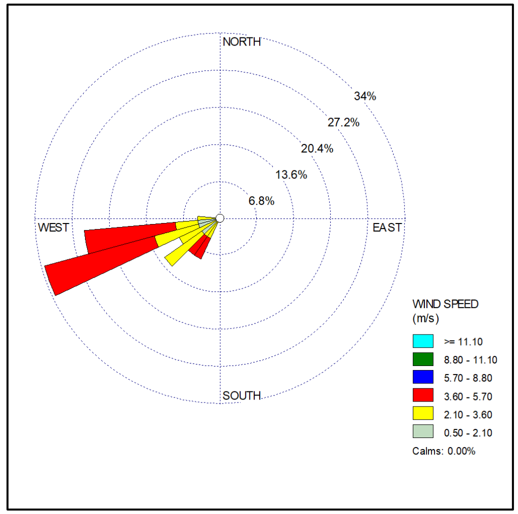

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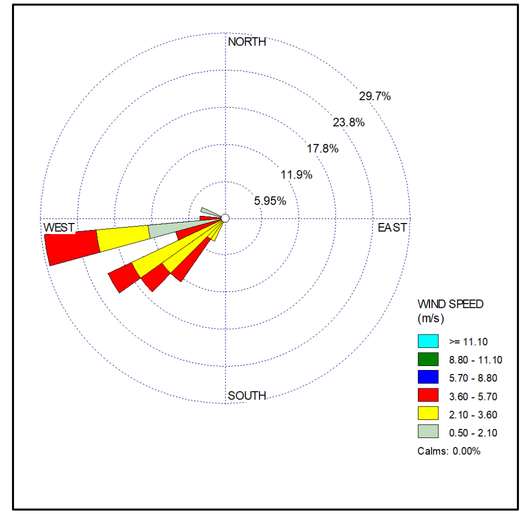

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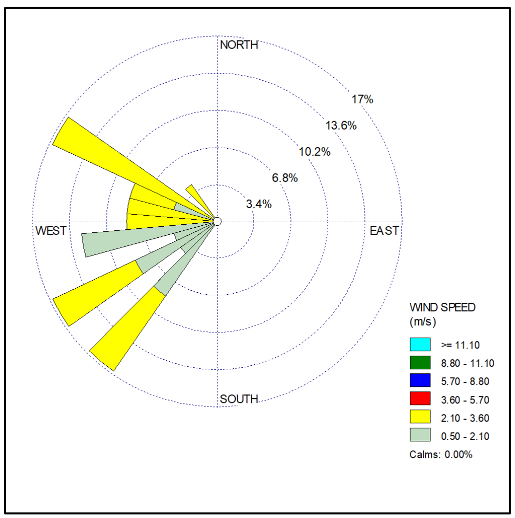

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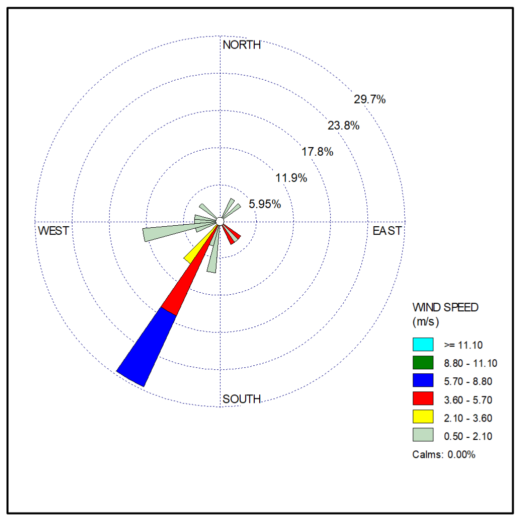

All Events

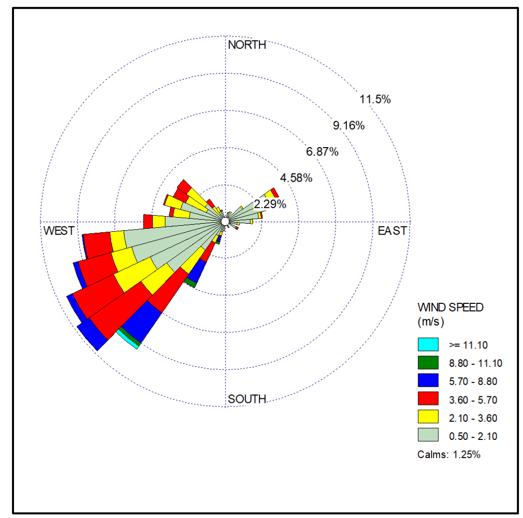

Figure 14. Wind Roses, $PM_{2.5}$ and Metals Sampling Events (Continued)

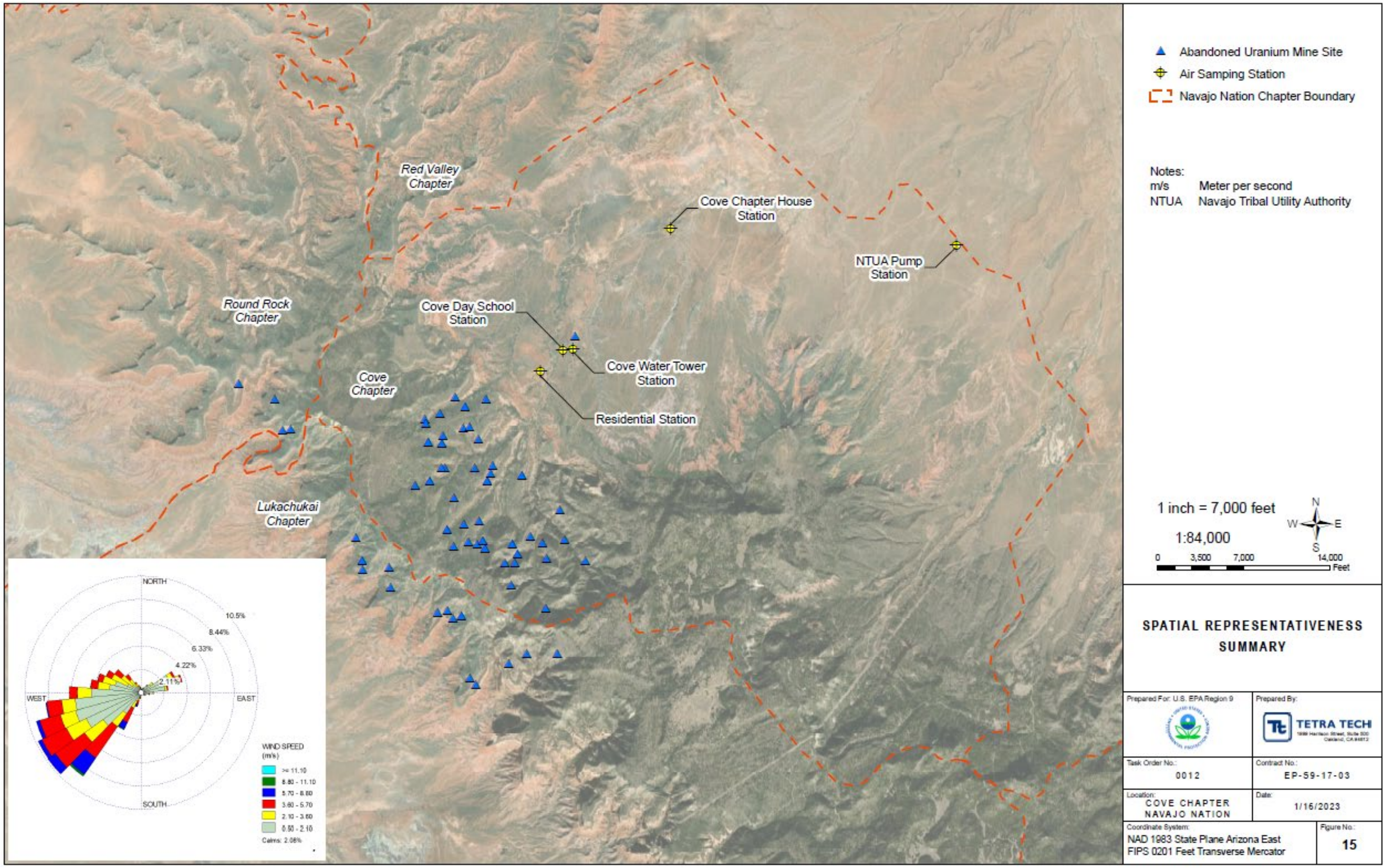

Figure 15. Spatial Representativeness Summary

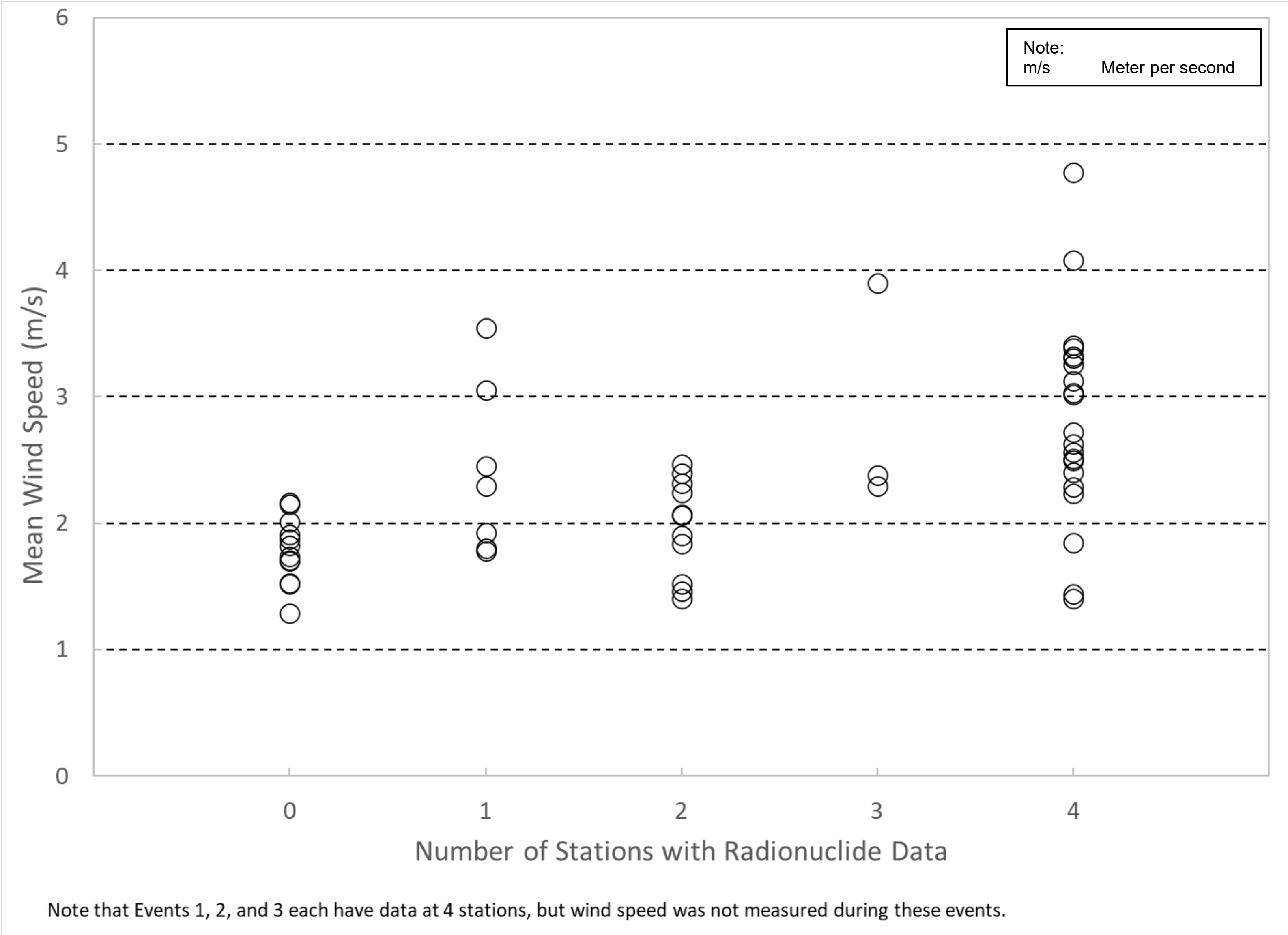

Figure 16. Temporal Representativeness – Averaged Hourly Wind Speed

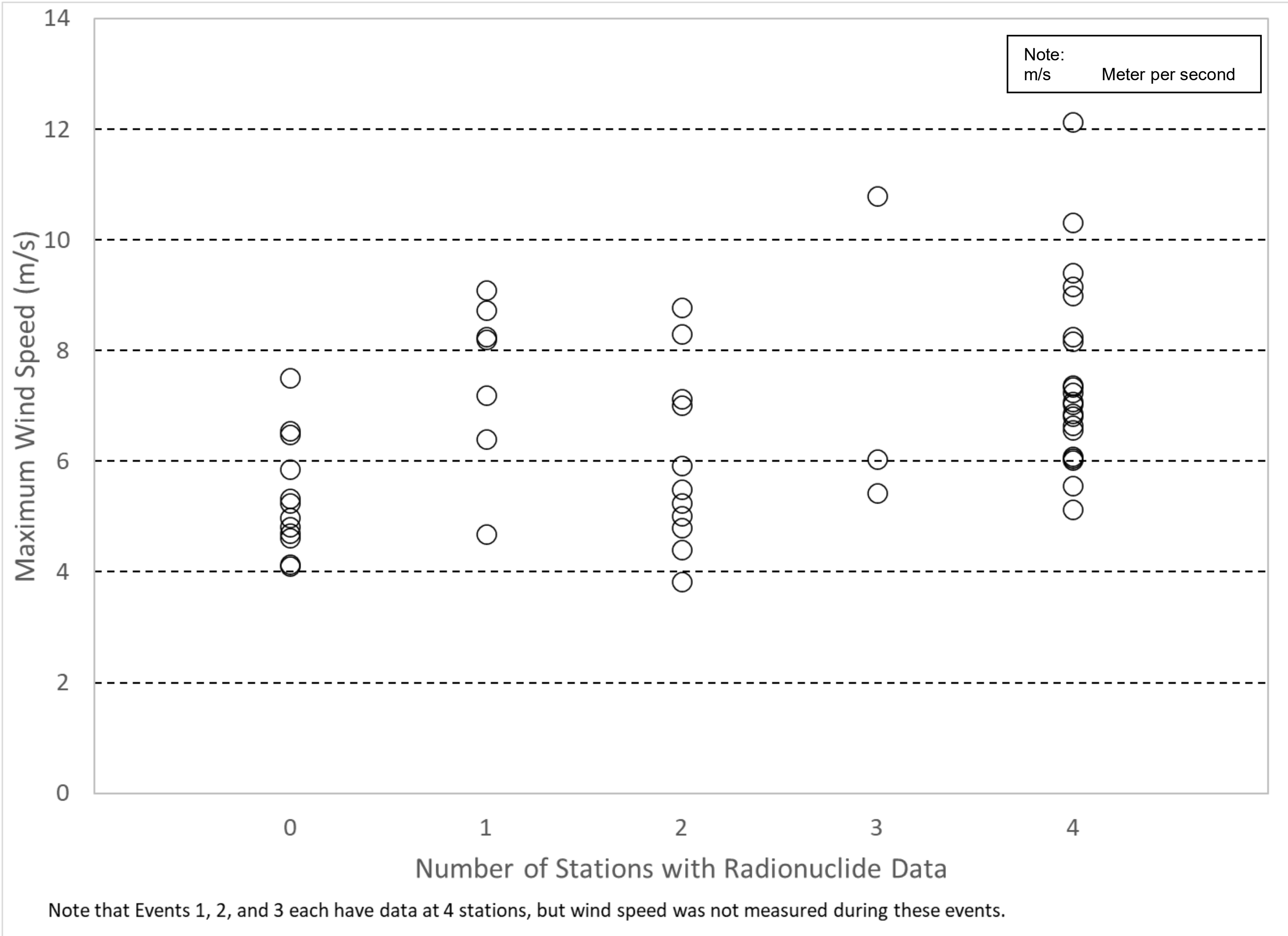

Figure 17. Temporal Representativeness – Maximum Hourly Wind Speed

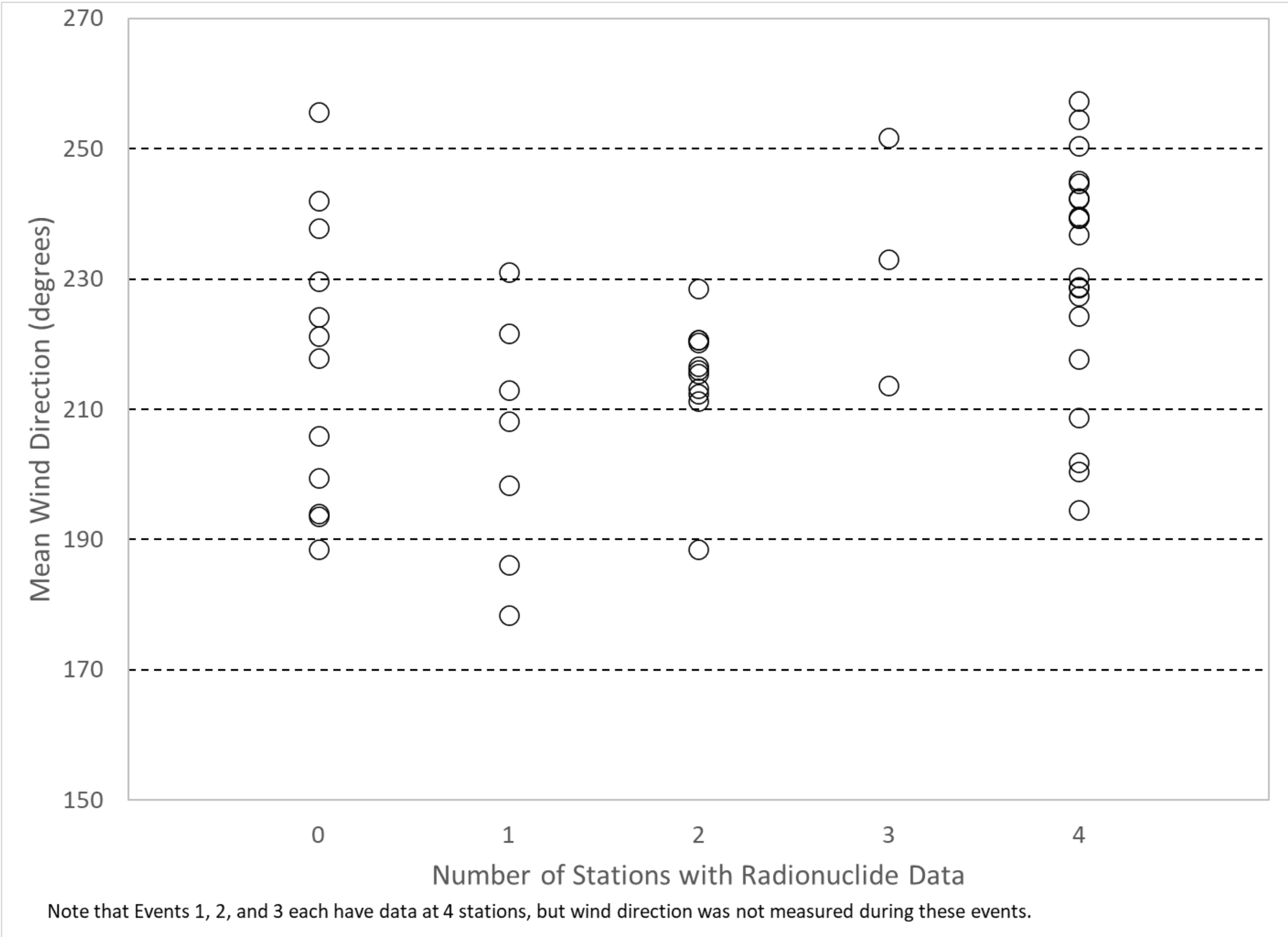

Figure 18. Temporal Representativeness – Averaged Hourly Vector Wind Direction

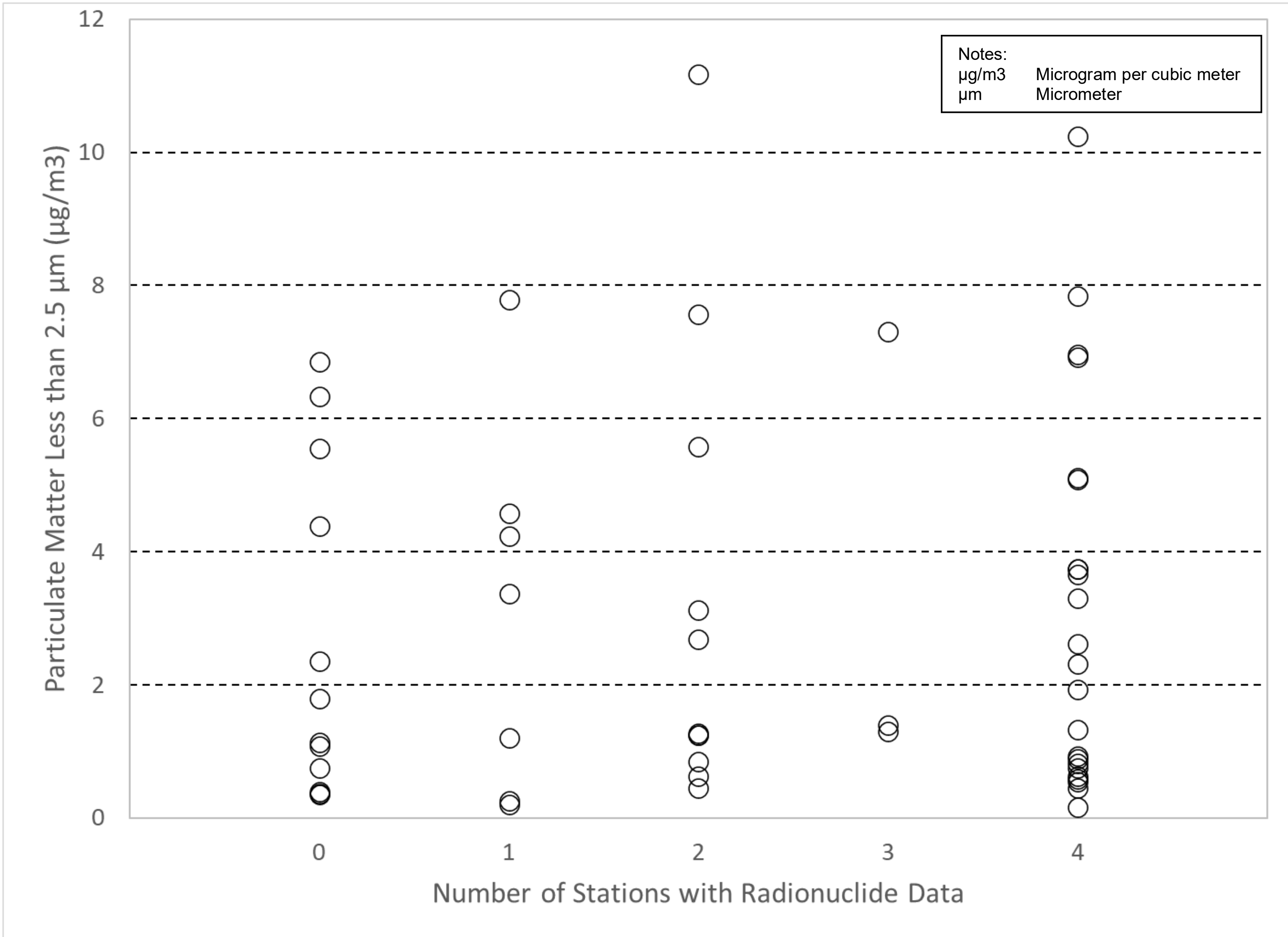

Figure 19. Temporal Representativeness – Averaged $PM_{2.5}$ Concentration

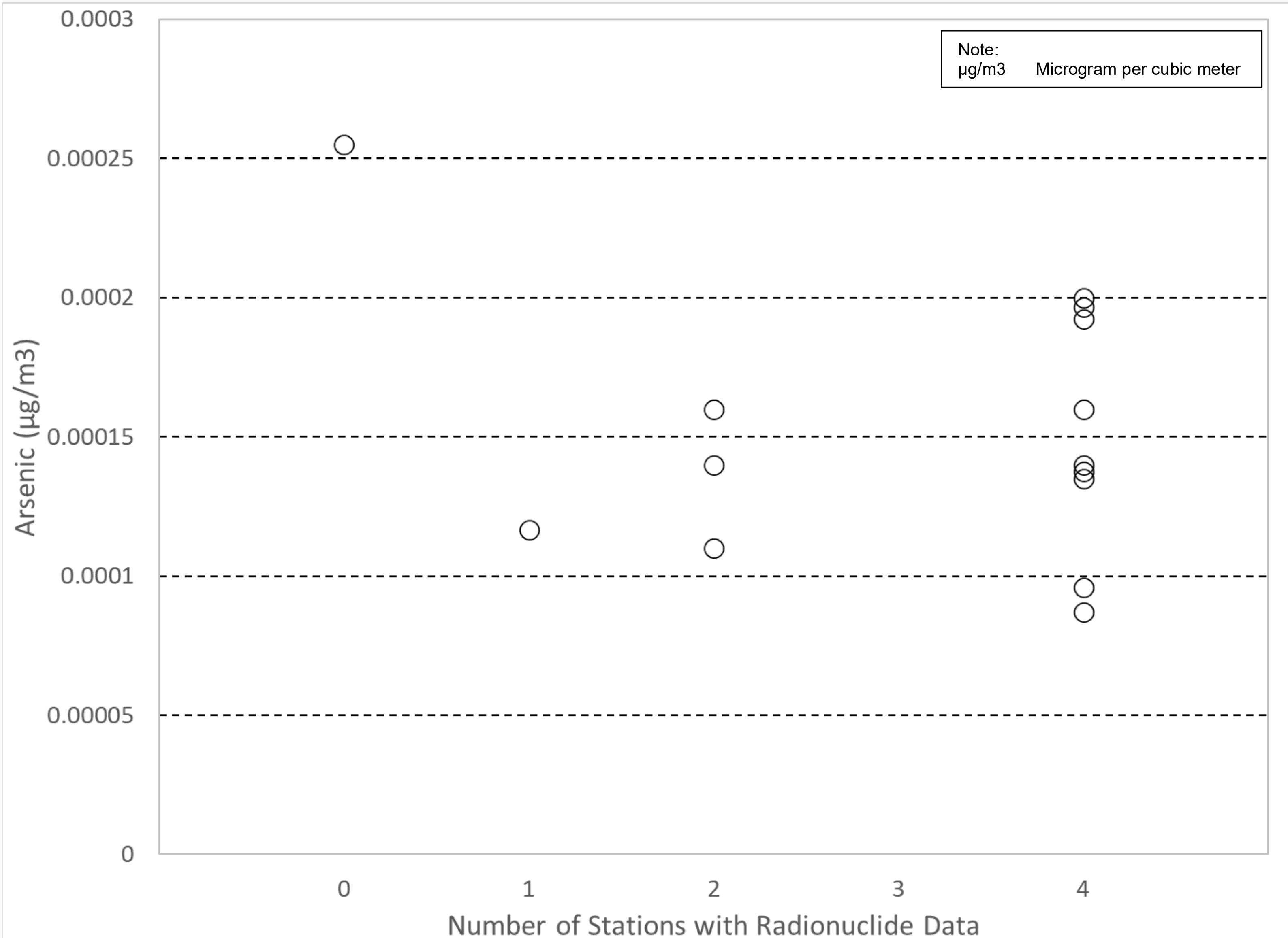

Figure 20. Temporal Representativeness – Averaged Arsenic Concentration

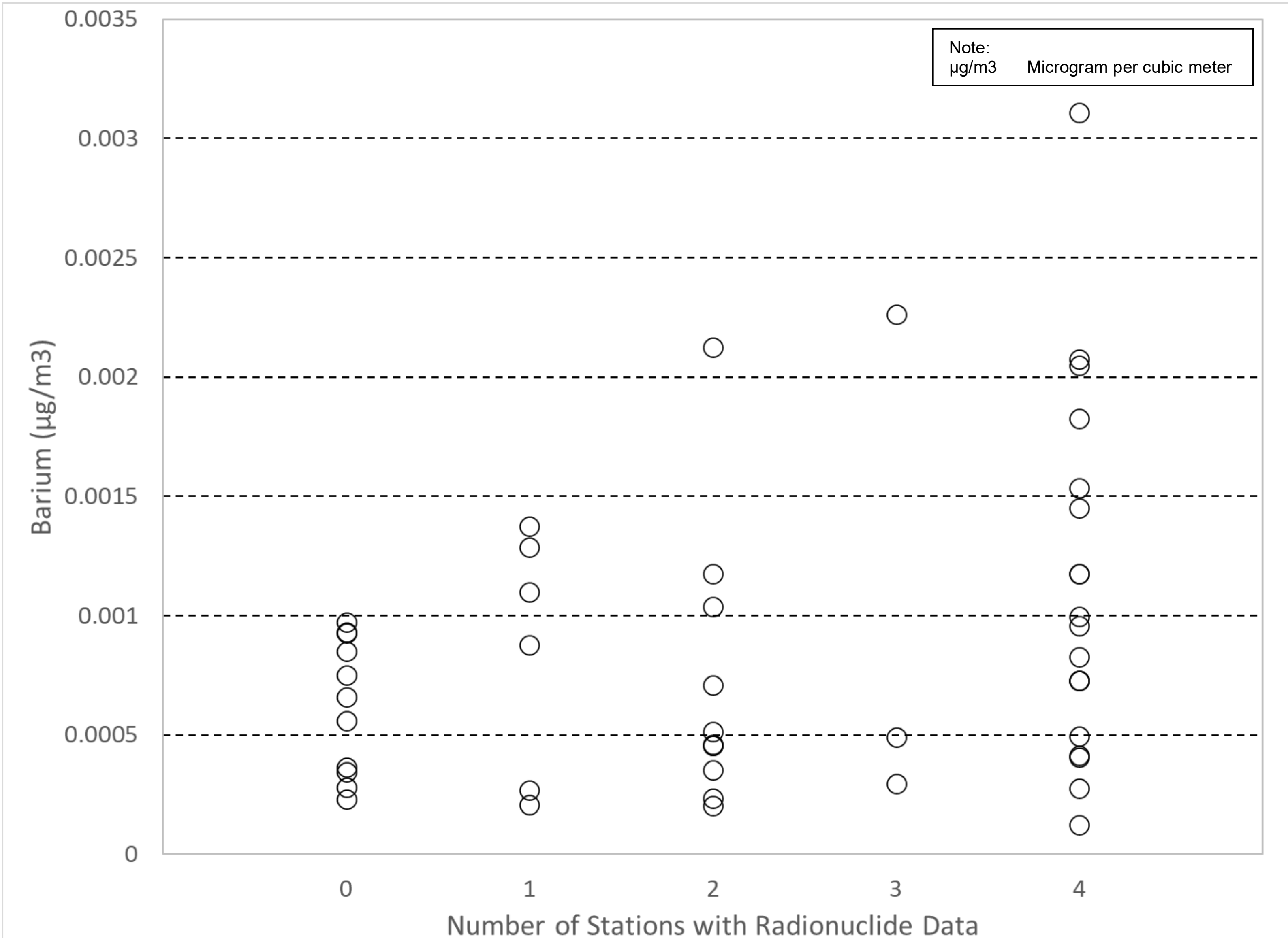

Figure 21. Temporal Representativeness – Averaged Barium Concentration

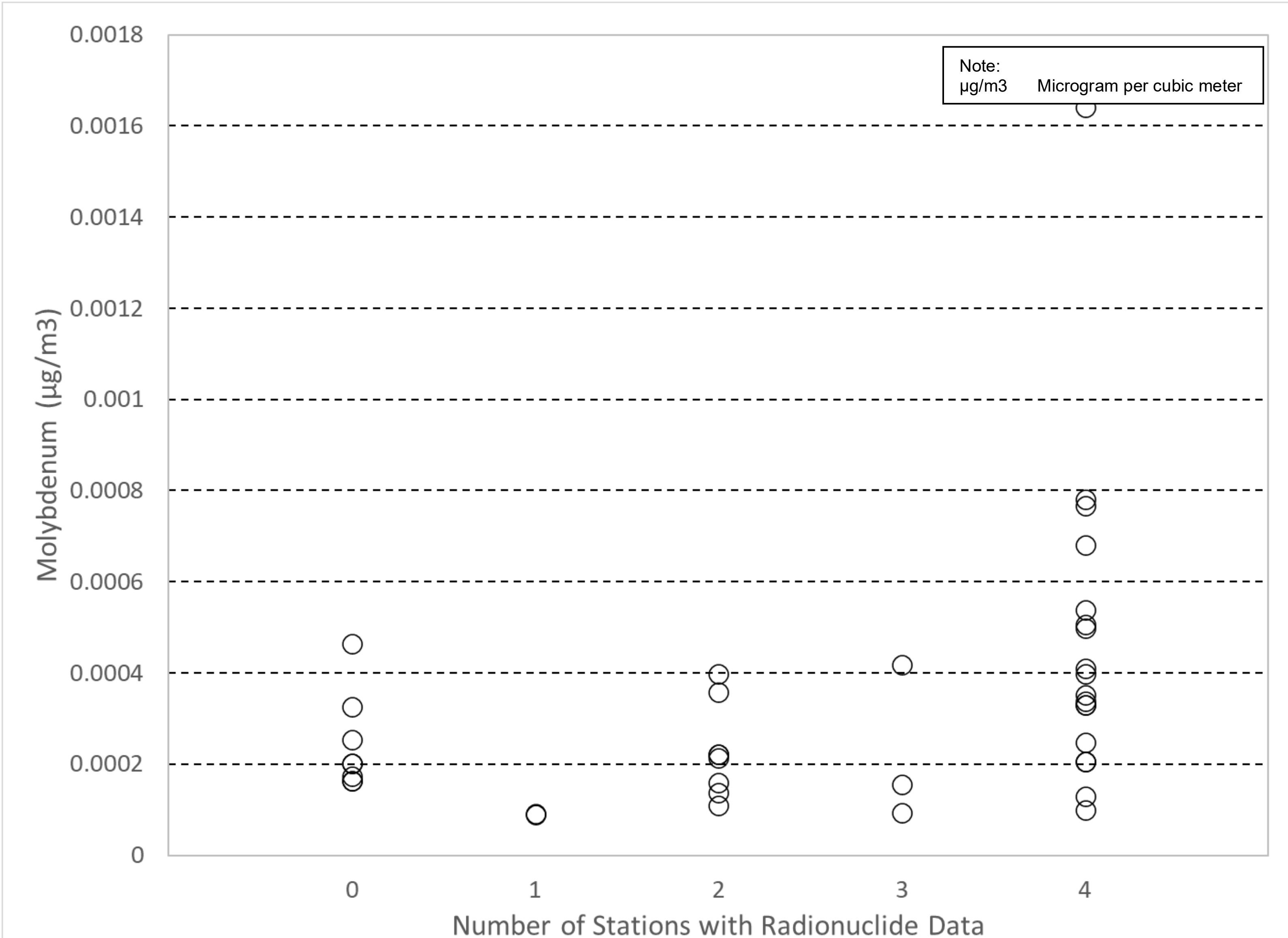

Figure 22. Temporal Representativeness – Averaged Molybdenum Concentration

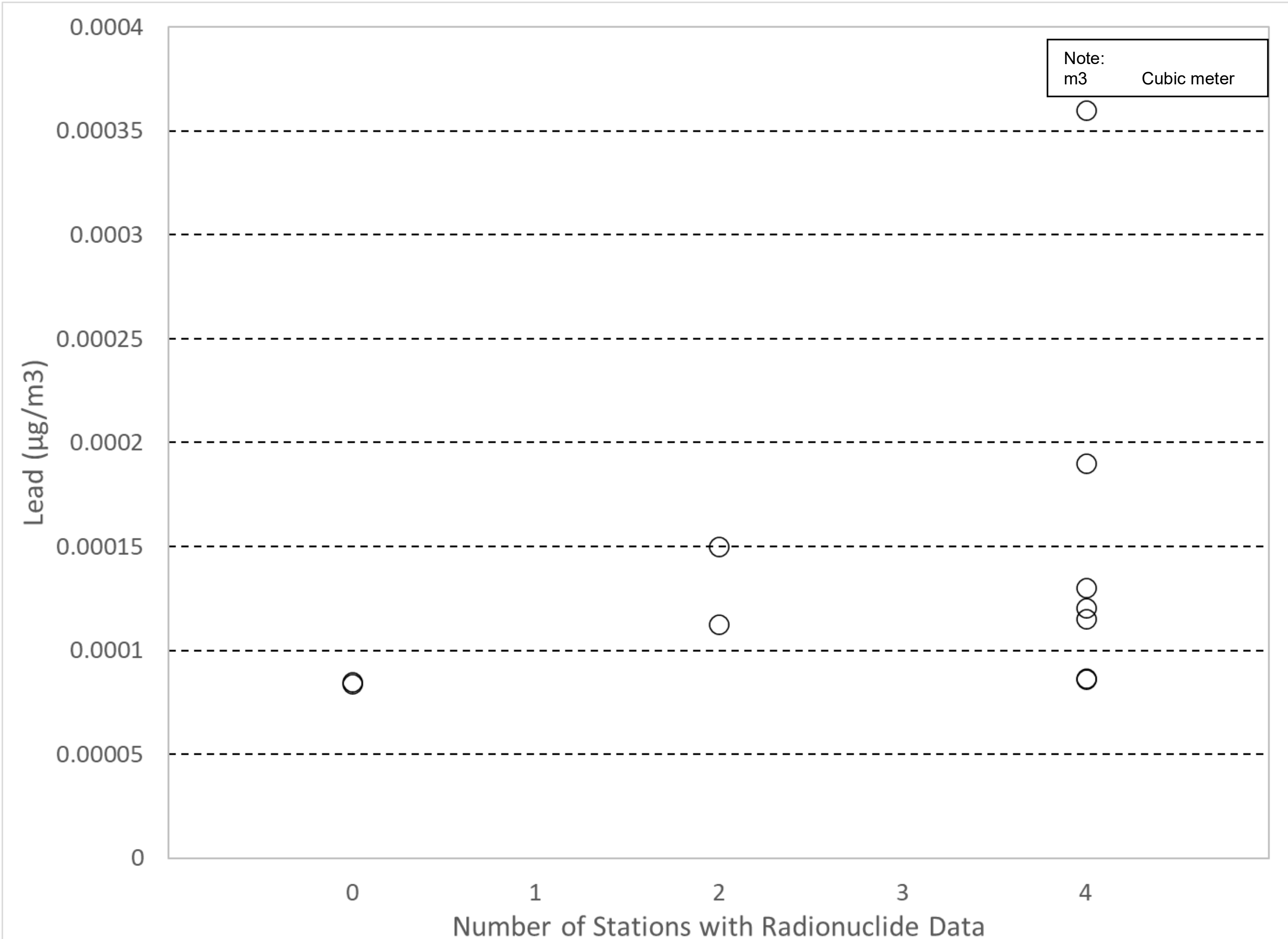

Figure 23. Temporal Representativeness – Averaged Lead Concentration

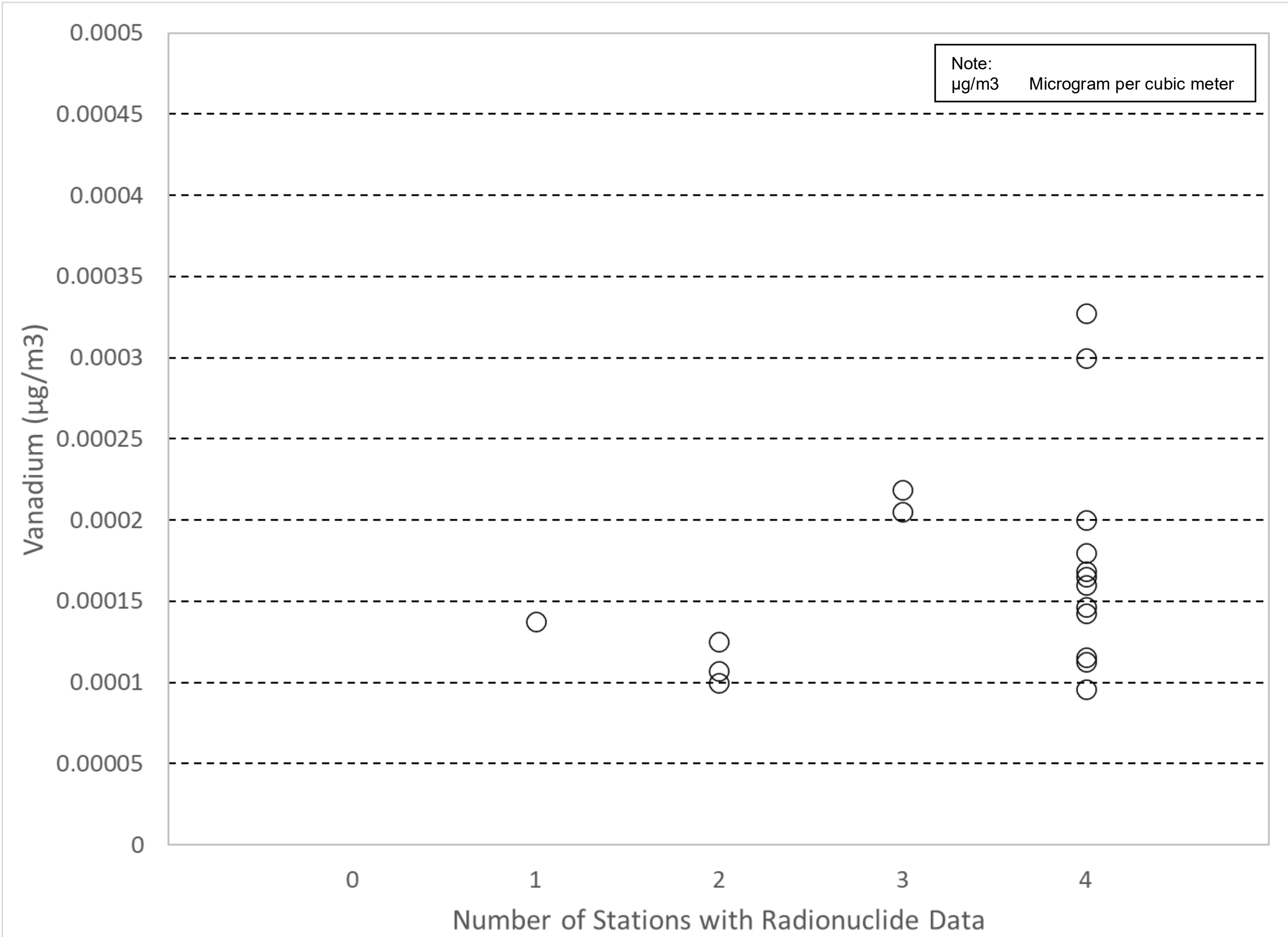

Figure 24. Temporal Representativeness – Averaged Vanadium Concentration

TABLES

Table 1. Field Sampling Summary - Radionuclides

Year	Event	Start Date	End Date	**Stations Sampled** (Latitude and Longitude)					Usable Results (not including duplicates)	
				Residential (36.55600^{o}, -109.23242^{o})	Cove Day School (36.55533^{o}, -109.23242^{o})	Cove Water Tower (36.56425^{o}, -109.21747^{o})	Cove Chapter House (36.56425^{o}, -109.19386^{o})	NTUA Pump Station (36.59022^{o}, -109.11764^{o})	Cove	Reference
2020	1	2/10/2020	2/17/2020	R	R	R	R2	R	4	1
	2	2/18/2020	2/25/2020	R	R	R	R2	R	4	1
	3	2/25/2020	3/3/2020	R	R	R	R	R	4	1
	4	3/3/2020	3/10/2020	R	R	R	R	R	4	1
	5	3/10/2020	3/17/2020	R	R	R	R2	R*	4	0
	6	3/17/2020	3/25/2020	R	R	R	R	R	4	1
	7	3/24/2020	3/31/2020	R2	R	R	R	R	4	1
2021	8	5/11/2021	5/18/2021	R2	R	R	R	R*	4	0
	9	5/18/2021	5/25/2021	R	R	R	R	--	4	0
	10	5/25/2021	6/2/2021	R2*	R*	R*	R	R*	2	0
	11	6/2/2021	6/8/2021	R*	R*	R	R	R*	2	0
	12	6/8/2021	6/15/2021	R2*	R*	R	R	R*	3	0
	13	6/15/2021	6/22/2021	R*	R*	R*	R	R	1	1
	14	6/22/2021	6/29/2021	--	--	--	R	R	1	1
	15	6/29/2021	7/6/2021	--	--	--	R	R	1	1
	16	7/6/2021	7/13/2021	--	--	--	R	R	1	1
	17	7/13/2021	7/20/2021	--	--	--	R*	R	0	1
	18	7/20/2021	7/27/2021	--	--	--	R*	R	0	1
	19	7/27/2021	8/3/2021	--	--	--	R*	--	0	0
	20	8/3/2021	8/10/2021	--	--	--	--	--	0	0
	21	8/10/2021	8/17/2021	--	--	--	--	--	0	0
	22	8/17/2021	8/24/2021	--	R	--	R	--	2	0
	23	8/24/2021	8/31/2021	--	R	--	R	--	2	0
	24	8/31/2021	9/7/2021	--	R	--	R	--	2	0
	25	9/7/2021	9/14/2021	--	R	--	R	--	2	0
	26	9/14/2021	9/21/2021	R	R	R	R	R	4	1

Table 1. Field Sampling Summary – Radionuclides (Continued)

Year	Event	Start Date	End Date	Stations Sampled (Latitude and Longitude)					Usable Results (not including duplicates)	
				Residential (36.55600o, -109.23242o)	Cove Day School (36.55533o, -109.23242o)	Cove Water Tower (36.56425o, -109.21747o)	Cove Chapter House (36.56425o, -109.19386o)	NTUA Pump Station (36.59022o, -109.11764o)	Cove	Reference
2021	27	9/21/2021	9/28/2021	R	R	R	R	R	4	1
	28	9/28/2021	10/5/2021	R	R	R	R	R	4	1
	29	10/5/2021	10/12/2021	R	R	R	R	R	4	1
	30	10/12/2021	10/19/2021	R	R*	R*	R	R	2	1
	31	10/19/2021	10/26/2021	R*	R*	R	R	R	2	1
	32	10/26/2021	11/2/2021	--	--	R*	R*	R*	0	0
	33	11/2/2021	11/9/2021	--	--	--	--	--	0	0
	34	11/9/2021	11/16/2021	--	--	--	--	--	0	0
	35	11/16/2021	11/23/2021	--	--	--	--	--	0	0
	36	11/23/2021	11/30/2021	--	R	--	R	--	2	0
	37	11/30/2021	12/7/2021	--	R	--	R	R	2	1
	38	12/7/2021	12/14/2021	--	R	--	R	R	2	1
	39	12/14/2021	12/21/2021	--	R	--	R*	R	1	1
	40	12/21/2021	12/28/2021	--	R	--	R*	R	1	1
	41	12/28/2021	1/4/2022	--	R	--	R*	R*	1	0
2022	42	1/4/2022	1/11/2022	--	--	--	--	--	0	0
	43	1/11/2022	1/18/2022	--	--	--	--	--	0	0
	44	1/18/2022	1/25/2022	--	--	--	--	--	0	0
	45	3/22/2022	3/29/2022	R	R	R2	R	R	4	1
	46	3/29/2022	4/5/2022	R	R*	R2	R	R	3	1
	47	4/5/2022	4/12/2022	R	R	R2	R	R	4	1
	48	4/12/2022	4/19/2022	R	R	R2	R	R	4	1
	49	4/19/2022	4/26/2022	R	R2	R*	R*	R	3	1
	50	4/26/2022	5/3/2022	R	R2	R	R	R	4	1
	51	5/3/2022	5/10/2022	R	R2	R	R	R	4	1

Table 1. Field Sampling Summary – Radionuclides (Continued)

Year	Event	Start Date	End Date	**Stations Sampled** (Latitude and Longitude)					Usable Results (not including duplicates)	
				Residential (36.55600°, -109.23242°)	**Cove Day School** (36.55533°, -109.23242°)	**Cove Water Tower** (36.56425°, -109.21747°)	**Cove Chapter House** (36.56425°, -109.19386°)	**NTUA Pump Station** (36.59022°, -109.11764°)	**Cove**	**Reference**
2022	52	5/10/2022	5/17/2022	R	R2	R	R	R	4	1
	53	5/17/2022	5/24/2022	R	R	R	R	R2	4	1
	54	5/24/2022	5/31/2022	R	R	R	R	R2	4	1
	55	5/31/2022	6/7/2022	R	R	R	R	R2	4	1
	56	6/7/2022	6/14/2022	R	R	R	R	R2	4	1
	57	6/14/2022	6/21/2022	R	R	R	R	R2	4	1
								Total	**134**	**35**

Notes:

*	A sample was collected, but the result was rejected. See Section 3.4 for discussion.
--	Sample was not collected this week because of equipment failure (or in the case of Event 7, not analyzed because of expired holding time).
NTUA	Navajo Tribal Utility Authority
R	Radionuclide sample was collected for this location and event
R2	Radionuclide sample and duplicate were collected for this location and week

Table 2. Field Sampling Summary – Metals and $PM_{2.5}$

Year	Event	Start Date	End Date	**Stations Sampled** (Latitude and Longitude)					Usable Results (not including duplicates)	
				Residential (35.55600°, -109.23242°)	**Cove Day School** (35.55533°, -109.23242°)	**Cove Water Tower** (36.56425°, -109.21747°)	**Cove Chapter House** (36.56425°, -109.19386°)	**NTUA Pump Station** (36.59022°, -109.11764°)	**Cove**	**Reference**
2020	1	2/10/2020	2/17/2020	M	M	M	M2	M	4	1
	2	2/18/2020	2/25/2020	M	M	M	M2	M	4	1
	3	2/25/2020	3/3/2020	M	M	M	M	M	4	1
	4	3/3/2020	3/10/2020	M	M	M	M	M	4	1
	5	3/10/2020	3/17/2020	M	M	M	M2	M	4	1
	6	3/17/2020	3/25/2020	M	M	M	M	M	4	1
	7	3/24/2020	3/31/2020	--	--	--	--	--	0	0
2021	8	5/11/2021	5/18/2021	M2	M	M	M	M	4	1
	9	5/18/2021	5/25/2021	M	M	M	M	M	4	1
	10	5/25/2021	6/2/2021	M2	M	M	M	M	4	1
	11	6/2/2021	6/8/2021	M	M	M	M	M	4	1
	12	6/8/2021	6/15/2021	M2	M	M	M	M	4	1
	13	6/15/2021	6/22/2021	M	M	M	M	M	4	1
	14	6/22/2021	6/29/2021	M2	M	M	M	M	4	1
	15	6/29/2021	7/6/2021	M	M	M	M	M	4	1
	16	7/6/2021	7/13/2021	M2	M	M	M	M	4	1
	17	7/13/2021	7/20/2021	M	M	M	M	M	4	1
	18	7/20/2021	7/27/2021	M	M	M2	M	M2	4	1
	19	7/27/2021	8/3/2021	M	M	M	M	M	4	1
	20	8/3/2021	8/10/2021	M	M	M2	M	M2	4	1
	21	8/10/2021	8/17/2021	M	M	M	M	M	4	1
	22	8/17/2021	8/24/2021	M	M	M	M	M2	4	1
	23	8/24/2021	8/31/2021	M	M	M	M	M	4	1
	24	8/31/2021	9/7/2021	M	M	M	M	M2	4	1
	25	9/7/2021	9/14/2021	M	M	M	M	M	4	1
	26	9/14/2021	9/21/2021	M	M	M	M	M2	4	1

Table 2. Field Sampling Summary – Metals and $PM_{2.5}$ (Continued)

Year	Event	Start Date	End Date	**Stations Sampled** (Latitude and Longitude)					**Usable Results (not including duplicates)**	
				Residential (35.55600°, -109.23242°)	**Cove Day School** (35.55533°, -109.23242°)	**Cove Water Tower** (36.56425°, -109.21747°)	**Cove Chapter House** (36.56425°, -109.19386°)	**NTUA Pump Station** (36.59022°, -109.11764°)	**Cove**	**Reference**
2021	27	9/21/2021	9/28/2021	M	M	M	M	M	4	1
	28	9/28/2021	10/5/2021	M	M2	M	M	M	4	1
	29	10/5/2021	10/12/2021	M	M	M	M	M	4	1
	30	10/12/2021	10/19/2021	M	M2	M	M	M	4	1
	31	10/19/2021	10/26/2021	M	M	M	M	M	4	1
	32	10/26/2021	11/2/2021	M	M2	M	M	M	4	1
	33	11/2/2021	11/9/2021	M	M	M	M	M	4	1
	34	11/9/2021	11/16/2021	M	M2	M	M	M	4	1
	35	11/16/2021	11/23/2021	M	M	M	M	M	4	1
	36	11/23/2021	11/30/2021	M	M2	M	M	M	4	1
	37	11/30/2021	12/7/2021	M	M	M	M	M	4	1
	38	12/7/2021	12/14/2021	M	M2	M	M	M	4	1
	39	12/14/2021	12/21/2021	M	M	M	M	M	4	1
	40	12/21/2021	12/28/2021	M	M	M2	M	M	4	1
	41	12/28/2021	1/4/2022	M	M	M	M	M	4	1
2022	42	1/4/2022	1/11/2022	M	M	M2	M	M	4	1
	43	1/11/2022	1/18/2022	M	M	M	M	M	4	1
	44	1/18/2022	1/25/2022	M	M	M2	M	M	4	1
	45	3/22/2022	3/29/2022	M	M	M	M	M	4	1
	46	3/29/2022	4/5/2022	M	M	M2	M	M	4	1
	47	4/5/2022	4/12/2022	M	M	M	M	M	4	1
	48	4/12/2022	4/19/2022	M	M	M2	M	M	4	1
	49	4/19/2022	4/26/2022	M	M	M	M	M	4	1
	50	4/26/2022	5/3/2022	M	M2	M	M	M	4	1
	51	5/3/2022	5/10/2022	M	M	M	M	M	4	1

Table 2. Field Sampling Summary – Metals and $PM_{2.5}$ (Continued)

Year	Event	Start Date	End Date	Stations Sampled (Latitude and Longitude)					Usable Results (not including duplicates)	
				Residential (35.55600°, -109.23242°)	Cove Day School (35.55533°, -109.23242°)	Cove Water Tower (36.56425°, -109.21747°)	Cove Chapter House (36.56425°, -109.19386°)	NTUA Pump Station (36.59022°, -109.11764°)	Cove	Reference
2022	52	5/10/2022	5/17/2022	M	M2	M	M	M	4	1
	53	5/17/2022	5/24/2022	M	M	M	M	M	4	1
	54	5/24/2022	5/31/2022	M	M	M	M	M2	4	1
	55	5/31/2022	6/7/2022	M	M	M	M	M	4	1
	56	6/7/2022	6/14/2022	M	M	M	M	M2	4	1
	57	6/14/2022	6/21/2022	M	M	M	M	M	4	1
								Total	**224**	**56**

Notes:

-- Sample was not analyzed this week because of expired holding time.
M Metals and $PM_{2.5}$ sample was collected for this location and event.
M2 Metals and $PM_{2.5}$ sample and duplicate were collected for this location and event.
NTUA Navajo Tribal Utility Authority
$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter

Table 3. Summary Statistics – Radionuclides, All Cove Stations

Analyte	Project Action Limit (pCi/m^3)		Location	Detection Frequency	Minimum Concentration (pCi/m^3)	Maximum Concentration (pCi/m^3)	Exceedances
	QAPP PAL	Alternate PAL					
Radium-226	3.15E-02	1.05E-02	All Stations	61 / 130	9.36E-05	2.77E-04	None
Radium-228	9.90E-03	3.30E-03	All Stations	4 / 134	1.87E-04	1.24E-03	None
Thorium-230	2.00E-02	6.67E-03	All Stations	27 / 134	1.40E-04	2.27E-04	None
Thorium-232	8.05E-03	2.68E-03	All Stations	70 / 134	8.88E-05	2.02E-04	None
Uranium-234	1.54E-02	5.13E-03	All Stations	57 / 134	6.87E-05	1.87E-04	None
Uranium-235	5.93E-03	1.98E-03	All Stations	6 / 134	1.21E-05	2.56E-05	None
Uranium-238	1.29E-02	4.80E-03	All Stations	55 / 134	6.50E-05	1.90E-04	None
Gross Alpha	Not applicable	Not applicable	All Stations	130 / 130	7.74E-04	1.10E-02	None
Gross Beta	Not applicable	Not applicable	All Stations	130 / 130	1.16E-02	4.53E-02	None

Notes:
PALs listed are per the QAPP and are based on USEPA preliminary remediation goals for a target cancer risk of 3E-04. The alternate PALs are based on USEPA preliminary remediation goals for a target cancer risk of 1E-04.

PAL Project action limit
pCi/m^3 Picocurie per cubic meter
QAPP Quality assurance project plan
USEPA U.S. Environmental Protection Agency

Table 4. Summary Statistics – Radionuclides, by Analyte and Station

Analyte	Project Action Limit (pCi/m^3)		Location	Detection Frequency	Minimum Concentration (pCi/m^3)	Maximum Concentration (pCi/m^3)	Exceedances
	QAPP PAL	Alternate PAL					
Radium-226	3.15E-02	1.05E-02	Residential	13 / 29	9.76E-05	2.32E-04	None
			Cove Day School	13 / 34	9.56E-05	2.33E-04	None
			Cove Water Tower	18 / 27	9.91E-05	2.77E-04	None
			Cove Chapter House	17 / 40	9.36E-05	2.15E-04	None
			NTUA Pump Station	15 / 34	1.04E-04	2.24E-04	None
			Field Blank	47 / 47	5.55E-05	1.27E-04	None
Radium-228	9.90E-03	3.30E-03	Residential	1 / 29	1.23E-03	1.23E-03	None
			Cove Day School	1 / 36	9.85E-04	9.85E-04	None
			Cove Water Tower	0 / 28	--	--	None
			Cove Chapter House	2 / 41	1.87E-04	1.24E-03	None
			NTUA Pump Station	0 / 35	--	--	None
			Field Blank	3 / 49	8.65E-04	1.76E-03	None
Thorium-230	2.00E-02	6.67E-03	Residential	6 / 29	1.49E-04	2.13E-04	None
			Cove Day School	6 / 36	1.43E-04	2.27E-04	None
			Cove Water Tower	11 / 28	1.40E-04	1.89E-04	None
			Cove Chapter House	4 / 41	1.40E-04	1.70E-04	None
			NTUA Pump Station	9 / 35	1.25E-04	2.48E-04	None
			Field Blank	37 / 49	5.51E-05	2.10E-04	None
Thorium-232	8.05E-03	2.68E-03	Residential	13 / 29	1.01E-04	1.94E-04	None
			Cove Day School	18 / 36	8.88E-05	1.97E-04	None
			Cove Water Tower	18 / 28	9.81E-05	1.92E-04	None
			Cove Chapter House	21 / 41	9.76E-05	2.02E-04	None
			NTUA Pump Station	18 / 35	1.02E-04	1.54E-04	None
			Field Blank	45 / 49	2.86E-05	1.31E-04	None

Table 4. Summary Statistics – Radionuclides, by Analyte and Station (Continued)

Analyte	Project Action Limit (pCi/m^3)		Location	Detection Frequency	Minimum Concentration (pCi/m^3)	Maximum Concentration (pCi/m^3)	Exceedances
	QAPP PAL	Alternate PAL					
Uranium-234	1.54E-02	5.13E-03	Residential	9 / 29	6.87E-05	1.35E-04	None
			Cove Day School	19 / 36	6.88E-05	1.55E-04	None
			Cove Water Tower	17 / 28	6.98E-05	1.87E-04	None
			Cove Chapter House	12 / 41	7.30E-05	1.14E-04	None
			NTUA Pump Station	16 / 35	7.60E-05	1.34E-04	None
			Field Blank	48 / 49	4.30E-05	9.52E-05	None
Uranium-235	5.93E-03	1.98E-03	Residential	1 / 29	2.13E-05	2.13E-05	None
			Cove Day School	2 / 36	1.97E-05	2.56E-05	None
			Cove Water Tower	1 / 28	1.21E-05	1.21E-05	None
			Cove Chapter House	2 / 41	1.24E-05	1.38E-05	None
			NTUA Pump Station	1 / 35	1.65E-05	1.65E-05	None
			Field Blank	0 / 49	--	--	None
Uranium-238	1.29E-02	4.30E-03	Residential	14 / 29	7.20E-05	1.39E-04	None
			Cove Day School	16 / 36	7.39E-05	1.90E-04	None
			Cove Water Tower	15 / 28	7.65E-05	1.56E-04	None
			Cove Chapter House	10 / 41	6.50E-05	1.32E-04	None
			NTUA Pump Station	11 / 35	7.97E-05	1.17E-04	None
			Field Blank	48 / 49	3.00E-05	1.01E-04	None
Gross Alpha	Not applicable	Not applicable	Residential	28 / 28	1.02E-03	1.04E-02	None
			Cove Day School	36 / 36	9.90E-04	1.10E-02	None
			Cove Water Tower	27 / 27	8.41E-04	9.76E-03	None
			Cove Chapter House	39 / 39	7.74E-04	9.77E-03	None
			NTUA Pump Station	31 / 33	8.63E-04	1.07E-02	None
			Field Blank	26 / 46	1.68E-04	8.88E-04	None

Table 4. Summary Statistics – Radionuclides, by Analyte and Station (Continued)

Analyte	Project Action Limit (pCi/m^3)		Location	Detection Frequency	Minimum Concentration (pCi/m^3)	Maximum Concentration (pCi/m^3)	Exceedances
	QAPP PAL	Alternate PAL					
Gross Beta	Not applicable	Not applicable	Residential	28 / 28	1.16E-02	3.02E-02	None
			Cove Day School	36 / 36	1.20E-02	4.53E-02	None
			Cove Water Tower	27 / 27	1.27E-02	3.51E-02	None
			Cove Chapter House	39 / 39	1.25E-02	4.50E-02	None
			NTUA Pump Station	32 / 33	9.50E-03	4.67E-02	None
			Field Blank	46 / 46	4.09E-03	6.24E-03	None

Notes:
PALs listed are per the QAPP and are based on USEPA preliminary remediation goals for a target cancer risk of 3E-04. The alternate PALs are based on USEPA preliminary remediation goals for a target cancer risk of 1E-04.
NTUA Navajo Tribal Utility Authority
PAL Project action limit
pCi/m^3 Picocurie per cubic meter
QAPP Quality assurance project plan
USEPA U.S. Environmental Protection Agency

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration

Analyte	Sampling Week	Detected Concentration (pCi/m³)	Minimum Detectable Concentration (pCi/m³)
Gross Alpha	1	4.77E-04	2.80E-04
	3	3.77E-04	2.90E-04
	6	4.24E-04	2.90E-04
	8	5.24E-04	2.80E-04
	10	3.35E-04	2.80E-04
	11	2.87E-04	2.80E-04
	12	3.65E-04	3.10E-04
	14	5.54E-04	3.10E-04
	16	4.13E-04	3.00E-04
	18	3.66E-04	3.00E-04
	22	4.05E-04	3.20E-04
	25	4.52E-04	3.20E-04
	29	3.57E-04	3.20E-04
	36	5.72E-04	3.40E-04
	39	3.83E-04	3.40E-04
	45	5.72E-04	2.70E-04
	48	8.88E-04	2.90E-04
	50	4.80E-04	2.60E-04
	51	4.33E-04	2.60E-04
	52	2.84E-04	2.80E-04
	54	6.13E-04	2.80E-04
Gross Beta	1	4.76E-03	5.60E-04
	2	4.91E-03	5.40E-04
	3	5.12E-03	5.60E-04
	4	5.08E-03	5.60E-04
	5	5.05E-03	5.60E-04
	6	5.56E-03	5.70E-04
	7	4.79E-03	5.60E-04
	8	4.77E-03	5.60E-04
	9	5.65E-03	5.50E-04
	10	4.65E-03	5.50E-04
	11	5.22E-03	5.50E-04
	12	5.41E-03	5.60E-04
	13	4.86E-03	5.50E-04
	14	5.18E-03	5.70E-04
	15	4.87E-03	5.50E-04
	16	4.98E-03	5.60E-04
	17	4.54E-03	5.50E-04
	18	4.30E-03	5.60E-04
	19	4.57E-03	5.50E-04

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Gross Beta (continued)	22	4.74E-03	5.60E-04
	23	6.24E-03	5.50E-04
	24	4.55E-03	5.60E-04
	25	5.24E-03	5.70E-04
	26	5.26E-03	5.60E-04
	27	4.70E-03	5.60E-04
	28	5.25E-03	5.50E-04
	29	5.17E-03	5.60E-04
	36	4.28E-03	5.90E-04
	37	5.49E-03	5.70E-04
	38	4.80E-03	5.70E-04
	39	5.26E-03	5.80E-04
	40	4.09E-03	5.50E-04
	41	5.27E-03	5.60E-04
	45	4.17E-03	5.60E-04
	46	4.51E-03	5.40E-04
	47	4.89E-03	5.50E-04
	48	6.02E-03	5.80E-04
	49	5.42E-03	5.50E-04
	50	4.67E-03	5.70E-04
	51	5.06E-03	5.60E-04
	52	5.32E-03	5.50E-04
	53	5.46E-03	5.50E-04
	54	4.86E-03	5.70E-04
	55	5.46E-03	5.60E-04
	56	6.07E-03	5.60E-04
	57	4.57E-03	5.60E-04
Radium-226	1	5.72E-05	2.39E-05
	2	9.62E-05	1.72E-05
	3	6.91E-05	1.34E-05
	4	5.97E-05	1.44E-05
	5	8.06E-05	2.30E-05
	6	8.61E-05	1.85E-05
	7	8.41E-05	1.94E-05
	8	9.06E-05	2.36E-05
	10	8.83E-05	3.34E-05
	12	7.87E-05	3.00E-05
	13	1.03E-04	2.39E-05
	14	1.08E-04	2.83E-05
	15	9.50E-05	3.92E-05

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Radium-226 (continued)	16	7.72E-05	3.04E-05
	17	1.18E-04	2.18E-05
	18	1.20E-04	3.16E-05
	19	9.09E-05	3.26E-05
	22	1.24E-04	2.16E-05
	23	8.56E-05	5.24E-05
	24	5.93E-05	3.98E-05
	25	6.70E-05	4.27E-05
	26	5.55E-05	1.75E-05
	27	7.59E-05	1.82E-05
	28	8.62E-05	1.96E-05
	29	1.16E-04	2.08E-05
	30	7.12E-05	2.32E-05
	31	7.12E-05	1.78E-05
	32	1.24E-04	2.35E-05
	36	6.83E-05	2.05E-05
	37	9.83E-05	1.77E-05
	38	1.06E-04	2.52E-05
	39	8.27E-05	1.61E-05
	40	8.46E-05	2.80E-05
	41	9.53E-05	2.44E-05
	45	9.40E-05	1.83E-05
	46	9.51E-05	2.09E-05
	47	9.73E-05	1.82E-05
	48	1.02E-04	3.16E-05
	49	1.02E-04	2.07E-05
	50	1.05E-04	1.83E-05
	51	7.94E-05	2.99E-05
	52	1.11E-04	1.94E-05
	53	1.27E-04	2.91E-05
Radium-228	29	1.76E-03	1.62E-03
Thorium-230	2	9.17E-05	8.77E-05
	8	9.28E-05	5.96E-05
	9	8.87E-05	6.17E-05
	12	1.06E-04	8.98E-05
	13	1.18E-04	8.74E-05
	14	1.38E-04	9.26E-05
	15	1.02E-04	9.42E-05
	17	8.61E-05	8.53E-05
	22	1.39E-04	8.61E-05

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Thorium-230 (continued)	23	1.59E-04	8.86E-05
	25	1.09E-04	8.89E-05
	26	1.31E-04	8.47E-05
	27	8.62E-05	8.36E-05
	29	1.66E-04	8.92E-05
	31	1.52E-04	8.47E-05
	32	1.08E-04	8.56E-05
	36	8.49E-05	8.44E-05
	46	2.10E-04	8.47E-05
	47	9.33E-05	8.78E-05
	50	9.04E-05	8.11E-05
	53	8.75E-05	8.42E-05
Thorium-232	1	3.76E-05	3.71E-05
	2	4.66E-05	3.67E-05
	3	4.87E-05	3.53E-05
	5	6.45E-05	3.10E-05
	6	6.50E-05	3.14E-05
	7	5.84E-05	3.22E-05
	8	4.95E-05	1.69E-05
	9	6.11E-05	2.32E-05
	10	4.87E-05	3.18E-05
	11	5.43E-05	2.86E-05
	12	7.47E-05	3.57E-05
	13	6.46E-05	2.94E-05
	14	8.08E-05	3.40E-05
	16	3.96E-05	3.16E-05
	17	6.15E-05	2.81E-05
	18	3.75E-05	3.71E-05
	19	7.92E-05	2.52E-05
	22	5.56E-05	2.65E-05
	23	6.37E-05	3.32E-05
	24	4.80E-05	3.49E-05
	25	5.06E-05	2.87E-05
	26	5.91E-05	2.89E-05
	27	4.83E-05	2.78E-05
	28	5.52E-05	3.58E-05
	29	8.17E-05	3.65E-05
	30	5.95E-05	3.70E-05
	31	7.65E-05	3.66E-05

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Thorium-232 (continued)	32	5.45E-05	3.03E-05
	39	7.32E-05	2.61E-05
	40	5.91E-05	3.15E-05
	45	5.42E-05	2.85E-05
	46	5.23E-05	2.98E-05
	47	7.40E-05	3.53E-05
	48	5.79E-05	3.03E-05
	49	5.85E-05	2.99E-05
	50	8.54E-05	2.82E-05
	51	8.96E-05	3.35E-05
	52	1.10E-04	3.29E-05
	53	6.94E-05	3.13E-05
	54	4.53E-05	3.62E-05
	55	1.31E-04	3.78E-05
	56	4.58E-05	3.50E-05
	57	7.70E-05	3.91E-05
Uranium-234	1	8.63E-05	1.99E-05
	2	4.74E-05	2.67E-05
	3	5.38E-05	2.39E-05
	4	7.01E-05	2.59E-05
	5	8.47E-05	1.96E-05
	6	7.23E-05	1.96E-05
	7	9.52E-05	1.91E-05
	8	4.99E-05	1.56E-05
	9	7.73E-05	1.66E-05
	10	8.12E-05	2.14E-05
	11	6.70E-05	1.60E-05
	12	5.83E-05	2.45E-05
	13	4.76E-05	2.31E-05
	14	4.30E-05	2.48E-05
	15	5.87E-05	2.96E-05
	16	7.86E-05	3.08E-05
	17	7.23E-05	2.73E-05
	19	8.43E-05	2.64E-05
	22	5.24E-05	2.73E-05
	23	7.80E-05	2.80E-05
	24	7.49E-05	1.88E-05

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Uranium-234 (continued)	25	5.49E-05	1.96E-05
	26	6.67E-05	1.67E-05
	27	5.19E-05	1.63E-05
	28	6.53E-05	1.86E-05
	29	6.51E-05	1.94E-05
	30	6.87E-05	1.95E-05
	31	5.47E-05	2.02E-05
	32	6.78E-05	1.93E-05
	36	8.01E-05	2.44E-05
	37	7.70E-05	1.92E-05
	38	6.56E-05	1.57E-05
	39	7.64E-05	1.60E-05
	40	6.48E-05	2.34E-05
	41	7.72E-05	2.43E-05
	45	6.64E-05	1.58E-05
	46	8.92E-05	1.60E-05
	47	8.77E-05	1.63E-05
	48	8.03E-05	2.43E-05
	49	5.79E-05	1.71E-05
	50	6.49E-05	1.71E-05
	51	8.21E-05	1.97E-05
	52	5.57E-05	2.11E-05
	53	8.25E-05	2.35E-05
	54	7.75E-05	2.43E-05
	55	6.88E-05	1.82E-05
	56	7.26E-05	2.53E-05
	57	7.15E-05	1.99E-05
Uranium-238	1	6.04E-05	1.99E-05
	2	5.13E-05	2.67E-05
	3	6.22E-05	1.95E-05
	4	5.18E-05	2.92E-05
	5	5.40E-05	2.40E-05
	6	7.55E-05	1.96E-05
	7	3.62E-05	2.52E-05
	8	8.29E-05	2.06E-05
	9	4.62E-05	1.66E-05
	10	5.24E-05	1.55E-05
	11	3.83E-05	1.60E-05
	12	3.97E-05	1.99E-05

Table 5. Radionuclide Field Blank Detections Above the Minimum Detectable Concentration (Continued)

Analyte	Sampling Week	Detected Concentration (pCi/m^3)	Minimum Detectable Concentration (pCi/m^3)
Uranium-238 (continued)	13	5.51E-05	2.31E-05
	14	6.32E-05	2.48E-05
	15	3.00E-05	2.41E-05
	16	4.82E-05	2.34E-05
	17	8.80E-05	2.73E-05
	19	6.29E-05	2.64E-05
	22	4.20E-05	2.42E-05
	23	5.52E-05	2.49E-05
	24	3.99E-05	2.31E-05
	25	5.49E-05	1.96E-05
	26	5.67E-05	1.67E-05
	27	1.01E-04	1.63E-05
	28	6.73E-05	2.09E-05
	29	6.09E-05	2.19E-05
	30	5.92E-05	2.57E-05
	31	5.14E-05	2.66E-05
	32	4.28E-05	1.93E-05
	36	6.31E-05	2.27E-05
	37	8.12E-05	2.36E-05
	38	7.39E-05	1.92E-05
	39	4.78E-05	1.60E-05
	40	5.35E-05	2.14E-05
	41	7.29E-05	1.98E-05
	45	4.21E-05	2.19E-05
	46	6.80E-05	2.21E-05
	47	6.50E-05	1.63E-05
	48	6.42E-05	1.61E-05
	49	8.17E-05	1.71E-05
	50	6.03E-05	2.10E-05
	51	8.43E-05	2.22E-05
	52	4.46E-05	1.87E-05
	53	5.99E-05	2.09E-05
	54	8.27E-05	2.98E-05
	55	5.55E-05	2.51E-05
	56	7.40E-05	2.06E-05
	57	6.62E-05	2.45E-05

Note:
pCi/m^3 Picocurie per cubic meter

Table 6. Radionuclide Field Duplicate Result Summary

Analyte	Sampling Week	Location	Original Concentration (pCi/m^3)	Field Duplicate Concentration (pCi/m^3)	Relative Percent Difference
Gross Alpha	1	Cove Chapter House	8.34E-03	7.44E-03	11%
	2	Cove Chapter House	9.44E-03	1.01E-02	7%
	5	Cove Chapter House	4.72E-03	4.28E-03	10%
	7	Residential	5.40E-03	6.60E-03	20%
	8	Residential	2.94E-03	2.12E-03	32%
	10	Residential	1.41E-03	1.04E-03	30%
	45	Water Tower	8.72E-04	1.00E-03	14%
	47	Water Tower	1.20E-03	1.19E-03	1%
	48	Water Tower	1.17E-03	1.50E-03	25%
	49	Cove Day School	1.59E-03	1.61E-03	1%
	50	Cove Day School	2.32E-03	2.77E-03	18%
	51	Cove Day School	1.30E-03	1.30E-03	0%
	52	Cove Day School	1.50E-03	1.77E-03	17%
	53	NTUA Pump House	1.35E-03	1.67E-03	21%
	54	NTUA Pump House	6.25E-04	1.24E-03	66%
	55	NTUA Pump House	1.03E-03	1.67E-03	47%
	56	NTUA Pump House	1.35E-03	2.19E-03	47%
	57	NTUA Pump House	1.76E-03	1.86E-03	6%
Gross Beta	1	Cove Chapter House	2.72E-02	2.21E-02	21%
	2	Cove Chapter House	2.78E-02	2.73E-02	2%
	5	Cove Chapter House	1.29E-02	1.21E-02	6%
	7	Residential	1.85E-02	1.84E-02	1%
	8	Residential	2.84E-02	2.39E-02	17%
	10	Residence	7.04E-03	2.54E-02	113%
	45	Water Tower	1.68E-02	1.88E-02	11%
	46	Water Tower	1.79E-02	9.27E-03	64%
	47	Water Tower	1.79E-02	2.13E-02	17%
	48	Water Tower	2.04E-02	2.34E-02	14%
	49	Cove Day School	2.40E-02	2.43E-02	1%
	50	Cove Day School	2.93E-02	3.10E-02	6%
	51	Cove Day School	2.17E-02	2.18E-02	0%
	52	Cove Day School	2.23E-02	2.36E-02	6%
	53	NTUA Pump House	2.22E-02	2.70E-02	20%
	54	NTUA Pump House	1.85E-02	2.14E-02	15%
	55	NTUA Pump House	1.95E-02	2.29E-02	16%
	56	NTUA Pump House	1.95E-02	2.55E-02	27%
	57	NTUA Pump House	1.81E-02	2.31E-02	24%
Thorium-230	53	NTUA Pump House	1.53E-04	1.94E-04	24%
	55	NTUA Pump House	2.51E-04	2.45E-04	2%
	56	NTUA Pump House	1.97E-04	2.24E-04	13%

Table 6. Radionuclide Field Duplicate Result Summary (Continued)

Analyte	Sampling Week	Location	Original Concentration (pCi/m^3)	Field Duplicate Concentration (pCi/m^3)	Relative Percent Difference
Thorium-232	2	Cove Chapter House	1.25E-04	1.14E-04	9%
	8	Residential	1.11E-04	1.19E-04	7%
	49	Cove Day School	1.09E-04	1.29E-04	17%
	51	Cove Day School	1.33E-04	1.40E-04	5%
	53	NTUA Pump House	1.37E-04	1.70E-04	21%
	54	NTUA Pump House	1.09E-04	1.37E-04	23%
	49	Cove Day School	1.09E-04	1.48E-04	17%
Uranium-234	45	Water Tower	7.06E-05	6.90E-05	2%
	47	Water Tower	1.02E-04	1.19E-04	15%
	49	Cove Day School	1.11E-04	9.80E-05	12%
	50	Cove Day School	9.05E-05	9.61E-05	6%
	51	Cove Day School	1.09E-04	9.18E-05	17%
	52	Cove Day School	8.72E-05	8.94E-05	2%
	53	NTUA Pump House	1.06E-04	1.07E-04	1%
	54	NTUA Pump House	1.01E-04	9.29E-05	8%
	56	NTUA Pump House	7.36E-05	7.84E-05	6%
	57	NTUA Pump House	8.40E-05	1.03E-04	20%
Uranium-238	45	Water Tower	1.26E-05	1.15E-05	9%
	45	Water Tower	7.06E-05	8.24E-05	15%
	47	Water Tower	8.01E-05	9.47E-05	17%
	49	Cove Day School	9.81E-05	1.40E-04	35%
	50	Cove Day School	7.19E-05	9.90E-05	32%
	51	Cove Day School	1.01E-04	9.94E-05	2%
	53	NTUA Pump House	7.03E-05	1.05E-04	40%
	54	NTUA Pump House	1.20E-04	8.43E-05	35%

Notes:
Results are only shown for field duplicate pairs for which both analytes were detected.
NTUA Navajo Tribal Utility Authority
pCi/m^3 Picocurie per cubic meter

Table 7. Summary Statistics – Metals and $PM_{2.5}$, All Cove Stations

Analyte	Project Action Limit (µg/m³)		Location	Detection Frequency	Minimum Concentration (µg/m³)	Maximum Concentration (µg/m³)	Exceedances
	QAPP PAL	Alternate PAL					
Arsenic	0.00156	0.00156	All Stations	34 / 224	0.000087	0.00029	None
Barium	0.052	0.052	All Stations	166 / 224	0.0000985	0.0032	None
Lead	0.15	0.15	All Stations	109 / 224	0.000088	0.0039	None
Molybdenum	0.209	0.209	All Stations	15 / 224	0.000084	0.00036	None
Selenium	2.09	2.09	All Stations	1 / 224	0.0005	0.0005	None
Uranium	0.00417	0.00417	All Stations	2 / 224	0.000084	0.000086	None
Vanadium	0.0104	0.0104	All Stations	48 / 224	0.000093	0.00039	None
$PM_{2.5}$	35	35	All Stations	204 / 224	0.0416	12.74	None

Notes:
PALs are per the QAPP and are based on USEPA regional screening levels for a target cancer risk of 3E-04 and a target noncancer hazard quotient of 0.1.
Alternate PALs are based on USEPA regional screening levels for a target cancer risk of 1E-04 and a target noncancer hazard quotient of 0.1. The $PM_{2.5}$ PAL is from the National Ambient Air Quality Standard for $PM_{2.5}$.

µg/m³ Microgram per cubic meter
PAL Project action limit
$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter
QAPP Quality assurance project plan
USEPA U.S. Environmental Protection Agency

Table 8. Summary Statistics – Metals and $PM_{2.5}$, by Analyte and Station

Analyte	Project Action Limit (µg/m³)		Location	Detection Frequency	Minimum Concentration (µg/m³)	Maximum Concentration (µg/m³)	Exceedances
	QAPP PAL	Alternate PAL					
Arsenic	0.00156	0.00156	Residential	11 / 56	0.000087	0.00029	None
			Cove Day School	9 / 56	0.00011	0.00026	None
			Cove Water Tower	6 / 56	0.0001	0.00028	None
			Cove Chapter House	8 / 56	0.0000915	0.0002	None
			NTUA Pump Station	8 / 56	0.000087	0.00017	None
			Field Blank	1 / 56	0.00013	0.00013	None
Barium	0.052	0.052	Residential	42 / 56	0.00013	0.0024	None
			Cove Day School	41 / 56	0.00014	0.00215	None
			Cove Water Tower	40 / 56	0.00012	0.002	None
			Cove Chapter House	43 / 56	0.0000985	0.0032	None
			NTUA Pump Station	47 / 56	0.00015	0.007	None
			Field Blank	15 / 56	0.000084	0.0061	None
Lead	0.15	0.15	Residential	29 / 56	0.000088	0.0011	None
			Cove Day School	27 / 56	0.000105	0.0017	None
			Cove Water Tower	26 / 56	0.000094	0.0039	None
			Cove Chapter House	27 / 56	0.00009	0.00062	None
			NTUA Pump Station	28 / 56	0.00012	0.0016	None
			Field Blank	8 / 56	0.000088	0.0016	None
Molybdenum	0.209	0.209	Residential	6 / 56	0.000086	0.00036	None
			Cove Day School	7 / 56	0.000084	0.00015	None
			Cove Water Tower	2 / 56	0.00015	0.00019	None
			Cove Chapter House	0 / 56	--	--	None
			NTUA Pump Station	2 / 56	0.00022	0.00048	None
			Field Blank	0 / 56	--	--	None

Table 8. Summary Statistics – Metals and $PM_{2.5}$, by Analyte and Station (Continued)

Analyte	Project Action Limit (µg/m³)		Location	Detection Frequency	Minimum Concentration (µg/m³)	Maximum Concentration (µg/m³)	Exceedances
	QAPP PAL	Alternate PAL					
Selenium	2.09	2.09	Residential	0 / 56	--	--	None
			Cove Day School	1 / 56	0.0005	0.0005	None
			Cove Water Tower	0 / 56	--	--	None
			Cove Chapter House	0 / 56	--	--	None
			NTUA Pump Station	0 / 56	--	--	None
			Field Blank	1 / 56	0.0005	0.0005	None
Uranium	0.00417	0.00417	Residential	2 / 56	0.000084	0.000086	None
			Cove Day School	0 / 56	--	--	None
			Cove Water Tower	0 / 56	--	--	None
			Cove Chapter House	0 / 56	--	--	None
			NTUA Pump Station	0 / 56	--	--	None
			Field Blank	0 / 56	--	--	None
Vanadium	0.0104	0.0104	Residential	14 / 56	0.000096	0.00039	None
			Cove Day School	13 / 56	0.000093	0.00039	None
			Cove Water Tower	11 / 56	0.0001	0.00027	None
			Cove Chapter House	10 / 56	0.000099	0.00028	None
			NTUA Pump Station	14 / 56	0.000087	0.00033	None
			Field Blank	3 / 56	0.000094	0.00049	None
$PM_{2.5}$	35	35	Residential	56 / 56	0.167	12.41	None
			Cove Day School	52 / 56	0.042	12.74	None
			Cove Water Tower	51 / 56	0.0416	10.45	None
			Cove Chapter House	45 / 56	0.25	12.495	None
			NTUA Pump Station	49 / 56	0.083	20.6	None
			Field Blank	5 / 56	0.0417	0.333	None

Notes:
PALs are per the QAPP and are based on USEPA regional screening levels for a target cancer risk of 3E-04 and a target noncancer hazard quotient of 0.1. Alternate PALs are based on USEPA regional screening levels for a target cancer risk of 1E-04 and a target noncancer hazard quotient of 0.1. The $PM_{2.5}$ PAL is from the National Ambient Air Quality Standard for $PM_{2.5}$.

µg/m³ Microgram per cubic meter
NTUA Navajo Tribal Utility Authority
PAL Project action limit
$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter
QAPP Quality assurance project plan
USEPA U.S. Environmental Protection Agency

Table 9. Metal and $PM_{2.5}$ Field Blank Detections Above the Reporting Limit

Analyte	Sampling Week	Detected Concentration (µg/m^3)	Reporting Limit (µg/m^3)
Barium	11	1.60E-03	8.30E-04
	14	4.10E-03	8.30E-04
	39	1.00E-03	8.30E-04
	50	1.20E-03	8.30E-04
	53	6.10E-03	8.30E-04
$PM_{2.5}$	8	0.333	0.0417
	20	0.210	0.0417
	29	0.208	0.0417

Notes:
µg/m^3 Microgram per cubic meter
$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter

Table 10. Metal and $PM_{2.5}$ Field Duplicate Result Summary

Analyte	Sampling Week	Location	Original Concentration (µg/m^3)	Field Duplicate Concentration (µg/m^3)	Relative Percent Difference
Arsenic	2	Chapter House	0.0001	0.000083	19%
	57	NTUA Pump House	0.00017	0.00017	0%
Barium	2	Chapter House	0.00038	0.00045	17%
	5	Chapter House	0.00011	0.000087	23%
	8	Residence	0.00099	0.0011	11%
	10	Residence	0.0011	0.0014	24%
	16	Residence	0.0015	0.0014	7%
	18	NTUA Pump House	0.0013	0.002	42%
	20	NTUA Pump House	1.40E-03	2.10E-03	40%
	22	NTUA Pump House	8.80E-04	7.60E-04	15%
	24	NTUA Pump House	8.20E-04	2.90E-03	112%
	26	NTUA Pump House	8.40E-04	1.60E-03	62%
	34	Cove Day School	3.50E-04	1.70E-04	69%
	36	Cove Day School	5.20E-04	2.60E-04	67%
	38	Cove Day School	3.00E-04	1.80E-04	50%
	44	Water Tower	4.20E-04	4.30E-04	2%
	45	Water Tower	1.80E-03	1.30E-03	32%
	49	Cove Day School	2.00E-03	2.30E-03	14%
	51	Cove Day School	7.60E-04	9.00E-04	17%
	53	NTUA Pump House	6.10E-03	7.90E-03	26%
	55	NTUA Pump House	8.20E-04	1.10E-03	29%
	57	NTUA Pump House	2.20E-03	2.10E-03	5%
Lead	2	Chapter House	0.00032	0.00034	6%
	18	NTUA Pump House	0.000099	0.00017	53%
	24	NTUA Pump House	0.00025	0.00044	55%
	28	Cove Day School	0.0001	0.00011	10%
	30	Cove Day School	0.00011	0.00015	31%
	32	Cove Day School	0.00015	0.00015	0%
	34	Cove Day School	0.00019	0.00019	0%
	36	Cove Day School	0.00017	0.00016	6%
	42	Water Tower	0.00017	0.0001	52%
	44	Water Tower	0.00029	0.00064	75%
	49	Cove Day School	0.00042	0.00047	11%
$PM_{2.5}$	1	Chapter House	0.417	0.416	0%
	2	Chapter House	0.541	0.208	89%
	5	Chapter House	0.583	0.333	55%
	8	Residence	3.87	5.12	28%
	10	Residence	2.58	6.12	81%
	12	Residence	1	2.46	84%
	14	Residence	2.25	4.12	59%

Table 10. Metal and $PM_{2.5}$ Field Duplicate Result Summary (Continued)

Analyte	Sampling Week	Location	Original Concentration (pCi/m³)	Field Duplicate Concentration (pCi/m³)	Relative Percent Difference
$PM_{2.5}$ (continued)	16	Residence	4.75	4.75	0%
	18	NTUA Pump House	5.04	6.37	23%
	20	NTUA Pump House	10.24	10.65	4%
	22	NTUA Pump House	11.95	12.15	2%
	24	NTUA Pump House	8.16	11.86	37%
	26	NTUA Pump House	1.998	2.247	12%
	28	Cove Day School	0.541	0.375	36%
	34	Cove Day School	0.666	0.666	0%
	36	Cove Day School	0.916	0.583	44%
	40	Water Tower	0.125	0.042	99%
	44	Water Tower	0.749	1.249	50%
	45	Water Tower	3.707	3.374	9%
	49	Cove Day School	5.745	6.122	6%
	51	Cove Day School	3.747	3.164	17%
	53	NTUA Pump House	18.326	18.394	0%
	55	NTUA Pump House	2.79	2.83	1%
	57	NTUA Pump House	9.12	9.41	3%
Vanadium	49	Cove Day School	0.0002	0.00027	30%
	57	NTUA Pump House	0.00031	0.00027	14%

Notes:

$\mu g/m^3$ Microgram per cubic meter

NTUA Navajo Tribal Utility Authority

$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter

Table 11. Meteorological Summary for Radionuclide Sampling Events

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m^2)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
1	2/13/2020	Full dataset not collected							
2	2/20/2020	Full dataset not collected							
3	2/27/2020	Full dataset not collected							
4	3/3/2020	Full dataset not collected							
5	3/10/2020	7.9	68.2	0.5	26,045	2.1	1.8	193	195
6	3/17/2020	6.0	56.2	0.5	30,124	2.9	2.6	231	230
7	3/24/2020	7.0	40.1	0.0	38,594	3.6	3.4	238	237
8	5/11/2021	18.3	13.6	0.0	56,169	2.9	2.5	241	239
9	5/18/2021	17.2	22.0	0.0	53,141	4.4	4.1	225	227
10	5/25/2021	20.8	13.4	0.0	53,708	2.6	2.2	218	220
11	6/2/2021	24.9	17.5	0.0	47,548	2.9	2.5	226	217
12	6/8/2021	25.5	7.2	0.0	62,873	2.7	2.4	214	214
13	6/15/2021	29.5	15.3	0.0	56,147	2.3	1.9	197	198
14	6/22/2021	22.0	35.9	0.2	48,169	2.8	2.5	212	213
15	6/29/2021	24.9	37.1	0.1	49,673	2.6	2.3	179	178
16	7/6/2021	28.3	22.3	0.0	55,615	2.2	1.8	194	186
17	7/13/2021	25.9	34.8	0.0	46,542	2.3	1.9	195	194
18	7/20/2021	23.3	53.3	0.4	40,226	2.2	1.9	207	206
19	7/27/2021	23.0	52.9	0.6	42,910	1.8	1.5	194	194
20	8/3/2021	25.7	21.4	0.0	54,588	2.5	2.2	250	256
21	8/10/2021	25.2	33.5	0.0	43,703	2.5	2.1	192	189
22	8/17/2021	22.0	44.3	0.5	46,472	2.7	2.4	212	211
23	8/24/2021	25.1	25.4	0.0	48,484	2.2	1.9	191	189
24	8/31/2021	21.0	48.2	1.1	37,731	1.8	1.5	218	216
25	9/7/2021	25.1	23.3	0.0	44,208	2.1	1.8	216	216
26	9/14/2021	21.4	29.5	0.2	43,803	2.6	2.3	243	242

Table 11. Meteorological Summary for Radionuclide Sampling Events (Continued)

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m^2)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
27	9/21/2021	17.6	35.5	0.2	36,003	1.7	1.4	205	202
28	9/28/2021	12.9	68.8	1.0	27,455	1.6	1.4	199	200
29	10/5/2021	13.6	52.5	0.3	31,240	2.6	2.4	229	229
30	10/12/2021	7.3	49.7	0.0	33,457	2.3	2.1	225	229
31	10/19/2021	11.5	38.4	0.0	30,393	2.3	2.1	214	213
32	10/26/2021	9.3	47.4	0.0	28,227	2.2	2.0	238	238
33	11/2/2021	11.2	37.0	0.0	28,543	1.9	1.7	222	221
34	11/9/2021	9.2	40.3	0.0	24,995	2.0	1.8	243	242
35	11/16/2021	5.7	35.0	0.0	22,276	1.7	1.5	224	224
36	11/23/2021	3.4	47.3	0.0	21,545	1.7	1.5	217	221
37	11/30/2021	6.1	37.0	0.0	22,454	1.6	1.4	221	221
38	12/7/2021	1.0	66.2	1.1	16,386	2.5	2.3	214	212
39	12/14/2021	-2.5	65.5	0.1	20,017	2.0	1.8	207	208
40	12/21/2021	3.6	61.3	1.1	11,582	3.8	3.5	221	222
41	12/28/2021	-2.4	67.1	0.3	19,956	3.3	3.1	232	231
42	1/4/2022	3.2	57.4	0.0	21,673	2.0	1.7	199	199
43	1/11/2022	1.2	51.2	0.0	23,488	1.5	1.3	217	218
44	1/18/2022	1.3	52.3	0.0	23,710	1.9	1.7	230	230
45	3/22/2022	12.2	22.9	0.0	43,435	2.9	2.6	241	240
46	3/29/2022	9.7	53.2	0.5	42,936	2.6	2.3	254	252
47	4/5/2022	11.4	20.8	0.0	49,093	3.6	3.3	258	257
48	4/12/2022	10.5	22.4	0.1	48,341	3.3	3.0	243	245
49	4/19/2022	12.6	25.6	0.0	50,158	4.2	3.9	234	233
50	4/26/2022	15.3	18.8	0.0	56,195	3.7	3.4	245	245
51	5/3/2022	16.7	20.6	0.0	56,083	5.1	4.8	243	242
52	5/10/2022	17.5	14.6	0.0	57,750	3.0	2.7	227	229

Table 11. Meteorological Summary for Radionuclide Sampling Events (Continued)

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m²)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
53	5/17/2022	19.1	19.5	0.0	53,118	3.6	3.3	255	255
54	5/24/2022	19.3	17.3	0.0	57,112	3.7	3.3	250	250
55	5/31/2022	21.6	15.9	0.0	59,213	2.9	2.5	226	224
56	6/7/2022	27.6	14.6	0.0	59,696	3.5	3.1	238	239
57	6/14/2022	22.6	27.1	0.3	51,889	2.6	2.2	213	209

Notes:
Meteorological data collection began halfway through Event 4.
Although no radionuclide samples were collected during Event 20, meteorological data are presented for informational purposes.
°C Degree Celsius
m/s Meter per second
W/m² Weber per square meter

Table 12. Meteorological Summary for Metal and $PM_{2.5}$ Sampling Events

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m^2)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
1	2/13/2020	Full dataset not collected							
2	2/20/2020	Full dataset not collected							
3	2/27/2020	Full dataset not collected							
4	3/3/2020	Full dataset not collected							
5	3/13/2020	7.3	71.0	0.3	4,681	4.0	3.7	219	218
6	3/19/2020	2.2	81.7	0.3	3,689	4.1	3.9	238	234
7	3/26/2020	11.2	28.5	0.0	6,468	5.6	5.3	232	231
8	5/14/2021	21.5	9.9	0.0	8,978	2.8	2.4	242	240
9	5/21/2021	17.6	31.6	0.0	7,016	8.2	7.9	213	213
10	5/28/2021	20.5	14.0	0.0	9,010	2.0	1.7	208	206
11	6/4/2021	24.7	24.6	0.0	8,619	2.1	1.6	165	162
12	6/11/2021	23.9	8.3	0.0	9,521	2.2	1.8	212	211
13	6/18/2021	27.5	19.2	0.0	7,892	1.8	1.4	180	178
14	6/25/2021	20.9	35.8	0.2	5,307	2.6	2.2	246	245
15	7/2/2021	26.3	28.7	0.0	7,228	2.2	1.8	169	167
16	7/9/2021	29.0	19.7	0.0	7,720	1.9	1.5	221	205
17	7/16/2021	27.0	28.2	0.0	6,807	2.5	2.2	212	211
18	7/23/2021	23.8	53.4	0.1	6,258	3.0	2.6	262	260
19	7/30/2021	22.7	51.5	0.0	6,191	2.0	1.7	203	188
20	8/6/2021	27.2	21.7	0.0	7,722	3.5	3.2	250	249
21	8/13/2021	25.9	30.7	0.0	7,408	2.6	2.2	126	125
22	8/20/2021	18.4	55.0	0.1	7,348	1.7	1.4	196	187
23	8/27/2021	24.7	34.6	0.0	7,062	2.0	1.7	169	169
24	9/3/2021	19.7	59.5	0.0	6,101	1.2	1.0	204	198
25	9/10/2021	26.7	21.8	0.0	6,724	2.5	2.1	217	216
26	9/17/2021	22.7	18.4	0.0	6,813	2.4	2.2	255	255

Table 12. Meteorological Summary for Metal and $PM_{2.5}$ Sampling Events (Continued)

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m²)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
27	9/24/2021	20.3	24.6	0.0	6,246	1.9	1.6	171	170
28	10/1/2021	10.3	79.5	0.1	4,738	1.4	1.3	136	134
29	10/8/2021	16.9	44.0	0.0	2,839	2.8	2.6	235	235
30	10/15/2021	5.0	42.8	0.0	5,468	1.6	1.4	266	267
31	10/22/2021	9.5	38.4	0.0	4,841	1.2	1.0	194	192
32	10/29/2021	8.6	54.9	0.0	4,587	1.1	1.0	186	185
33	11/5/2021	8.6	43.2	0.0	4,336	1.3	1.1	190	188
34	11/12/2021	8.6	43.0	0.0	4,038	2.3	2.1	260	260
35	11/19/2021	4.8	38.0	0.0	2,904	1.3	1.0	215	216
36	11/26/2021	-0.2	47.5	0.0	3,539	1.1	0.9	192	192
37	12/3/2021	5.1	42.8	0.0	3,337	1.3	1.2	225	225
38	12/10/2021	-0.1	70.2	0.5	1,728	4.2	4.0	264	264
39	12/17/2021	-1.4	60.6	0.0	3,316	1.8	1.7	253	252
40	12/24/2021	4.9	78.4	1.1	587	5.4	5.1	228	227
41	12/31/2021	2.7	72.0	0.1	2,128	4.6	4.3	236	236
42	1/7/2022	5.6	60.9	0.0	3,365	1.6	1.2	214	212
43	1/14/2022	3.6	51.8	0.0	3,627	2.2	1.9	262	262
44	1/21/2022	-1.5	50.1	0.0	2,804	1.2	1.1	182	183
45	3/25/2022	12.5	29.8	0.0	6,955	1.6	1.3	253	252
46	4/1/2022	8.3	62.6	0.2	7,338	2.2	1.8	273	265
47	4/8/2022	10.9	22.4	0.0	7,826	2.0	1.7	231	228
48	4/15/2022	13.1	19.2	0.0	8,041	4.0	3.7	242	241
49	4/22/2022	13.4	25.4	0.0	3,964	7.8	7.5	225	224
50	4/29/2022	14.0	17.3	0.0	8,754	4.8	4.5	262	262
51	5/6/2022	19.9	14.9	0.0	8,412	3.2	3.0	249	248
52	5/13/2022	13.6	17.1	0.0	9,174	2.1	1.8	275	290

Table 12. Meteorological Summary for Metal and $PM_{2.5}$ Sampling Events (Continued)

Event	Start Date	Average Temperature (°C)	Average Relative Humidity (Percent)	Total Rainfall (inches)	Total Solar Radiation (W/m^2)	Average Wind Speed (m/s)		Average Wind Direction (degrees)	
						Scalar Average	Vector Average	Scalar Average	Vector Average
53	5/20/2022	17.9	19.9	0.0	9,001	6.3	5.9	257	257
54	5/27/2022	24.2	13.0	0.0	9,124	3.5	3.2	244	243
55	6/3/2022	23.1	10.3	0.0	8,196	3.3	3.0	244	242
56	6/10/2022	28.4	12.9	0.0	9,257	2.6	2.3	264	263
57	6/17/2022	26.4	19.0	0.0	5,378	3.2	2.7	205	202

Notes:
Meteorological data collection began halfway through Event 4.
Although no metals and $PM_{2.5}$ samples were collected during Event 7, meteorological data are presented for informational purposes.
°C Degree Celsius
m/s Meter per second
$PM_{2.5}$ Particulate matter less than 2.5 micrometers in diameter
W/m^2 Weber per square meter

Table 13. Seasonal and Monthly Coverage Summary

Season [1]	Samples Collected [2]		Month [1,3]	Samples Collected [2]	
	Radionuclides	Metals		Radionuclides	Metals
Winter	32	40	December	10	20
			January	0	12
			February	12	12
Spring	73	76	March	20	16
			April	20	20
			May	28	28
Summer	21	52	June	25	28
			July	5	20
			August	4	16
Fall	30	56	September	12	16
			October	18	20
			November	2	16
Total	**156**	**224**	**Total**	**156**	**224**

Notes:

[1] Events that cross months or seasons are assigned to the month or season having the most days in that month or season.

[2] Only field samples from the four Cove stations are included. Field quality control and reference station samples are not counted.

[3] Months are arbitrarily separated into seasons based more on climatic conditions than typical calendar associations.