Air Quality Evaluation - Utopia, New Brunswick

FINAL REPORT

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Department of Environment and Local Government

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Data for this study was collected in partnership with Environment and Climate Change Canada using equipment provided through the National Air Pollution Surveillance (NAPS) program.

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1.0 Executive Summary

In 2021 an air quality evaluation was initiated in Utopia, New Brunswick (NB), in response to ongoing citizen complaints related to air pollution emissions from the J.D. Irving Ltd. - Lake Utopia Paper mill.

Air quality monitoring equipment was deployed to the Utopia area on December 3, 2021, with the goal of collecting data for a period of one year. Data collection concluded approximately one year later on December 1, 2022.

Monitoring focused on air contaminants associated with the mill, based on available emissions data. This entailed the use of real-time continuous monitoring equipment for all monitored contaminants except formaldehyde. Formaldehyde sampling was conducted via integrated sampling (with subsequent laboratory analysis of sample media). This report provides results and analysis of the findings from this monitoring work.

Exceedances of air quality objectives/guidelines were observed for sulphur dioxide (SO_2) and hydrogen sulphide (H_2S). For all other monitored pollutants, concentrations in the area remained below applicable objective/guideline values.

With respect to SO_2 values, two objective/guideline values were exceeded. The first was the regulated provincial objective for hourly average concentrations, which was exceeded only during a single two-hour event. The second was one of the two Canadian Ambient Air Quality Standards (CAAQS) for SO_2. However, this is based on an extrapolation of data from the single year of monitoring data available, since the standard applies to the average of values from 3 years of monitoring.

H_2S exceedances were frequent and substantive. These results provide clear corroboration of citizen complaints of odour in this area. Wind direction data suggests that the source of the H_2S is the J.D. Irving Ltd. - Lake Utopia Paper mill.

Monitoring results for both SO_2 and H_2S suggest a need for additional, permanent, sentinel ambient air quality monitoring near the facility. The facility currently operates a single monitoring station, which monitors only for SO_2, and appears to be sub-optimally located.

2.0 Introduction

2.1 BACKGROUND

The Department of Environment and Local Government (DELG) has, over many years, received complaints from citizens in the Utopia area. Odour impacts are primarily described.

The mill is a known emissions source for several contaminants. However, based on available emissions data, the key contaminant (i.e., the contaminant with greatest potential for local air quality impacts) is sulphur dioxide (SO_2), which is monitored near the mill via a permanent, facility-operated, air quality monitoring station. Data from this station are reported annually by DELG via its annual air quality monitoring results report, and in real-time via DELG's online air quality data portal. Results to date from the permanent station have revealed no significant air quality issues. There have been no past (prior to project commencement) observed exceedances of the SO_2 standards at this location.

In response to continuing citizen complaints from the area, DELG has undertaken a general air quality evaluation in the area, with an expanded list of monitored contaminants.

2.2 AREA EMISSION SOURCES

The only major air pollution emitter in Utopia is the corrugated-medium pulp and paper mill that is operated by J.D. Irving Ltd. - Lake Utopia Paper. The area is rural, forested, and with few smaller industries and emissions sources. Utopia is lightly populated with permanent dwellings and seasonal cottages. Air quality in Utopia may be seasonally affected by residential wood smoke, and pollen.

As is the case for all of New Brunswick, Utopia also experiences long-range (transboundary) air pollution impacts (primarily fine particulates and ground level ozone) from pollution sources elsewhere in the World.

Emissions from the J.D. Irving Ltd. - Lake Utopia Paper mill include combustion products related to its boilers, which burn natural gas, biogas, fuel oil, and wood waste; exhaust gases from the production and waste treatment processes; vehicle (trucking) exhaust; and windblown dust from the property. It should be noted that the mill is subject to regulation under the *Air Quality Regulation* (N.B. Regulation 97-133) - *Clean Air Act*, and operates a variety of pollution control equipment to reduce air pollution emissions from the facility.

2.3 PROJECT DESIGN AND LOCATION

Based on a review of emissions data for the J.D. Irving Ltd. - Lake Utopia Paper mill, a selection of air contaminants were chosen for the evaluation. The list of the included pollutant parameters is provided in Appendix A along with the rationale for the inclusion of each.

The work was carried out on Horseshoe Lane, Utopia, New Brunswick. This is a rural, lightly populated, forested residential area.

The monitoring location was selected to be representative of a "highly impacted" area with respect to emissions from the J.D. Irving Ltd. - Lake Utopia Paper mill. This was determined based on assessment of available wind data and air pollution dispersion modelling.

The DELG mobile air quality monitoring unit was positioned at the project site (approximately 45°09'36.65"N 66°46'25.96"W), which is approximately 300 meters northwest of the J.D. Irving Ltd. - Lake Utopia Paper mill. Due to the size of the mill property, the facility grounds span almost the entire southeast quadrant as viewed from the project site (spanning approximately 100 degrees to 180 degrees). The project site and surrounding area is pictured in Figures 1 and 2.

In addition, the J.D. Irving Ltd. - Lake Utopia Paper mill operated its permanent SO_2 monitoring station throughout the project period. The location of the permanent station is indicated in Figures 1 and 2.

2.4 PROJECT TIMING

DELG began data collection with its mobile air quality monitoring unit at the Horseshoe Lane location on December 3, 2021 and concluded operations on December 1, 2022.

Figure 1. Project Site and the Utopia Area (Image courtesy of Google Earth)

Figure 2. Project Site and Nearby Surroundings (Image courtesy of Google Earth)

3.0 Methodology

3.1 METEOROLOGY EQUIPMENT

Meteorological equipment (Vaisala model WXT520) was deployed at the project site to provide wind speed and wind direction data. The meteorological unit also collected relative humidity, temperature, and barometric pressure data.

All monitored meteorological parameters were logged as one-minute averages and retrieved automatically on an hourly basis.

3.2 CONTINUOUS AIR QUALITY MONITORING EQUIPMENT

Continuous monitors provide objective measurements of air quality at all times, and do not rely on modelling or statistical approximations. With the exception of brief, intermittent, calibration cycles and occasional malfunctions, there are no gaps in coverage. Air is constantly drawn through the monitors.

Continuous monitoring equipment was deployed to the mobile unit to measure ambient (outside air) concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), hydrogen sulphide (H_2S) (measured as total reduced sulphur - TRS), ground level ozone (O_3), fine particulate matter ($PM_{2.5}$), respirable particulate (PM_{10}), and carbon monoxide (CO).

All continuously monitored parameters at the project site were logged as one-minute averages and retrieved automatically on an hourly basis by both DELG and J.D. Irving - Pulp and Paper Ltd.

Continuously monitored SO_2 at the permanent J.D. Irving Ltd. - Lake Utopia Paper monitoring site was logged as hourly averages and retrieved automatically on an hourly basis.

Technical specifications for all continuous instruments are provided in Appendix B.

3.3 INTEGRATED SAMPLING

Integrated sampling involves the collection of a single sample over an extended period of time. These samples are subsequently analyzed by a laboratory. The collected values represent the "average" concentration of the monitored contaminant experienced over the sample collection period.

Integrated sampling was undertaken for formaldehyde using *581 TraceAir II Aldehyde High Sampling Rate Monitors* (with rain shelter) which collect formaldehyde by absorption to 2,4-dinitro-phenylhydrazine (DNPH) treated fibreglass "badges". Samplers were deployed for 24-hour exposure periods, 4 days per week (Monday through Thursday) between June 6, 2022 and June 23, 2022. A total of 12 samples were collected.

Collected samples were analyzed for formaldehyde concentration by Assay Technologies (laboratory) using Occupational Health and Safety Administration (OSHA)

method 1007 by High Pressure Liquid Chromatography (HPLC) (method equivalent to United States Environmental Protection Agency (USEPA) Method TO-11).

3.4 QUALITY ASSURANCE

Data collection and validation for continuous air quality monitoring equipment was conducted in accordance with the Canadian Council of Ministers of Environment (CCME) *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines, 2019* (ISBN 978-1-77202-056-4 PDF).

Integrated sampling was undertaken in accordance with the quality assurance and validation requirements prescribed for the method (see subsection 3.3).

4.0 Results

4.1 METEOROLOGY - WIND AT PROJECT SITE

Winds at the project site originated predominantly from either the northwest (31% of the time) or south (21% of the time) during the project period. Winds from the southeast (i.e., the general direction of the mill) were less common, occurring approximately 12% of the time. Northeasterly winds were least frequent, occurring only 4% of the time. Average wind conditions for the project period are further illustrated in Appendix C.

For the integrated sampling period (Mondays through Thursdays, June 6, 2022 to June 23, 2022), wind direction was variable. The most favourable day (44% of observations indicating winds from the southeast) during the integrated sampling period occurred on June 8, 2022. The least favourable day (4% of observations indicating winds from the southeast) occurred on June 14, 2022. Southeasterly wind occurrence for each day of integrated sampling is detailed in Table 1.

Table 1: Southeasterly Wind Occurrence During Integrated Sampling

Date	Southeasterly Winds (% of Time)
June 6, 2022	11%
June 7, 2022	37%
June 8, 2022	44%
June 9, 2022	11%
June 13, 2022	24%
June 14, 2022	4%
June 15, 2022	11%
June 16, 2022	17%
June 20, 2022	6%
June 21, 2022	20%
June 22, 2022	23%
June 23, 2022	16%

4.2 CONTINUOUS MONITORS AT PROJECT SITE

Summary statistics for each of the continuously monitored parameters are provided in Table 2.

Additional data for each parameter is illustrated graphically in Appendix D.

Table 2: Summary Statistics - Continuously Monitored Parameters

Parameter	Average Concentration (1- year)	Peak Concentration (24-hour average)	Peak Concentration (1-hour average)
Sulphur Dioxide at Project Site (SO_2)	2.2 ppb	51.5 ppb	179.8 ppb
Sulphur Dioxide at Permanent Station (SO_2)	0.7 ppb	18 ppb	69.3 ppb
Nitrogen Dioxide (NO_2)	1.6 ppb	11.9 ppb	23.5 ppb
Hydrogen Sulphide (as TRS) (TRS)	2.1 ppb	23.8 ppb	172 ppb
Ground Level Ozone (O_3)	24.7 ppb	44.1 ppb	59.9 ppb
Fine Particulate ($PM_{2.5}$)	5.0 µg/m^3	12.0 µg/m^3	54.4 µg/m^3
Respirable Particulate (PM_{10})	10 µg/m^3	30 µg/m^3	99 µg/m^3
Carbon Monoxide (CO)	0.1 ppm	0.3 ppm	0.5 ppm

4.3 Integrated Sampling at Project Site

Summary statistics for formaldehyde monitoring via integrated sampling are provided in Table 3.

Table 3: Summary Statistics - Integrated Sampling of Formaldehyde via Passive Absorption

Parameter	Overall Average Concentration (12 days over 3 weeks)	Peak Concentration (24-hour average)
Formaldehyde	2.0 µg/m^3	3.1 µg/m^3

5.0 Analysis

5.1 WIND DIRECTION & STATION LOCATIONS

Wind direction data indicates that the mobile unit was directly "downwind" of the mill approximately 12% of time during the project period. However, the mill property spans a large area such that the mobile unit could be impacted by mill emissions during southerly and easterly winds. Nevertheless, northwesterly winds are the most common at this location (occurring 31% of the time). This suggests that the mobile unit was positioned to frequently experience impacts from mill property, but not ideally so. Areas southeast of the mill may experience air quality impacts from mill emissions more frequently than the project site.

The permanent facility-operated station is located approximately east-northeast of the facility. This location was downwind less than 5% of the time during the project period. This suggests that the permanent station is poorly positioned to detect air quality impacts from the Lake Utopia Paper mill.

Wind data during the integrated formaldehyde sampling period (June 6, 2022 through June 23, 2022) suggest that the samplers were well placed to receive impacts under a variety of wind scenarios. This includes two days where the samplers were well placed to receive impacts from the mill (June 7, 2022 and June 8, 2022).

5.2 COMPARISONS TO STANDARDS AND GUIDELINES

The following analysis compares the monitored values against established air quality objectives, standards, and guidelines. New Brunswick has adopted "Maximum Permissible Ground Level Concentrations" under the *Air Quality Regulation* (New Brunswick Regulation #97-133) - *Clean Air Act* for some contaminants. However, the Regulation does not address all contaminants. In these cases, concentrations are evaluated against standard or guideline values that have been adopted by policy (*e.g.*, national standards, standards adopted by other jurisdictions, or guidelines adopted by various national or international agencies).

Note that air quality standards take a variety of statistical forms (*e.g.*, hourly averages, daily averages, annual averages, daily maximum, etc.). These various forms have been crafted to support specific environmental or public health goals. However, it is beyond the scope of this report to explore the underlying rationale for each. Rather, this analysis will focus on a simple comparison against the standards and guidelines that are relevant to the evaluation.

In order to compare results against regulated standards and guidelines the data must sometimes be converted into the correct form. For instance, by averaging 24 one-hour averages together to create a 24-hour average. In some cases, the data collected cannot be converted into the appropriate form. However, extrapolations, interpolations or approximations can sometimes be applied (*e.g.*, comparing data collected over a single year against a standard that is based on a three-year average).

Continuous monitoring results from the project site are compared against standards and guideline values in Table 4. Results from integrated sampling are compared

against standards and guideline values in Table 5.

As indicated in Tables 4 and 5 results for most parameters were below (i.e., better than) established objectives, standards, and guidelines. However, exceedances were observed for sulphur dioxide and total reduced sulphur.

Table 4: Comparisons to Standards and Guidelines - Continuous Monitors

Parameter	Standard/ Guideline Value	Standard/Guide-line Source	Monitored Value	Notes
Sulphur Dioxide (SO_2) **Project Site**	169.5 ppb (1-hour average)	N.B. Reg. 97-133, *Clean Air Act*	179.8 ppb (Highest 1-hour value recorded)	The standard was exceeded for two hours during a single event on March 6, 2022.
	56.5 ppb (24-hour average)	N.B. Reg. 97-133, *Clean Air Act*	51.5 ppb (Highest 24-hour value recorded)	
	11.5 ppb (Annual average)	N.B. Reg. 97-133, *Clean Air Act*	2.2 ppb (Annual average)	
	70 ppb (99th percentile daily maximum one-hour average, three year average)	Canadian Ambient Air Quality Standard	125 ppb (99th percentile daily maximum one-hour average, single year)	See subsection 5.4
	5.0 ppb (Annual average)	Canadian Ambient Air Quality Standard	2.2 ppb (Annual average)	
Sulphur Dioxide (SO_2) **Permanent Station**	169.5 ppb (1-hour average)	N.B. Reg. 97-133, *Clean Air Act*	69.3 ppb (Highest 1-hour value recorded)	
	56.5 ppb (24-hour average)	N.B. Reg. 97-133, *Clean Air Act*	18 ppb (Highest 24-hour value recorded)	
	11.5 ppb (Annual average)	N.B. Reg. 97-133, *Clean Air Act*	0.7 ppb (Annual average)	
	70 ppb (99th percentile daily maximum one-hour average, three year average)	Canadian Ambient Air Quality Standard	57 ppb (99th percentile daily maximum one-hour average, single year)	See subsection 5.4
	5 ppb (Annual average)	Canadian Ambient Air Quality Standard	0.7 ppb (Annual average)	

Table 4: Comparisons to Standards and Guidelines - Continuous Monitors (continued)

Parameter	Standard/ Guideline Value	Standard/Guide-line Source	Monitored Value	Notes
Nitrogen Dioxide (NO_2)	210 ppb (1-hour average)	N.B. Reg. 97-133, *Clean Air Act*	23.5 ppb (Highest 1-hour value recorded)	
	105 ppb (24-hour average)	N.B. Reg. 97-133, *Clean Air Act*	11.9 ppb (Highest 24-hour value recorded)	
	52 ppb (Annual average)	N.B. Reg. 97-133, *Clean Air Act*	1.6 ppb (Annual average)	
	60 ppb (98th percentile daily maximum one-hour average, three year average)	Canadian Ambient Air Quality Standard	18 ppb (98th percentile daily maximum one-hour average, single year)	See subsection 5.4
	17 ppb (Annual average)	Canadian Ambient Air Quality Standard	1.6 ppb (Annual Average)	
Hydrogen Sulphide, as Total Reduced Sulphur (TRS)	11 ppb (1-hour average)	N.B. Reg. 97-133, *Clean Air Act*	172 ppb (Highest 1-hour value recorded)	
	3.5 ppb (24-hour average)	N.B. Reg. 97-133, *Clean Air Act*	23.8 ppb (Highest 24-hour value recorded)	

Table 4: Comparisons to Standards and Guidelines - Continuous Monitors (continued)

Parameter	Standard/ Guideline Value	Standard/Guide-line Source	Monitored Value	Notes
Ground Level Ozone (O_3)	80 ppb (1-hour average)	Ontario Ambient Air Quality Criteria[1]	59.9 ppb (Highest 1-hour value recorded)	
	63 ppb (Fourth worst daily 8-hour average, averaged over three years)	Canadian Ambient Air Quality Standard	47.7 ppb (Fourth worst daily 8-hour average, single year)	See subsection 5.4
Fine Particulate ($PM_{2.5}$)	27 µg/m^3 (98th percentile daily average, three year average)	Canadian Ambient Air Quality Standard	11.0 µg/m^3 (98th percentile daily average, single year average)	See subsection 5.4
	8.8 µg/m^3 (3-year annual average)	Canadian Ambient Air Quality Standard	5.0 µg/m^3 (Annual average)	
Respirable Particulate (PM_{10})	50 µg/m^3 (24-hour average)	Ontario Ambient Air Quality Criteria[3]	30 µg/m^3 (Highest 24-hour value recorded)	
Carbon Monoxide (CO)	30 ppm (1-hour average)	N.B. Reg. 97-133, *Clean Air Act*	0.5 ppm (Highest 1-hour value recorded)	
	13 ppm (8-hour average)	N.B. Reg. 97-133, *Clean Air Act*	0.3 ppm (Highest 8-hour value recorded)	

Table 5: Comparisons to Standards and Guidelines - Integrated Sampling

Parameter	Standard/Guideline Value	Standard/Guide-line Source	Monitored Value	Notes
Formaldehyde (via 581 TraceAir II passive absorption sampling)	65 µg/m^3 (24-hour average)	Ontario Ambient Air Quality Criteria[1]	3.1 µg/m^3 (Highest 24-hour value recorded)	

[1] Human Toxicology and Air Standards Section, Technical Assessment and Standards Development Branch, Ontario Ministry of the Environment, Conservation and Parks (MECP). 2020. Ambient Air Quality Criteria. MECP, Toronto, ON, Canada. ISBN: 978-1-4868-4498-2. (Online). https://files.ontario.ca/mecp-ambient-air-quality-criteria-list-en-2020-05-01.pdf

5.3 PARAMETERS WITH NEGLIGIBLE IMPACT

No further analysis is provided for the continuously monitored parameters for which no exceedances of objectives, standards, or guidelines were observed (NO_2, O_3, $PM_{2.5}$, PM_{10}, and CO). Ample data was collected, under a wide variety of atmospheric conditions, throughout the 1-year monitoring period. As such, confidence is high that the potential for exceedances related to these parameters in this area is negligible. No further analysis of these parameters is warranted.

5.4 CANADIAN AMBIENT AIR QUALITY STANDARDS CONSIDERATIONS

Table 4 includes comparisons to certain Canadian Ambient Air Quality Standards (CAAQS). Some of these standards are based on statistics that require three years of data (an annual statistic that is repeated three times and the three years averaged together). However, only a single year of data is available from the current project. In these cases, although the results are not suitable for formal comparison to the CAAQS values, the comparison provided herein is nevertheless useful, and is based on the assumption that the single year of data is a reasonable basis for projecting/estimating air quality over a longer period (barring changes in local emissions). That is, to the extent that the current year is representative of a typical year at this location, we can be confident in a comparison of the calculated one-year value versus the three-year CAAQS standard. Based on available information, it does not appear that the 1-year period of the current project was exceptional or unusual for this location. As such, the comparison to the CAAQS statistics provide reasonable approximations of the values that would be generated if monitoring was to continue for the full three years required for these statistics.

Details with respect to the calculation of CAAQS statistics are available via the following Canadian Council of Ministers of Environment (CCME) guidance documents:

Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone, PN 1483, ISBN 978-1-896997-91-9 PDF, Canadian Council of Ministers of the Environment, 2012.

Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Sulphur Dioxide, PN 1610, ISBN 978-1-77202-063-2 PDF, Canadian Council of Ministers of the Environment, 2020.

Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Nitrogen Dioxide, PN 1608, ISBN 978-1-77202-061-8 PDF, Canadian Council of Ministers of the Environment, 2020.

Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Ozone, PN 1617, ISBN 978-1-77202-067-0 PDF, Canadian Council of Ministers of the Environment, 2021.

5.5 SULPHUR DIOXIDE CONCENTRATIONS - PERMANENT STATION

No exceedances of objectives, standards, or guideline values for SO_2 were detected at the permanent, facility-operated, monitoring station during the project period. As noted in subsection 5.1, this station is poorly positioned to receive air quality impacts from the mill. As such, these results may not be representative of air quality in areas that are more frequently downwind of the facility.

5.6 SULPHUR DIOXIDE CONCENTRATIONS - PROJECT SITE

New Brunswick's 1-hour objective for SO_2 (169.5 ppb) was exceeded for two hours at the project site during a single event on March 6, 2022. The peak 1-hour average concentration during the event reached 179.8 ppb. Average wind direction (direction of origin) during this event was approximately 132 degrees (approximately southeasterly), which is the general direction of the Lake Utopia Paper mill. This wind data, and the absence of other known SO_2 emissions sources in the area, is highly suggestive of the mill being the source of the SO_2 exceedance. The mill did not report any operational issues, malfunctions, or abnormalities during this period.

Based on the one-year of collected data, the "Daily Max" Canadian Ambient Air Quality Standard (CAAQS) for SO_2 is likely exceeded at this location. Please see subsection 5.4 for additional explanation concerning the comparison of one year of data against a three-year statistic. Based on available data, this location is experiencing a "Daily Max" statistic (the 99th percentile daily maximum 1-hour average) of 125 ppb, as compared to the 70 ppb CAAQS.

5.7 HYDROGEN SULPHIDE CONCENTRATIONS (MEASURED AS TOTAL REDUCED SULPHUR)

New Brunswick's 1-hour objective for H_2S (11 ppb) was exceeded for 387 hours (cumulative) at the project site over the course of the project, which represents an exceedance rate of 5%. That is, the 1-hour objective was exceeded 5% of the time at this location during the project. New Brunswick's 24-hour objective for H_2S (3.5 ppb) was exceeded for 1614 hours (cumulative), which represents an exceedance rate of 20%. That is, the 24-hour objective was exceeded 20% of the time.

The peak 1-hour average was 172 ppb and occurred on August 21, 2022 during the 05:00 to 06:00 period. The peak 24-hour average was 23.8 ppb and occurred on October 18, 2022.

Exceedances of the 1-hour hydrogen sulphide objective were correlated with wind direction. 94% of hourly exceedances (i.e., 1-hour average values > 11 ppb) occurred while winds were originating from the east, southeast, and south. This corresponds with the location of the Lake Utopia Paper mill property relative to the project site. The effect of wind direction on H_2S concentrations is illustrated in Figure 3.

Hydrogen sulphide concentrations also displayed a distinct seasonality, with the highest hourly concentrations occurring in the late Spring through early Fall

(approximately May through October). This is illustrated graphically in Figure D4 of Appendix D. The average concentration of H_2S during this period was 3.3 ppb (+/- 9.0 standard deviation), as compared to an average concentration of 0.9 ppb (+/- 2.6 standard deviation) during the other months.

The reasons for the seasonal H_2S variations are unclear. It is possible that the pattern is linked to seasonal changes in wind direction. Winds during the May through October period were more frequently (59% of the time) from the general direction of the mill (easterly, southeasterly, or southerly). During the other months winds originated from the general direction of the mill only 29% of the time. This is further supported by a similar pattern in the SO_2 data, although it is less pronounced (2.6 ppb SO_2 average during the May to October period versus 1.7 ppb average for the other months, +/- 10 ppb standard deviation for both).

As illustrated in Figure 4, the seven-month period of highest H_2S values also coincided with peak ambient temperature.

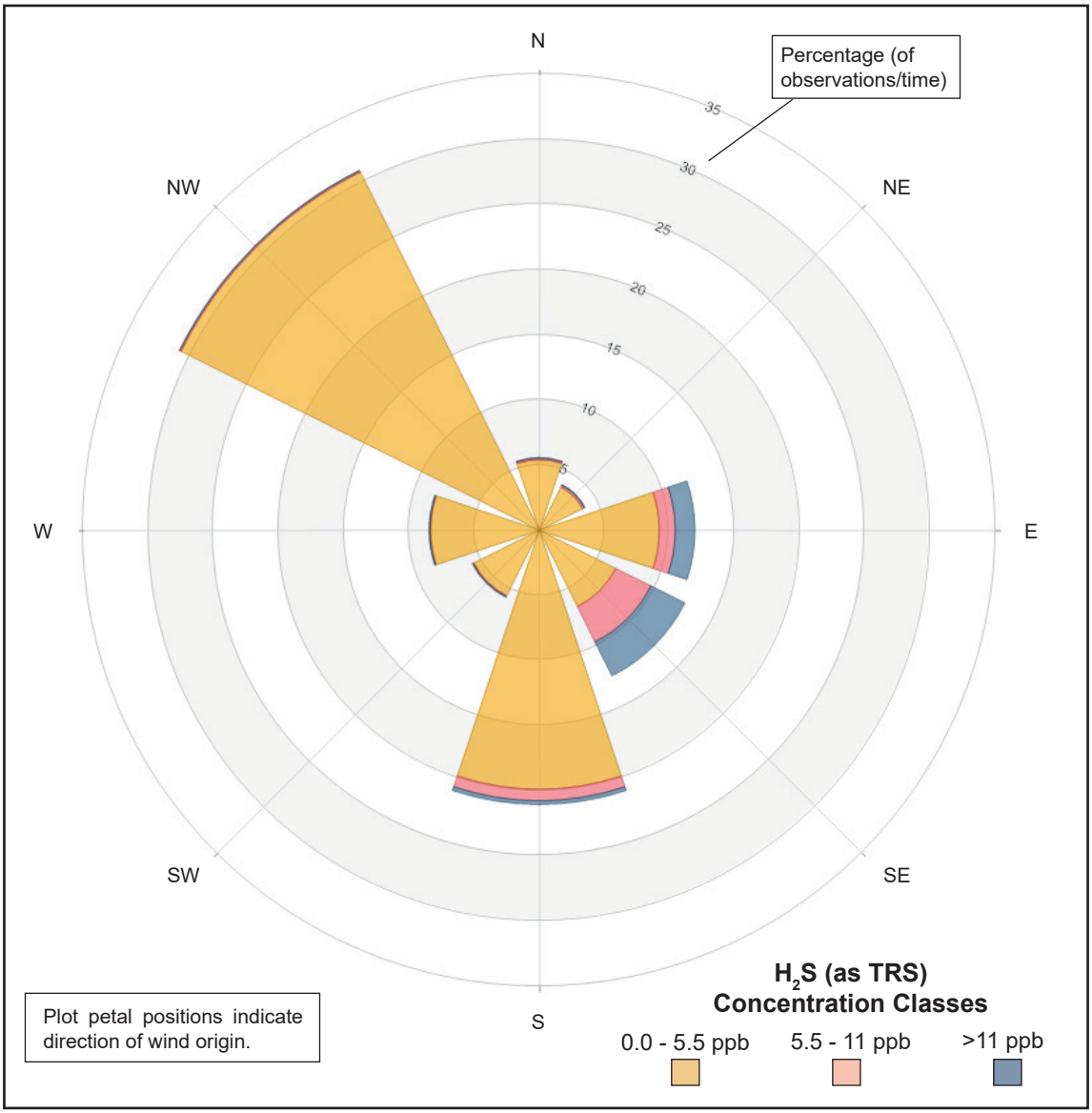

Figure 3: Hydrogen Sulphide (Measured as Total Reduced Sulphur) Pollution Rose Diagram, Indicating Frequency of Wind Direction and Associated Pollutant Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

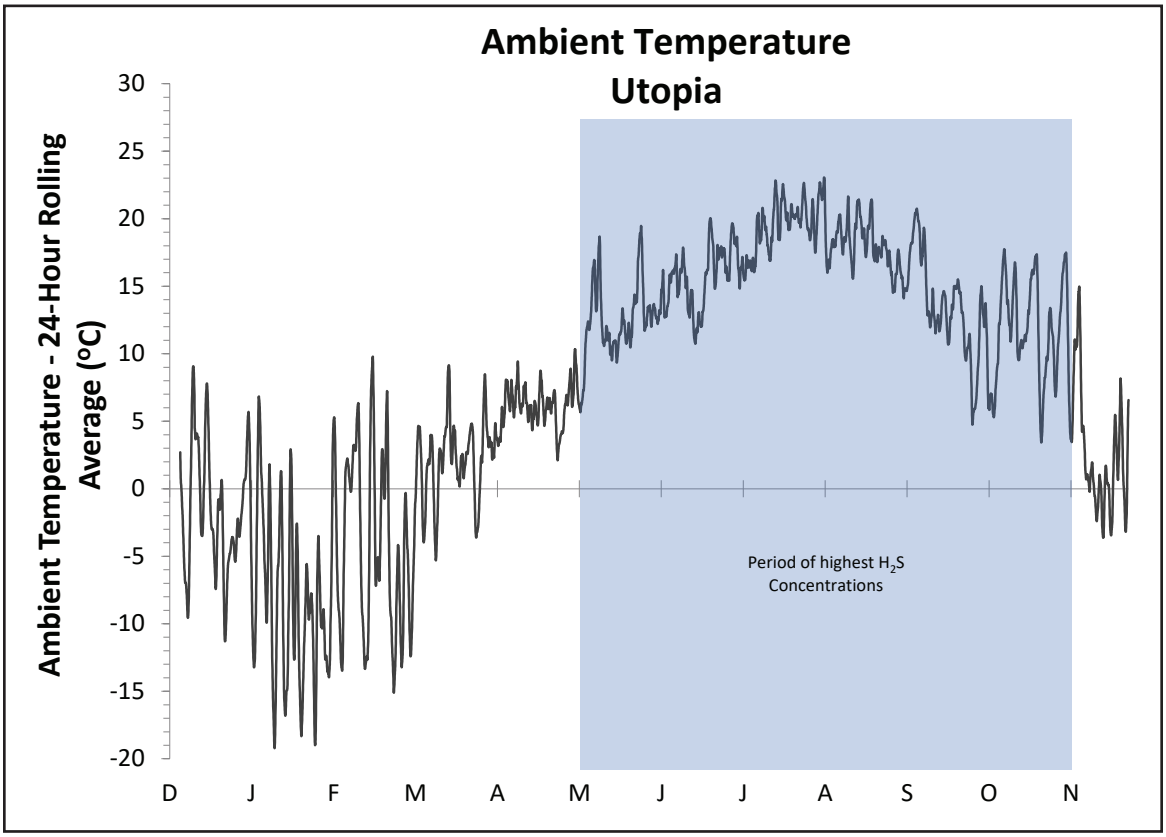

Figure 4: 24-Hour Running Average Ambient Temperature - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

5.8 INTEGRATED SAMPLING OF FORMALDEHYDE - WIND ANALYSIS

Formaldehyde monitoring results revealed no exceedances of the relevant standard (Ontario Air Quality Criterion). However, in consideration of the limited sampling (12 days), it is worthwhile to further examine the results and compare against available wind data.

The individual formaldehyde results are compared against the wind favourability data (previously provided in subsection 4.1) in Table 6 below. There is no clear relationship between wind direction and formaldehyde concentration. Regression analysis revealed no relationship between the two datasets (r^2 value of 0.06).

In consideration of the low formaldehyde values (relative to the standard) and the absence of discernible impact from nearby emissions sources (as reflected by the wind analysis), the potential for formaldehyde exceedances in this area is considered negligible. No further analysis of this parameter is warranted.

Table 6: Southeasterly Wind Occurrence and Integrated Formaldehyde Sampling Results

Date	Southeasterly Winds (% of Time)	Formaldehyde Concentration (24-hour Average)
June 6, 2022	11%	1.1 µg/m^3
June 7, 2022	37%	1.7 µg/m^3
June 8, 2022	44%	2.0 µg/m^3
June 9, 2022	11%	2.0 µg/m^3
June 13, 2022	24%	3.1 µg/m^3
June 14, 2022	4%	1.5 µg/m^3
June 15, 2022	11%	1.4 µg/m^3
June 16, 2022	17%	3.0 µg/m^3
June 20, 2022	6%	1.2 µg/m^3
June 21, 2022	20%	1.2 µg/m^3
June 22, 2022	23%	2.2 µg/m^3
June 23, 2022	16%	3.1 µg/m^3

6.0 Discussion

For many of the pollutants monitored (NO_2, PM_{10}, $PM_{2.5}$, O_3, CO, and formaldehyde), concentrations detected at Horseshoe Lane, Utopia were found to be well within (better than) applicable standards and guidelines, where suitable standards or guidelines exist.

With respect to SO_2, there was one exceedance event (spanning two hours) of the provincial 1-hour average objective. SO_2 concentrations otherwise remained within the regulated provincial objectives throughout the project (at the project site and at the permanent SO_2 station that is operated by the mill). This suggests that although there is potential for SO_2 exceedances at this location, actual exceedances are likely relatively rare. Continued sentinel monitoring is therefore warranted to detect potential future events and allow for immediate, real-time, responses by the facility operator.

SO_2 concentrations (as reflected in the number of exceedances detected, peak hourly values, and peak 24-hour averages) were generally higher at the project site than at the permanent monitoring station. This is suggestive that the permanent monitoring station may not be well positioned to represent worst-case SO_2 impacts in this area. Wind frequency data further supports this conclusion. That is, the project site was more frequently downwind of the mill property than was the permanent station. The area southeast of the mill may be most impacted as it was downwind of the mill even more frequently than the project site.

SO_2 concentrations at the permanent station indicate CAAQS achievement. However, values recorded at the project site suggest non-achievement (of the SO_2 "Daily Max" CAAQS, specifically). In consideration of the previously discussed relationship with wind direction, and the potential for poorer air quality to the southeast of the facility, the likelihood is high that there are offsite areas around the mill that are not achieving the SO_2 CAAQS. This further supports the notion that sentinel monitoring should continue, and also that the SO_2 monitoring plan for the area may require review to ensure that coverage is appropriate. It should be noted that although NB recognizes the health basis for the SO_2 CAAQS, achievement is not a regulated requirement. Nevertheless, if the SO_2 CAAQS are to be achieved, emissions reductions are likely necessary.

H_2S concentrations (measured as Total Reduced Sulphur) exceeded the regulated provincial objectives routinely (approximately 5% of the time for hourly averages and 20% of the time for 24-hour averages), and in many cases by substantial margins (more than 10X the hourly average objective in some cases). The regulated NB objectives are odour-based. These results therefore indicate a significant and ongoing H_2S odour issue, and corroborate citizen complaints of odour in the area.

Available emissions data for the mill does not suggest that it is a significant source of H_2S. However, the collected wind and ambient monitoring data strongly suggests that the mill is the likely source of the H_2S issue. This suggests that H_2S generation and emissions from the mill may not be fully understood. This must be addressed if emissions are to be reduced to achieve the provincial objectives.

It should be noted that H_2S concentrations were determined via Total Reduced Sulphur (TRS) monitoring, which detects all reduced sulphur compounds (e.g., H_2S, carbon disulphide, dimethyl sulphide, methyl mercaptan, etc) in aggregate. Since H_2S is the only known reduced sulphur compound that is emitted in the area, it is expected that the measured TRS values are representative of H_2S concentrations. However, as previously discussed, facility emissions may not be fully understood, which raises the possibility of other unknown reduced sulphur compounds contributing to the observed TRS results. If so, TRS values would not accurately represent H_2S concentrations. While this is unlikely, the possibility should be considered in any future efforts to further quantify facility emissions.

It is notable that TRS concentrations, and to a lesser extent SO_2 concentrations, were higher during the warmer months, which may be related to seasonal wind patterns causing the project site to be downwind of the mill more frequently during this period. However, a relationship with ambient temperature cannot be ruled out.

In light of the TRS/H_2S values detected, consideration should be given to implementing continuous ambient sentinel monitoring for H_2S in the Utopia area. The monitoring plan for H_2S should include consideration of the impact of wind direction (as per previous discussion with respect to the SO_2 parameter).

7.0 Data Limitations

The data collected represents conditions during the evaluation period and does not reflect all possible variations in ambient air quality conditions that may be possible at this location.

This project involved the collection of ambient air quality data under field conditions. Consequently, unforeseen and unavoidable disruptions (e.g., weather, electrical power failures, equipment malfunctions, etc.) resulted in temporary data interruptions at various points throughout the evaluation period.

The project analyzed air quality at a single fixed location. The results provide a quantitative assessment of air quality at that location only.

The project location may have been impacted by air pollutants from multiple sources during the evaluation period. Meteorology data can suggest likely sources for the contaminants detected during a given period. However, the data is insufficient for comprehensive “source apportionment” (i.e., it is not sufficient for discerning and quantifying the specific impacts of individual pollution sources).

Data was collected for a period of 12 months. However, some comparisons are made to standard or guideline values that require a longer observation period (e.g., 3 years). See subsection 5.4 for details.

8.0 Glossary of Abbreviations

API	(Teledyne) Advanced Pollution Instrumentation
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of Environment
CO	Carbon monoxide
DELG	Department of Environment and Local Government
DNPH	2,4-dinitro-phenylhydrazine
HPLC	High Pressure Liquid Chromatography
H_2S	Hydrogen sulphide
ISBN	International Standard Book Number
ISSN	International Standard Serial Number
km/hr	Kilometers per hour
MECP	Ministry of the Environment, Conservation and Parks (Ontario)
NAPS	National Air Pollution Surveillance (program)
NB	New Brunswick
NO_2	Nitrogen dioxide
O_3	Ozone (ground level ozone)
PDF	Portable Document Format
$PM_{2.5}$	Fine particulate (particulates with a diameter ≤ 2.5 microns)
PM_{10}	Respirable Particulate (particulates with a diameter ≤ 10 microns)
PN	Publication Number (CCME)
PPB	Parts per billion
PPM	Parts per million
r^2	Coefficient of determination
SO_2	Sulphur dioxide
TRS	Total reduced sulphur
USEPA	United States Environmental Protection Agency
$\mu g/m^3$	Micrograms per cubic meter

Appendix A: Pollutant Parameters

Table A1: Rationale for Inclusion of Monitored Parameters

Air Contaminant	Rationale for Inclusion
Sulphur Dioxide (SO_2)	Emissions monitoring (stack testing) for the mill indicates that SO_2 is being emitted from the facility. Inclusion of this parameter in the study provides quantification of off-site impacts from these emissions.
Nitrogen Dioxide (NO_2)	Emissions monitoring (stack testing) for the mill indicates that NO_2 is being emitted from the facility. Inclusion of this parameter in the study provides quantification of off-site impacts from these emissions.
Hydrogen Sulphide (As Total Reduced Sulphur)	Hydrogen sulphide (H_2S) is produced by the mill's neutral sulphite semi-chemical process. Also, wastewater treatment for the facility is accomplished via anaerobic digestion, which can release H_2S, and possibly other reduced sulphur compounds. This is verified by stack-testing information provided by the facility. Also, on-site, handheld, H_2S monitoring has verified the presence of H_2S gas at ground level at the facility. TRS compounds (including H_2S) are extremely odorous. Including this parameter will determine the extent to which these emissions impact the community.
Ground Level Ozone (O_3)	Ozone is not directly emitted by pollution sources. Rather, it is formed in the air by reactions between certain pollutants (principally between volatile organic compounds and nitrogen dioxide). Ground level ozone concentrations change in predictable ways in response to the presence of these other contaminants. Monitoring this parameter along with NO_2 allows inferences to be made about local volatile organic compound emissions.
Particulate Matter (PM_{10} and $PM_{2.5}$)	Emissions monitoring (stack testing) for the mill indicates that particulates are being emitted from the facility. Inclusion of these parameters in the study provides quantification of off-site impacts from these emissions and determination of the size-distribution of the particles.
Formalde-hyde	Formaldehyde can be generated from the heating and combustion of organic materials. The mill burns organic material as its fuel supply. It is therefore expected that the mill would emit this contaminant. Formaldehyde may also be produced by the mill's drying operations. This is verified by stack-testing information provided by the facility. Formaldehyde can contribute to odour.
Carbon Monoxide (CO)	Carbon monoxide (CO) is a product of incomplete combustion. Elevated levels signify combustion inefficiency. CO is known to be emitted from the mill. However, relative to applicable standards, significant amounts are not expected to be detected in the ambient environment. This parameter is included to verify this assumption.

Appendix B: Technical Specifications - Continuous Monitors

Table B1: Technical Specifications of Continuous Air Quality Monitors

Parameter	Instrument	Lower Detection Limit	Resolution
Sulphur Dioxide (SO_2)	Thermo Environmental Instruments Pulsed Fluorescence SO_2 Analyzer, Model 43iQ	1 ppb (60 second average of 300 millisecond samples)	± 0.5 ppb (noise) ± 1.0 ppb (precision)
Sulphur Dioxide (SO_2) *J.D. Irving Ltd. - Lake Utopia Paper - permanent station*	December 2021 to November 15, 2022: Teledyne Advanced Pollution Instrumentation (API)UV Fluorescence SO_2 Analyzer, Model 100E	0.4 ppb	± 0.5% of reading above 50 ppb (precision)
	November 16, 2022 to December 2022: Teledyne Advanced Pollution Instrumentation (API) UV Fluorescence SO_2 Analyzer, Model T100	0.4 ppb	± 0.5% of reading above 50 ppb (precision)
Nitrogen Dioxide (NO_2)	Thermo Environmental Instruments Chemiluminescence NO-NO_2-NO_X Analyzer, Model 42*iQ*.	0.4 ppb	± 0.2 ppb (noise) ± 0.4 ppb (precision)
Hydrogen Sulphide *As Total Reduced Sulphur* (TRS)	Thermo Environmental Instruments Pulsed Fluorescence SO_2 Analyzer, Model 43iQ, modified for TRS measurement using a CD Nova-Tech Inc. Thermal Oxidizer, Model CDN-101 operated at 850°C	1 ppb (60 second average of 300 millisecond samples)	± 0.5 ppb (noise) ± 1.0 ppb (precision)
Ground Level Ozone (O_3)	Thermo Environmental Instruments Ultraviolet Photometric Ozone Gas Analyzer, Model 49*i*	0.5 ppb	± 0.25 ppb (noise) ± 1.0 ppb (precision)
Fine and Respirable Particulate Matter ($PM_{2.5}$ and PM_{10})	Teledyne API Model T640 Mass Monitor	0.1 µg/m^3 (hourly)	± 0.5 µg/m^3
Carbon Monoxide (CO)	Thermo Environmental Instruments Non Dispersive Infrared (NDIR) with gas filter corellation CO Analyzer, Model 48i-TLE	0.04 ppm	± 0.1 ppm (noise)

Appendix C: Wind Rose

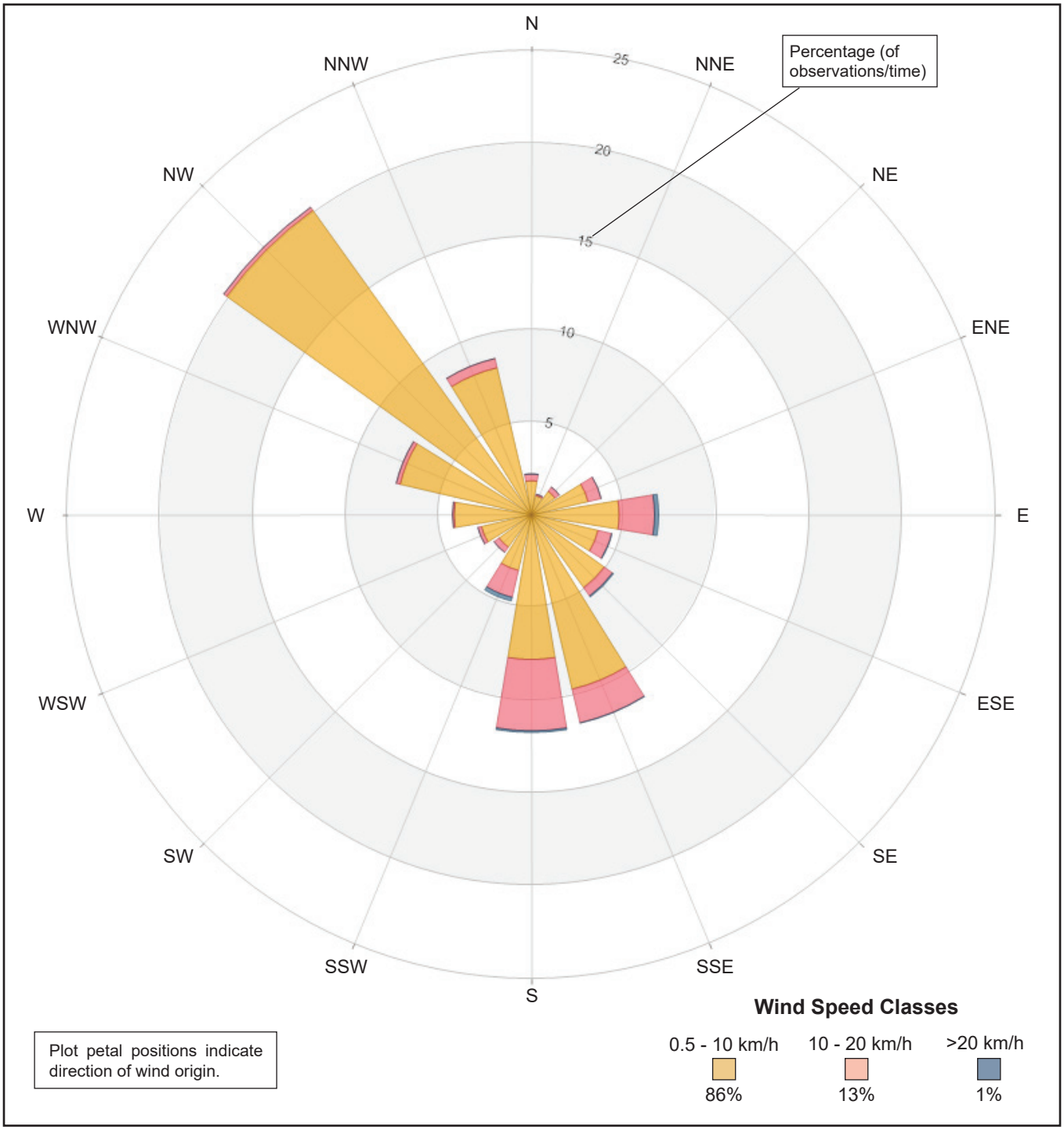

Figure C1: Wind Rose Diagram Indicating Frequency of Wind Direction and Speed - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

Appendix D: Continuous Monitors - Additional Data

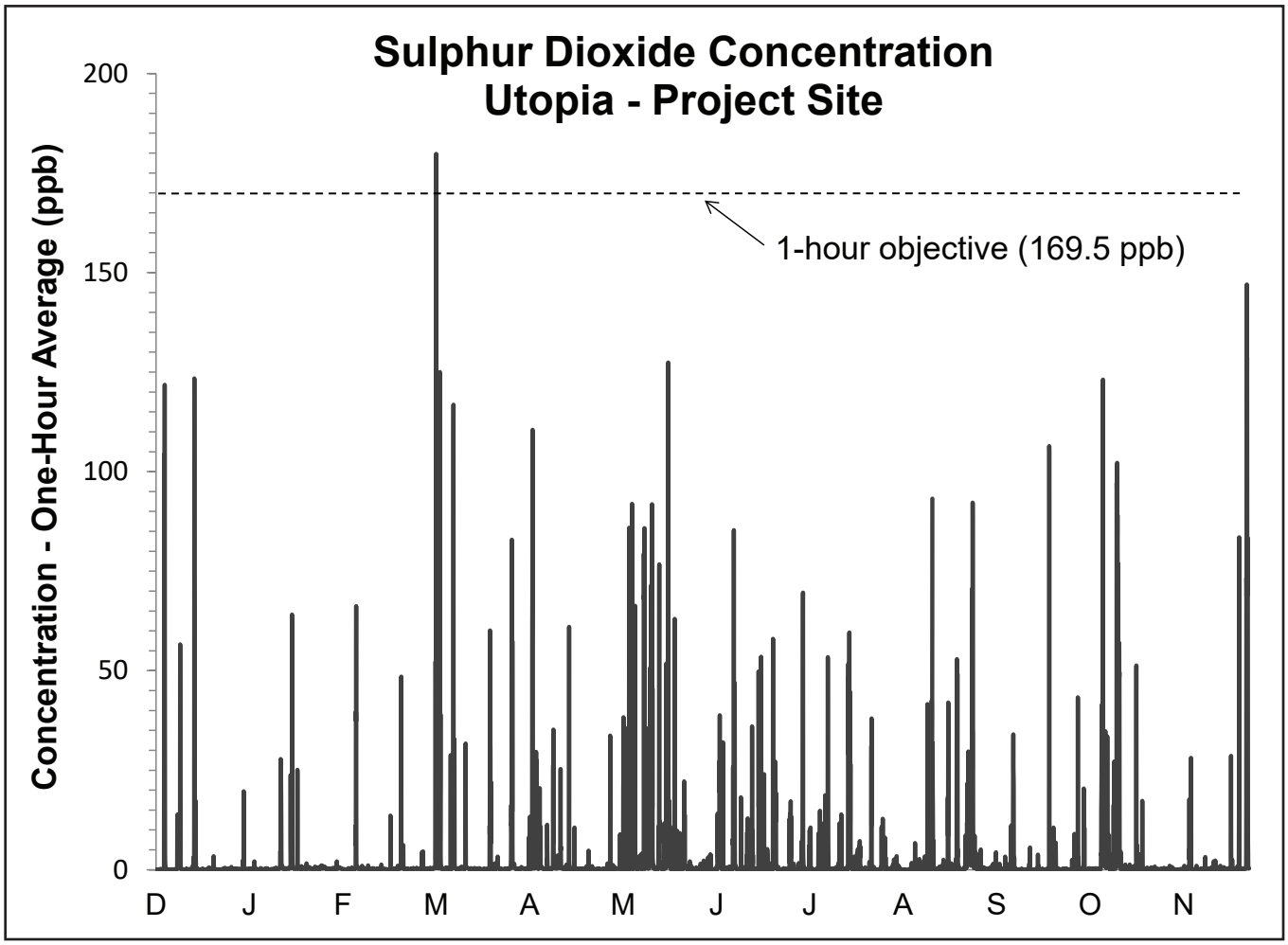

Figure D1: Hourly Average Sulphur Dioxide Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

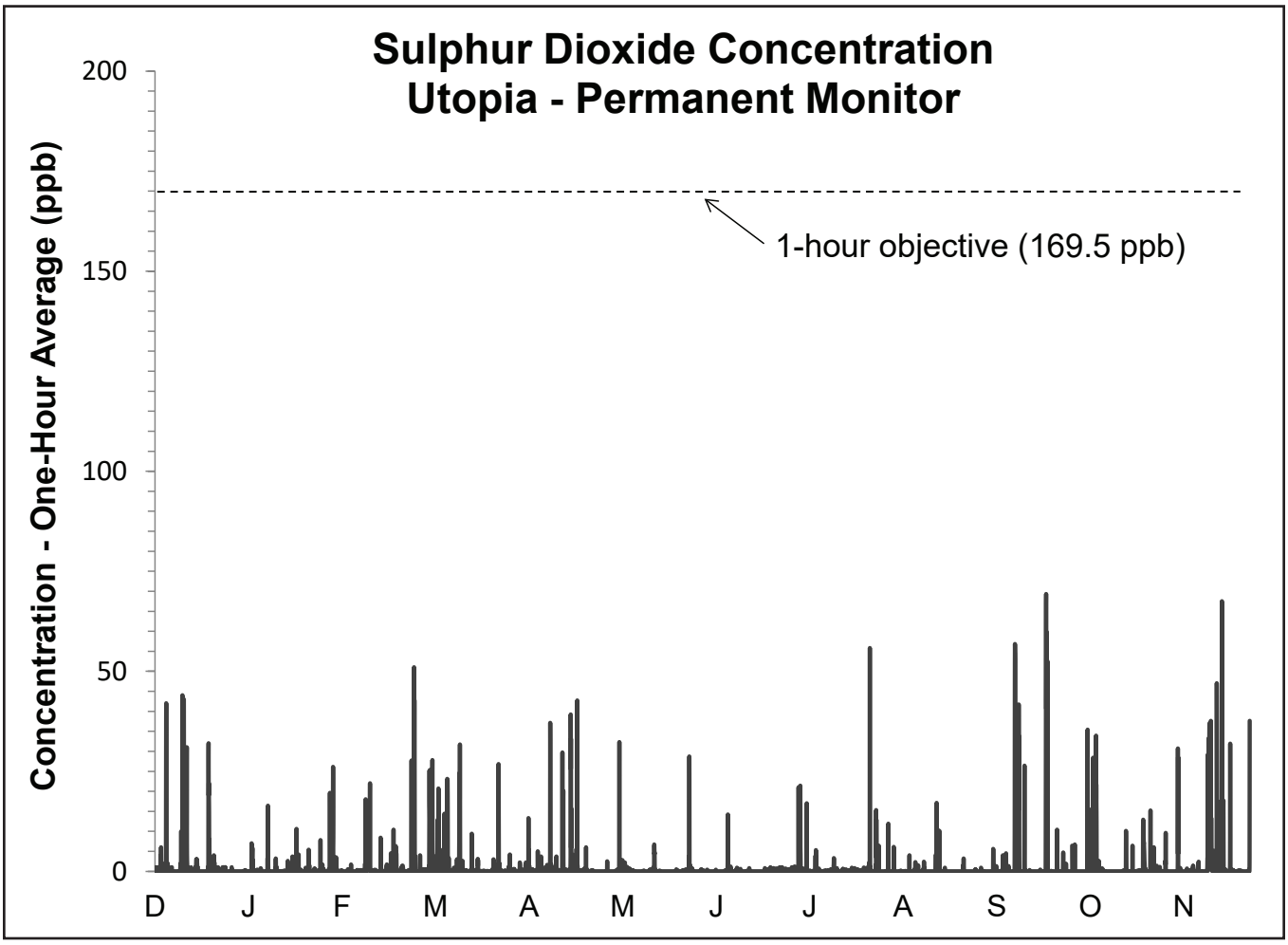

Figure D2: Hourly Average Sulphur Dioxide Concentration - J.D. Irving Ltd. Lake Utopia Paper Permanent Monitor, December 3, 2021 to December 1, 2022.

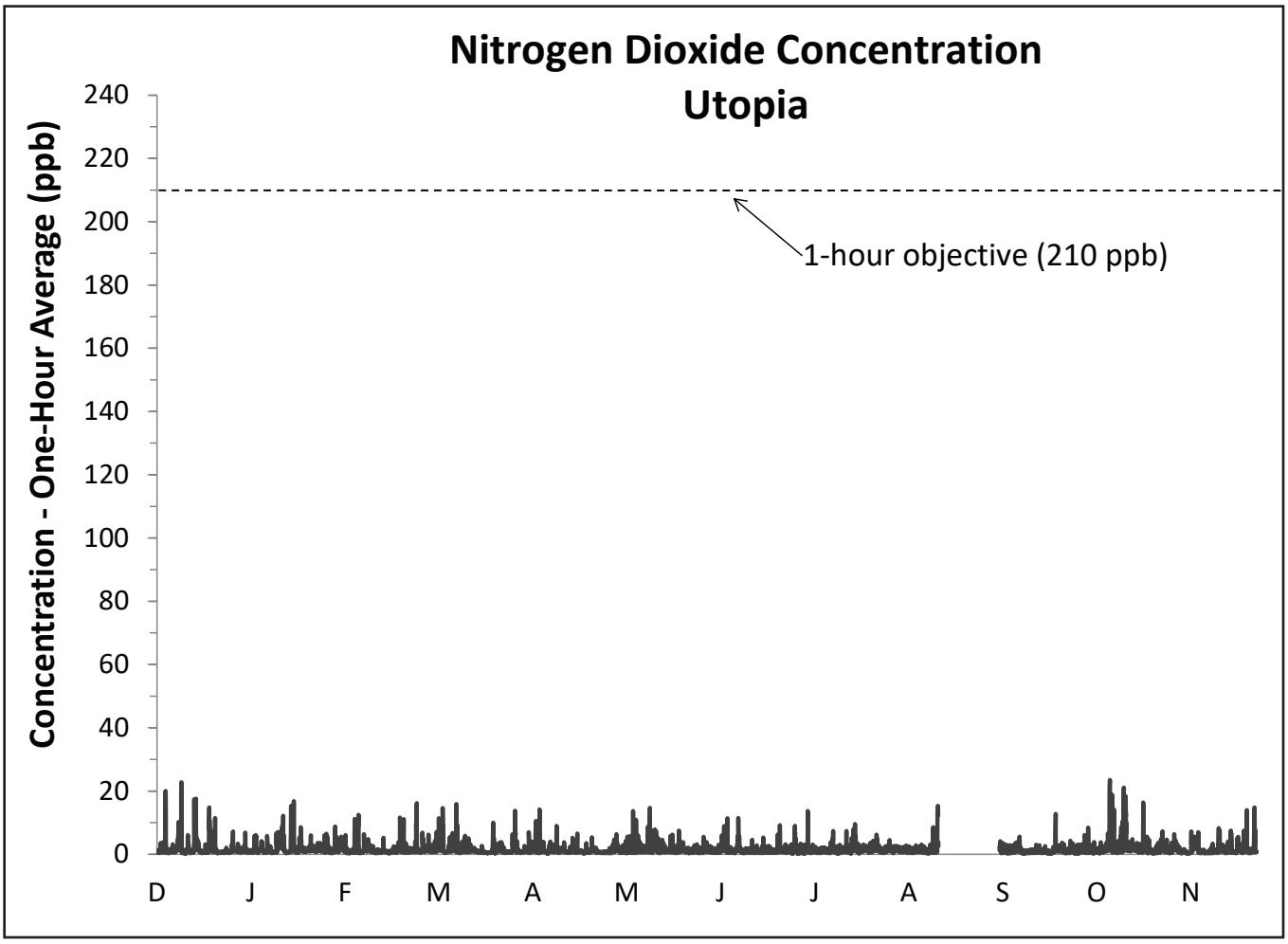

Figure D3: Hourly Average Nitrogen Dioxide Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

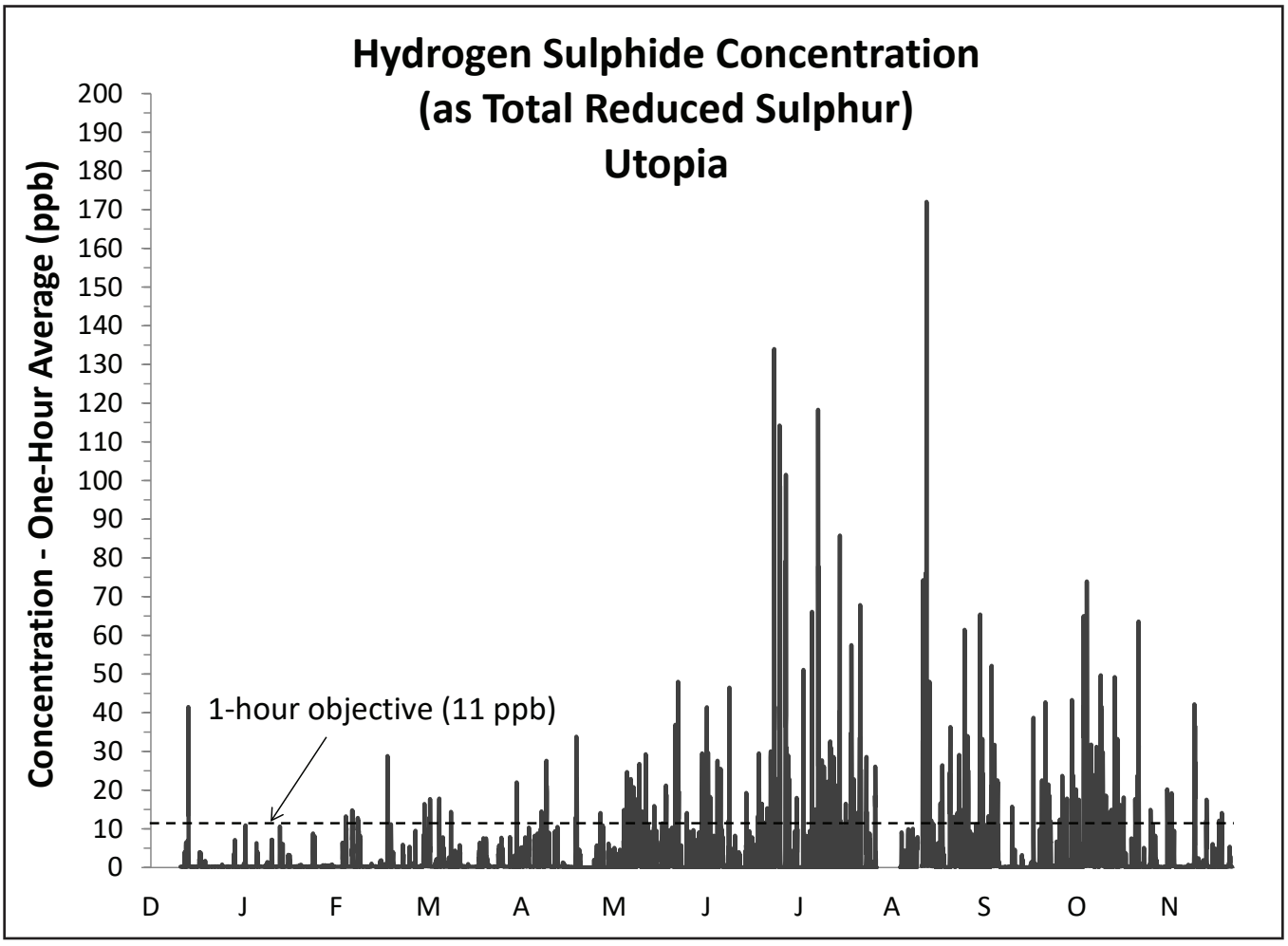

Figure D4: Hourly Average Hydrogen Sulphide (as Total Reduced Sulphur) Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

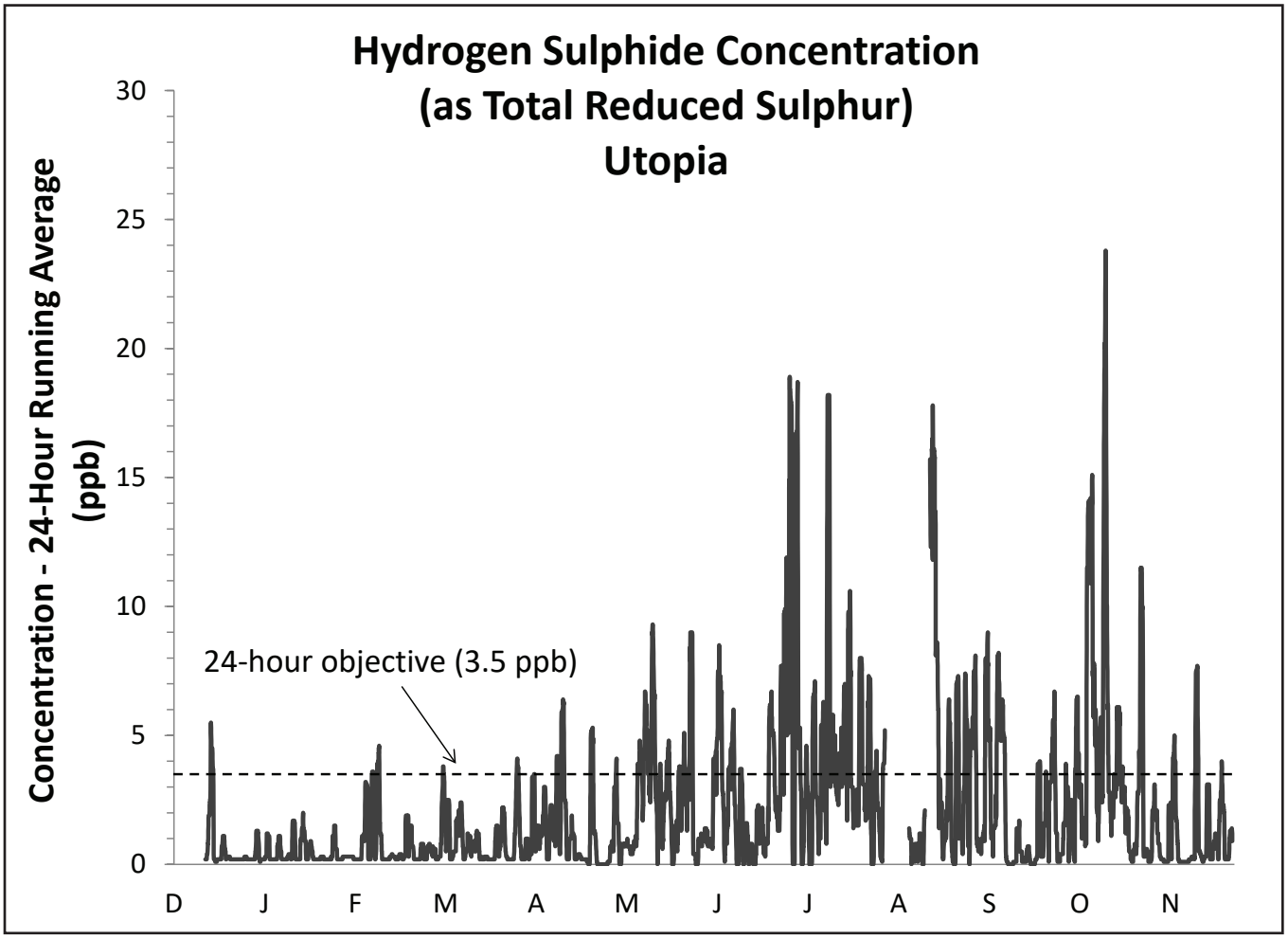

Figure D5: 24-Hour Running Average Hydrogen Sulphide (as Total Reduced Sulphur) Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

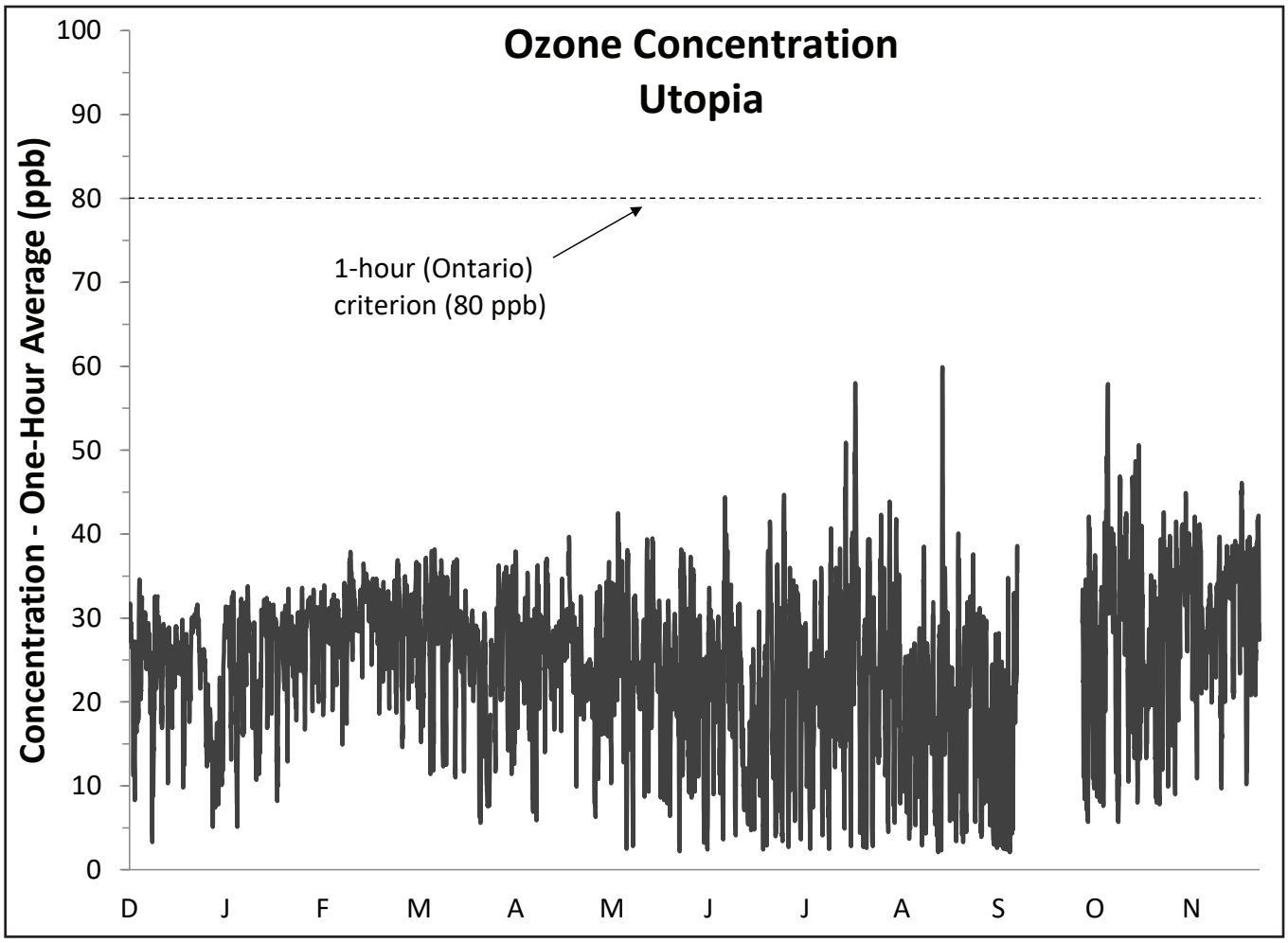

Figure D6: Hourly Average Ozone Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

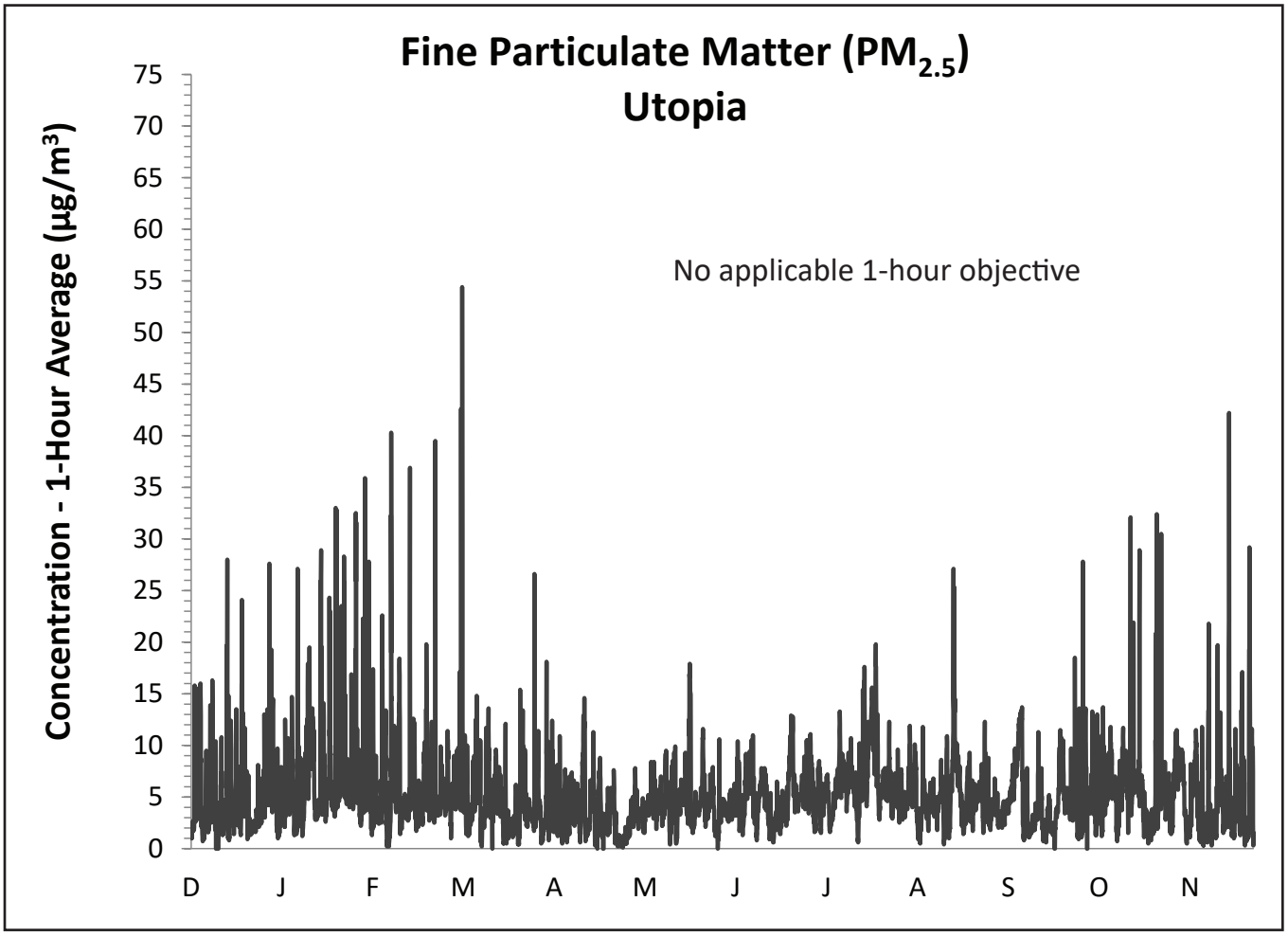

Figure D7: Hourly Average Fine Particulate Matter Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

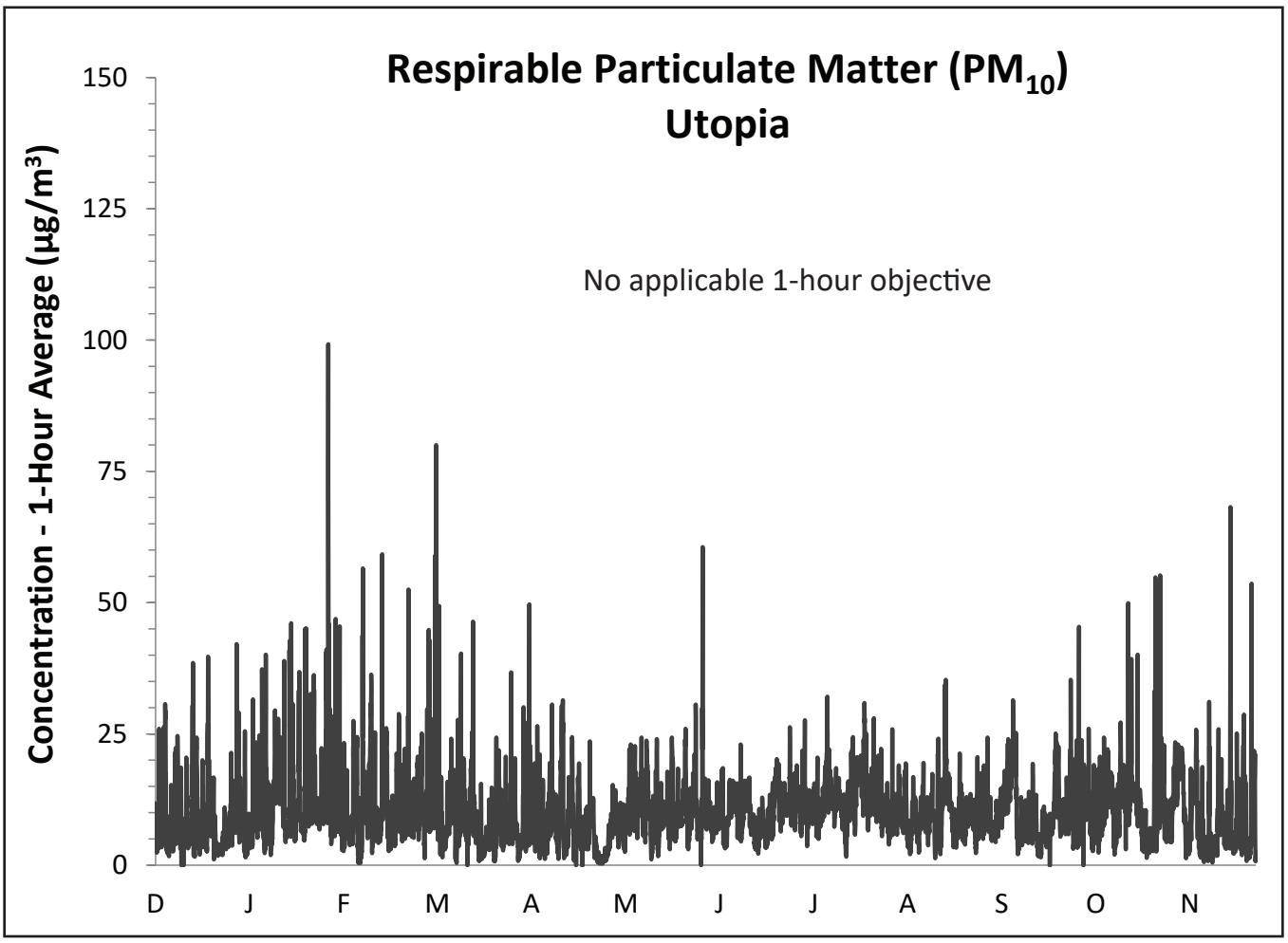

Figure D8: Hourly Respirable Particulate Matter Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

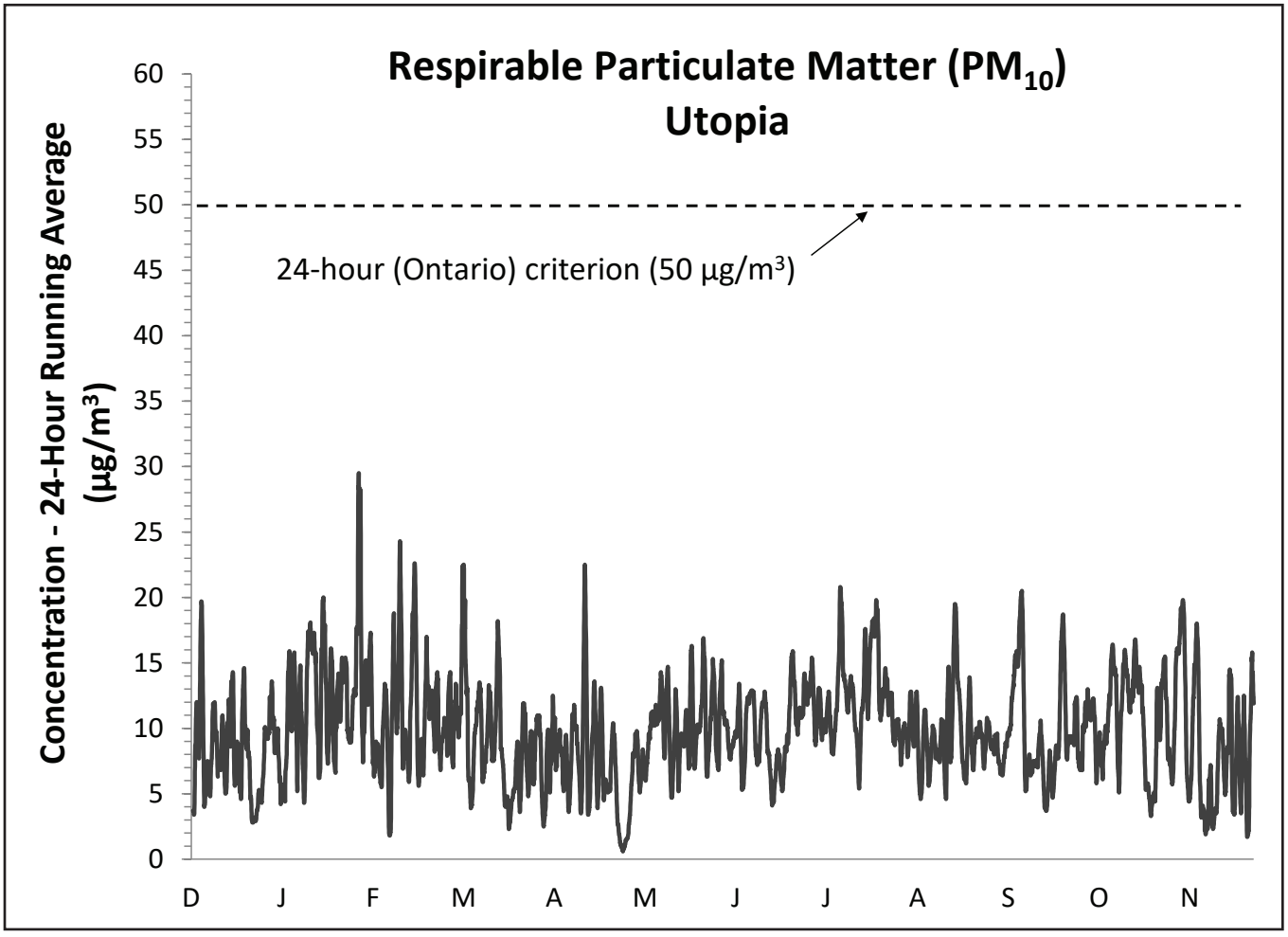

Figure D9: 24-Hour Running Average Respirable Particulate Matter Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.

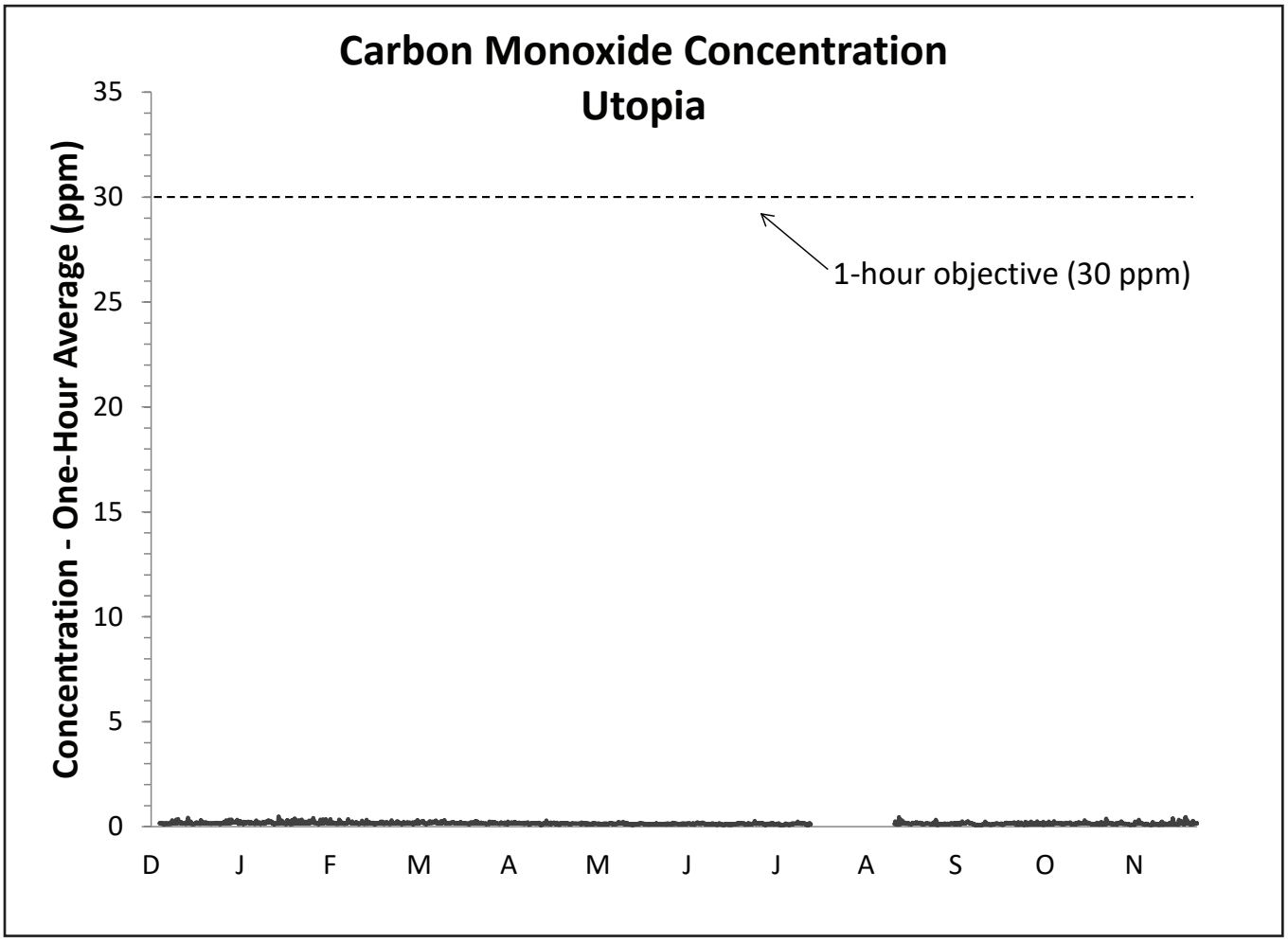

Figure D10: Hourly Average Carbon Monoxide Concentration - Horseshoe Lane, Utopia, December 3, 2021 to December 1, 2022.