Limited Investigation of Indoor Air Quality and Mould Growth

Emmerson Hall
31 University Avenue, Wolfville, Nova Scotia

Prepared for:

Sodexo Campus Canada
61 University Avenue
Wolfville, Nova Scotia
B4P 2R5

October 11, 2022

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EXECUTIVE SUMMARY

Sodexo Campus Canada retained Pinchin Ltd. (Pinchin) to perform a limited investigation of indoor air quality and potential mould growth within Emmerson Hall located at 31 University Avenue, Wolfville, Nova Scotia. The survey, conducted on August 9, 2022 was limited to the common areas of the building as well as Room 108. The investigation included interviews, site reviews and testing.

Spot measurements were collected in various locations in Emmerson Hall for carbon dioxide, carbon monoxide, temperature, relative humidity, PM_{10}, $PM_{2.5}$ and TVOCs. The temperatures were above the recommended comfort ranges for office environments of 24 to 27 °C for typical summer dress. All other parameters were within their respective guidelines and comfort ranges.

Datalogging was completed within the First Floor Area 102 and the Second Floor Hallway in Emmerson Hall from August 9th to August 16th, 2022. Datalogging was completed for carbon dioxide, carbon monoxide, temperature, relative humidity, PM_{10} and TVOCs.

In the First Floor Area 102, the temperature averaged 26.1°C, within the comfort range of 24 to 27 °C, but exceeded the comfort range at times throughout the datalogging period. PM_{10} concentrations averaged 0.007 mg/m^3, below the target of 16 mg/m^3 and the guideline of 0.050 mg/m^3, although there were a few exceedances of 0.050 mg/m^3 on August 14th, 2022, from 02:28 – 03:32. All other parameters were within their respective guidelines and comfort ranges.

During the datalogging in the Second Floor Hallway, the carbon monoxide exceeded the guideline of 5 ppm at the beginning of the datalogging period, but was below the guideline within 6 hours and stayed below the guideline for the remainder of the datalogging period. PM_{10} concentrations averaged 0.009 mg/m^3, below the target of 16 mg/m^3 and the guidelines of 0.050 mg/m^3, although there were a few exceedances of the guideline briefly on August 12th and August 14th. TVOC concentrations were above the US EPA recommendation in the Second Floor Hallway from 19:08 - 23:43 on August 11th, 2022. All other TVOC concentration were below 400 ppb. All other parameters were within their respective guidelines and comfort ranges.

The occupant load at the time of the investigation and pick up of equipment was low. Pinchin was not onsite during the datalogging and cannot speak on the occupant load throughout the week.

Water damage and mould growth was observed within the meeting room off Room 108 (Room 108 – B) on the first floor of Emmerson Hall. Elevated moisture readings were measured on both the east and south walls. Mould growth was observed on the pipe insulation under the heater on the east wall. Efflorescence was observed on the south wall in the southeast corner.

Five airborne mould samples were collected within the building: in Room 108, the Main Area Room 102, First Floor Hallway, Second Floor Area and within the Third Floor Office Hallway. In addition, one outdoor reference sample was collected. The sample results suggest that airborne mould levels were acceptable at the time of the sampling.

The following recommendations are offered:

1. Communicate the findings of this report to the occupants and staff.
2. Consider any necessary steps for interim risk management.
3. All source(s) of water infiltration should be identified and repaired to prevent further water damage and potential future mould growth. Consideration should be given into having a building envelope assessment conducted to ensure the cause of the water infiltration along the east and south walls is properly identified and repaired.
4. Remove and replace the mould-impacted pipe insulation following CCA Level 1 mould remediation methods.
5. Implement drying procedures as necessary. Ensure all surfaces are dry before installation of new finishes.

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1.0 INTRODUCTION AND SCOPE

1.1 Statement of Understanding

Pinchin Ltd. (Pinchin) was retained by Sodexo Campus Canada (the Client) to conduct a limited investigation of indoor air quality (IAQ) and potential mould growth within Emmerson Hall located at 31 University Avenue, Wolfville, Nova Scotia.

1.2 Scope of Work

Pinchin performed the investigation on August 9, 2022. The scope of this investigation was limited to the common areas of the building as well as Room 108.

The investigation involved the following activities:

- Review of occupant and management concerns.
- Spot readings of moisture content of building materials.
- Walkthrough site review for factors that could degrade air quality, including water damage or mould growth.
- Spot measurements of the following parameters:
    - Carbon dioxide
    - Carbon monoxide
    - Temperature
    - Relative Humidity (RH)
    - Total Volatile Organic Compounds (TVOC)
    - Particulate Matter smaller than 10 micrometres (PM_{10})
    - Particulate Matter smaller than 2.5 micrometres ($PM_{2.5}$)
- Datalogging of carbon dioxide, carbon monoxide, temperature, relative humidity, TVOCs and PM_{10} in two locations.
- Collection and analysis of six spore trap mould air samples including an outdoor reference sample.

2.0 METHODOLOGY

2.1 Interviews and Site Reviews

Pinchin interviewed the Property Manager to discuss the history of the building, maintenance practices, water damage and any indoor air quality complaints.

The investigator inspected the subject areas for factors that could degrade air quality.

Pinchin performed a walkthrough site review for indications of suspect mould growth and/or water damage on accessible building materials and/or contents, paying particular attention to areas where past water damage had been reported.

Where deemed necessary, the investigator inspected concealed conditions via existing access panels or by lifting lay in ceiling tiles.

The investigator used a moisture meter to test for elevated moisture levels in building materials.

2.2 Test Methods and Criteria

The following table presents the parameters measured in this investigation, the instruments and sampling/analytical methods used, the applicable units of measurement, and the criteria selected by Pinchin for the evaluation of the results.

Table I – Parameters Tested, Recommended Limits and Instruments or Methods Used

Parameter	Unit of Measurement	Recommended Limit	Instrumentation or Test Method
Carbon Dioxide, CO_2	Parts per million in air (ppm)	Outdoor Air (ppm) + 700 ppm[1]	3M® EVM-7 Air Quality Monitor
Carbon Monoxide, CO	ppm	5 ppm[2]	
Temperature, T	°C	Consider the risk of condensation on cold surfaces to prevent mould growth 24 to 27 °C, summer clothing [3]	

1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): Ventilation for Acceptable Indoor Air Quality [ANSI/ASHRAE Standard 62.1-2019]. Atlanta, GA: ASHRAE, 2019.
2 Health Canada: *Indoor Air Quality in Office Buildings: A Technical Guide*. Ottawa, ON: Health Canada, 1995.
3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): *Thermal Environmental Conditions for Human Occupancy* [ANSI/ASHRAE Standard 55-2020]. Atlanta, GA: ASHRAE, 2020.

Table I – Parameters Tested, Recommended Limits and Instruments or Methods Used

Parameter	Unit of Measurement	Recommended Limit	Instrumentation or Test Method
Relative Humidity, RH	%RH	Maintain long term below 80 %, to prevent mould growth[4] 25[5] to 65[6] %, for occupant comfort	
Total Volatile Organic Compounds, (TVOC)	Parts per billion (ppb)	400 ppb[7]	3M® EVM-7 Air Quality Monitor
Particulate Matter smaller than 10 micrometres, PM_{10}	mg/m^3	0.050 mg/m^3 [8], as guideline 0.016 mg/m^3 [9], as target	3M® EVM-7 Air Quality Monitor
Moisture in building materials (Note: detects surface moisture only, may not detect deeper moisture)	% moisture	Threshold for mould growth:[10] Drywall, 0.7% Wood materials, 17%	TRAMEX® Moisture Encounter Plus
Airborne mould (spore trap method)	Spores per cubic metre of air	Compare test area to reference areas and outdoors[11] Consider water-damage indicator moulds	Allergenco-D® sampler, laboratory analysis by Direct Microscope Examination

All direct-reading instruments were calibrated before use; all air sampling pumps were calibrated before use.

4 O.A.G. Adan, R.A. Samson (Editors): *Fundamentals of Mold Growth in Indoor Environments and Strategies for Healthy Living*. Wageningen, The Netherlands: Wageningen Academic Publishers, 2011
5 Health Canada: *Indoor Air Quality in Office Buildings: A Technical Guide*. Ottawa ON: Health Canada, 1995.
6 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): *Thermal Environmental Conditions for Human Occupancy* [ANSI/ASHRAE Standard 55-2020]. Atlanta, GA:ASHRAE, 2020.
7 Value calculated from: US Environmental Protection Agency (EPA) "Building Assessment Survey and Evaluation (BASE) Study [Online] Available at http://www.epa.gov/iaq/base/summarized_data.html#Volatile_Organic_Compounds (Accessed August 25, 2014).
8 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): *Ventilation for Acceptable Indoor Air Quality* [ANSI/ASHRAE Standard 62.1-2019]. Atlanta, GA:ASHRAE, 2019.
9 L.E. Burton, J.G. Girman, S.E. Womble: Airborne particulate matter within 100 randomly selected office buildings in the United States (BASE). Proceedings of Healthy Buildings 2000, Vol. 1 (2001).
10 Macher, J. (Ed): Bioaerosols, Assessment and Control. Cincinnati OH: American Conference of Governmental Industrial Hygienists, 1999.
11 Health Canada: Fungal Contamination in Public Buildings: Health Effects and Investigation Methods. Ottawa ON: Health Canada, 2004.

2.3 Laboratory Based Test Methods

The analysis for mould was performed at the Pinchin Environmental Microbiology Laboratory, Mississauga, Ontario. The Pinchin laboratory is independently accredited to ISO/IEC 17025:2017 for mould and bacteria analysis, by the American Industrial Hygiene Association Laboratory Accreditation Program LLC (AIHA LAP LLC) (Lab ID 158835)[12] and the Quebec government (Lab ID 495).[13]

3.0 FINDINGS

3.1 Results of Interviews

The Property Manager did not have any reported concerns from the occupants of the building. They reported that there was a water infiltration in the past in the meeting room off Room 108 (Room 108 – B). The damaged materials were removed and replaced.

3.2 Facility Description

Table II – Facility Description

Item	Details
Construction Date	1912
Number of Floors	3
Foundation Type	Concrete
Exterior Cladding	Brick
Roof	Not assessed
Flooring	Vinyl floor tile, carpet
Interior Walls	Drywall and Plaster
Ceilings	Drywall and Plaster

The facility was built at a time when asbestos-containing building materials were commonly used.

12 Accredited by the American Industrial Hygiene Association Laboratory Accreditation Program LLC (AIHA LAP LLC) under the Environmental Microbiology Laboratory Accreditation Program (EMLAP), for Bulk, Surface and Air testing for moulds, Escherichia coli, Legionella by the ISO 11731 method and for Legionella pneumophila by qPCR ISO 12869 method (Lab ID 158835).
13 Accredited by the Quebec government under the Programme d'accreditation des laboratoires d'analyses (PALA) program for Air Microbiology – domains 601, 603, 604, 605, 606.

3.3 Results of Site Reviews and Testing

This section presents the findings of the walkthrough investigation and any tests for mould. The analytical certificates for the mould tests are given in Appendix I.

Table III – Room 108

Extent of Mould Growth	None	Extent of Water Damage Including Mould Growth	None
Moisture Measurements			
Material/Location		**Results**	
Drywall – Walls		<0.7% -- DRY	
Sample Log			
Sample Type		**Sample No.**	**Result**
Airborne Mould Spore Trap		4579985	3,100 spores/m^3
Observations and Comments			
Water damage and mould growth were not observed. Elevated moisture readings were not measured.			

Table IV – Room 108 - B

Extent of Mould Growth	<1 ft^2	Extent of Water Damage Including Mould Growth	51 ft^2
 Photo 1 - View of east wall.		 Photo 2 - View of south wall.	

Table IV – Room 108 - B

Photo 3 - View of mould growth on the pipe insulation.

Photo 4 - View of bubbling paint and efflorescence on the south wall.

Moisture Measurements

Material/Location	Results
Concrete foundation with joint compound/Walls	>80% -- WET

Observations and Comments

Elevated moisture readings, water damage and mould growth were observed on the east and south walls. The walls are the concrete foundation, partially below grade. Elevated moisture readings were measured under the windows on the east wall and on half of the south wall, extending from the southeast corner towards the center of the wall. Approximately 20 ft^2 of elevated moisture readings were measured on the east wall, and approximately 30 ft^2 was measured on the south wall. Mould growth was observed on the pipe insulation under the heater on the east wall along with peeling paint. Efflorescence and bubbling paint were observed on the south wall in the southeast corner.

Table V – First Floor Hallway

Extent of Mould Growth	None	Extent of Water Damage Including Mould Growth	None

Moisture Measurements

Material/ Location	Results
Drywall/Walls	<0.7% -- DRY

Sample Log

Sample Type/Location	Sample No.	Result
Airborne Mould Spore Trap	4579891	14,000 spores/m^3

Observations and Comments

Mould growth and water damage were not observed. Elevated moisture readings were not measured.

Table VI – First Floor Area 102

Extent of Mould Growth	None	Extent of Water Damage Including Mould Growth	None

Photo 5 - View of datalogging location.

Moisture Measurements

Material/ Location	**Results**
Plaster/walls	<80% - DRY

Sample Log

Sample Type	**Sample No.**	**Result**
Airborne Mould Spore Trap	4579961	4,100 spores/m^3

Observations and Comments

Mould growth and water damage were not observed. Elevated moisture readings were not measured.

Table VII – Second Floor Area

Extent of Mould Growth	None	Extent of Water Damage Including Mould Growth	None

Table VII – Second Floor Area

Photo 6 - General view of area.

Moisture Measurements		
Material/ Location	**Results**	
Plaster/walls	<80% - DRY	
Sample Log		
Sample Type	**Sample No.**	**Result**
Airborne Mould Spore Trap	4580076	9,500 spores/m^3
Observations and Comments		
Mould growth and water damage were not observed. Elevated moisture readings were not measured.		

Table VIII – Third Floor Office Hallway

Extent of Mould Growth	None	Extent of Water Damage Including Mould Growth	None
Moisture Measurements			
Material/ Location		**Results**	
Plaster/walls		<80% - DRY	
Sample Log			
Sample Type/Location		**Sample No.**	**Result**
Airborne Mould Spore Trap		4579930	7,500 spores/m^3
Observations and Comments			
Mould growth and water damage were not observed. Elevated moisture readings were not measured.			

Table IX – Outdoors

Sample Type/Location	Mould Air Sample
Sample No.	**4579894**
Results	18000 spores/m^3
Observations and Comments	
On the day of sampling the weather was rainy, humidity averaged 71.7%RH and temperature averaged 24.1°C.	

3.4 Results of Indoor Air Quality Investigation

Spot-check measurements were collected in various locations. The results of the direct reading measurements are provided in Appendix II. Datalogging was conducted in the First Floor Area 102 and in the Second Floor Hallway from August 9 – 16, 2022. Appendix III presents the results of datalogging for IAQ parameters.

The occupancy at the time of the investigation was low due to COVID-19 measures.

3.4.1 Carbon Dioxide (CO_2)

Carbon dioxide was measured to judge the adequacy of outdoor air supply versus the occupancy of the areas tested. The indoor spot measurements of carbon dioxide ranged from 358 to 530 ppm and averaged 455 ppm. The outdoor concentration was 353 ppm. The datalogging completed within First Floor Area 102 ranged from 275 to 515 ppm and averaged 333 ppm. The datalogging completed within the Second Floor Hallway ranged from 311 to 511 ppm and averaged 350 ppm. The carbon dioxide concentrations were below the limit of 1053 ppm (353 ppm outdoors plus 700 ppm) as recommended by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) to provide indoor air quality acceptable to the majority of occupants. This indicates that the supply of outdoor air was adequate for the occupancy loading at the time of the investigation.

3.4.2 Carbon Monoxide (CO)

The indoor spot measurements of carbon monoxide ranged from below the detection limit of the instrument (<1 ppm) up to 1 ppm with an average concentration of <1 ppm. The outdoor concentration also average <1 ppm. The datalogging completed within the First Floor Area 102 ranged from <1 ppm to 1 ppm and averaged <1 ppm. The datalogging completed within the Second Floor Hallway ranged from <1 to 10 ppm and averaged <1 ppm. Health Canada advises that the detection of carbon monoxide above 5 ppm in an office building indicates a concern requiring further investigation. The CO

measurements collected during the datalogging period in the Second Floor Hallway were above 5 ppm from 13:54 – 17:59 on August 9, 2022. CO measurements collected during the remainder of the datalogging period were less than 5 ppm.

3.4.3 Temperature (Temp)

The indoor spot measurements of temperature ranged from 26.0 to 28.7 °C and averaged 27.1 °C. The outdoor temperature was 24.1 °C. The datalogging completed within First Floor Area 102 ranged from 24.0 to 28.5 °C and averaged 26.1 °C. The datalogging completed within the Second Floor Hallway ranged from 26.0 to 30.3 °C and averaged 28.4 °C. The temperatures generally were outside the recommended comfort ranges for office environments, of 24 to 27 °C for typical summer dress. The majority of the temperatures measured were above the recommended summer comfort range. Temperature preferences are, however, very personal and these conditions might be acceptable to the occupants.

3.4.4 Relative Humidity (RH)

The indoor spot measurements of relative humidity ranged from 55.3 to 64.2 %RH and averaged 60.6 %RH. The outdoor relative humidity was 71.1 %RH. The datalogging completed within First Floor Area 102 ranged from 45.8 to 65.4 %RH and averaged 57.2 °C. The datalogging completed within the Second Floor Hallway ranged from 43.7 to 55.8 %RH and averaged 47.4 %RH. ASHRAE recommends that long-term relative humidity be maintained below 65 %RH for occupant comfort. Relative humidity below 25 %RH may result in complaints of dry skin and eye and nose irritation. All relative humidity measurements collected during both the spot-check and datalogging sampling were within the recommended comfort range (25 – 65 %RH).

3.4.5 Airborne Dust (PM_{10})

The indoor spot measurements of airborne dust (PM_{10}, particles less than 10 micrometres in diameter) ranged from 0.001 to 0.016 milligrams per cubic metre (mg/m³) and averaged 0.005 mg/m³. The outdoor concentrations averaged 0.005 mg/m³. The datalogging completed within First Floor Area 102 ranged from less than the detection limit of the instrument of (<0.001 mg/m³) to 0.064 mg/m³ and averaged 0.007 mg/m³. The datalogging completed within the Second Floor Hallway ranged from <0.001 to 0.141 mg/m³ and averaged 0.009 mg/m³. For reference, US EPA research indicates that the PM_{10} concentrations measured in commercial buildings are generally less than 0.016 mg/m³. Pinchin considers this to be a target concentration; where most measurements fall within this range, complaints are not expected. ASHRAE provides a guideline of 0.050 mg/m³ but suggests that if the majority of concentrations are at this level, dust deposition may be undesirable. The PM_{10} concentrations in this building generally fell within the range typically measured in commercial buildings with exceptions during August 9th at 20:44,

and August 12th at 09:00 that exceeded the 0.050 mg/m^3. Both datalogging locations averaged below the target of 0.016 mg/m^3.

3.4.6 Airborne Dust ($PM_{2.5}$)

The indoor spot measurements of airborne dust ($PM_{2.5}$, particles less than 10 micrometres in diameter) ranged from below the detection limit of the instrument (<0.001 mg/m^3) to 0.002 mg/m^3 with an average concentration of 0.001 mg/m^3. The outdoor concentration was 0.002 mg/m^3. For reference, ASHRAE provides a guideline of 0.015 mg/m^3. The $PM_{2.5}$ concentrations in this building were below the ASHRAE guideline.

3.4.7 Total Volatile Organic Compounds (TVOC)

The indoor spot measurements of TVOC were all below the detection limit of the instrument (<1 parts per billion in air (ppb)) and were <1 ppb outdoors. The datalogging completed within First Floor Area 102 were all below the detection limit of the instrument (<1 ppb). The datalogging completed within the Second Floor Hallway ranged from <1 ppb to 800 ppb and averaged 34 ppb. Based on US EPA research, office environments with TVOC concentrations up to about 400 ppb would be at little risk of IAQ complaint. Complaints might be expected if concentrations were significantly above 400 ppb. TVOC concentrations were above the US EPA recommendation in the Second Floor Hallway from 19:08 - 23:43 on August 11th, 2022. All other TVOC concentration were below 400 ppb.

4.0 DISCUSSION

4.1 Indoor Air Quality

Spot measurements were collected in various locations in Emmerson Hall for carbon dioxide, carbon monoxide, temperature, relative humidity, PM_{10}, $PM_{2.5}$ and TVOCs. The temperatures were above the recommended comfort ranges for office environments of 24 to 27 °C for typical summer dress. Temperature levels are, however, very personal and these conditions might be acceptable to the occupants. All other parameters were within their respective guidelines and comfort ranges during the spot-check sampling.

Datalogging was completed within the First Floor Area 102 and the Second Floor Hallway in Emmerson Hall from August 9th to August 16th, 2022. Datalogging was completed for carbon dioxide, carbon monoxide, temperature, relative humidity, PM_{10} and TVOCs.

In the First Floor Area 102, the temperature averaged 26.1°C, within the comfort range of 24 to 27 °C, but exceeded the comfort range at times throughout the datalogging period. PM_{10} concentrations averaged 0.007 mg/m^3, below the target of 16 mg/m^3 and the guideline of 0.050 mg/m^3, although there were a few

exceedances of 0.050 mg/m^3 on August 14th, 2022, from 02:28 – 03:32. All other parameters were within their respective guidelines and comfort ranges.

During the datalogging in the Second Floor Hallway, the carbon monoxide exceeded the guideline of 5ppm at the beginning of the datalogging period, but was below the guideline within 6 hours and stayed below the guideline for the remainder of the datalogging period. PM_{10} concentrations averaged 0.009 mg/m^3, below the target of 16 mg/m^3 and the guidelines of 0.050 mg/m^3, although there were a few exceedances of the guideline briefly on August 12th and August 14th. TVOC concentrations were above the US EPA recommendation in the Second Floor Hallway from 19:08 - 23:43 on August 11th, 2022. All other TVOC concentration were below 400 ppb.

The occupant load at the time of the investigation and pick up of equipment was low. Pinchin was not onsite during the datalogging and cannot speak on the occupant load throughout the week.

4.2 Discussion of Water Damage and Mould Growth

Water damage and mould growth was observed within the meeting room off Room 108 on the first floor of Emmerson Hall. Elevated moisture readings were measured on both the east and south walls. The walls are concrete foundation. The paint was observed to be delaminating suggesting water intrusion. Mould growth was observed on the pipe insulation under the heater on the east wall. Efflorescence was observed on the south wall in the southeast corner.

Five airborne mould samples were collected within the building including in Room 108, the Main Area Room 102, First Floor Hallway, Second Floor Area and within the Third Floor Office Hallway. In addition, one outdoor reference sample was collected.

Generally, the composition and concentration of mould spores recovered from indoor samples should be similar to the composition and concentration of the mould spores recovered from the outdoor reference sample. However, many elements inside a building can affect the concentration and composition of indoor airborne mould samples. These elements include occupant activities, furnishings and the amount of air exchange.

The concentration of the outdoor reference sample was 18,000 spores/m^3. Indoor concentrations ranged from 3,100 spores/m^3 to 14,000 spores/m^3. The concentration of each of the indoor samples collected were less than the concentration of the outdoor sample. The composition of the indoor samples differed from the composition of the outdoor sample. However, the concentrations measured don't present a concern. The sample results suggest that airborne mould levels were acceptable at the time of the sampling.

The water damage, mould growth and wet materials identified in this investigation (Room 108 – B) was likely caused by the drain observed on the other side of the exterior south wall.

4.3 Mould Remediation and Site Reviews

Mould growth in buildings can be a risk factor for adverse health effects.[14] The mould growth found in this investigation should be remediated as soon as possible following currently accepted procedures. Pinchin recommends that mould remediation follow the procedures set by the Canadian Construction Association (CCA).[15] The work should be performed by a contractor with appropriate training, experience and insurance coverage. Ensure that remaining building materials are dry prior to reinstating mould-susceptible finishes, to prevent future mould growth.

Pinchin would be pleased to provide project management services to develop a remediation work plan and retain a specialized environmental abatement contractor. Pinchin could conduct a competitive bidding process to achieve the lowest possible price for the work. Proceeding in this manner will relieve the Client from taking on regulatory responsibility for contractor health and safety, and will reduce the risk of poor contractor performance and possible cross-contamination. Pinchin recommends that the Client retain services for project management, as well as for inspection and testing of this project. Health Canada and other authorities recommend independent inspection of medium and large scale mould remediation, to protect the occupants and building from cross-contamination.

4.4 Communication and Interim Risk Management

The findings of this report should be communicated to the occupants as recommended by current mould guidelines, and in workplaces, as mandated by occupational health and safety legislation. The Client should consider any interim risk management actions that would be appropriate under the circumstances, until the mould growth can be remediated. Interim risk management might include isolating an area of the building or relocating persons experiencing adverse health effects or with greater sensitivity to mould.

5.0 RECOMMENDATIONS

Pinchin offers the following recommendations to improve air quality in this building and address any mould growth or other microbial contamination found. Pinchin would be pleased to assist with further investigations indicated by this investigation, make recommendations for remediation contractors, and provide services for the planning and review of the recommended remediation work.

14 US Environmental Protection Agency: Mold Remediation in Schools and Commercial Buildings. US EPA. 2001.
15 Canadian Construction Association: Mould Guidelines for the Canadian Construction Industry, Ottawa, ON: CCA, 2004 (Revised 2018)

1. Communicate the findings of this report to the occupants and staff.
2. Consider any necessary steps for interim risk management.
3. All source(s) of water infiltration should be identified and repaired to prevent further water damage and potential future mould growth. Consideration should be given into having a building envelope assessment conducted to ensure the cause of the water infiltration along the east and south walls is properly identified and repaired.
4. Remove and replace the mould-impacted pipe insulation following CCA Level 1 mould remediation methods.
5. Implement drying procedures as necessary. Ensure all surfaces are dry before installation of new finishes.

6.0 TERMS AND LIMITATIONS

This work was performed subject to the Terms and Limitations presented or referenced in the proposal for this project.

Information provided by Pinchin is intended for Client use only. Pinchin will not provide results or information to any party unless disclosure by Pinchin is required by law. Any use by a third party of reports or documents authored by Pinchin or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted. No other warranties are implied or expressed.

APPENDIX I

Results of Mould Tests

PINCHIN
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Certificate of Analysis

Pinchin Environmental Microbiology Laboratory

Laboratoire d'analyse accrédité par le gouvernement du Québec
Lab ID# 495

CUSTOMER: Lauren Hughes
COMPANY: Pinchin Ltd.
ADDRESS: 42 Dorey Avenue
Dartmouth, NS B3B 0B1

PROJECT NAME: Emmerson Hall
TYPE OF SAMPLES: AllergencoD
NO. OF SAMPLES: 6
DATE COLLECTED: August 9, 2022
DATE RECEIVED: August 11, 2022
DATE ANALYSED: August 18, 2022
DATE REPORTED: August 18, 2022

PROJECT NO: 312422
LAB REFERENCE NO: m276625
ANALYST: Lubov Beliakov, CMS (PhD)
Environmental Microbiologist
REVIEWER: Rafic Dulymamode, PhD
Laboratory Manager

CONDITION OF SAMPLES ON RECEIPT: Acceptable

Method of Analysis: Analysis of Air Samples for Fungal Spores (SOP: DME-SPT, Rev. 13, December 18, 2019)

This SOP is based on the method described in the AIHA's "Field Guide for the Determination of Biological Contaminants in the Environmental Samples" and also partially on the ASTM method D7391-09. The cassette slide with the trace (area impacted with air) facing upwards is fixed on a clean microscope slide. It is stained with lactophenol cotton blue or lactofuschin, and then scanned under low power magnification to locate the trace and to give the analyst an idea of the diversity of the spores. The final analysis is performed at X600 magnification by counting the different spores along a number of traverses or fields of view to cover at least 25% of the sample. A lower percentage of the sample is counted if it is overloaded. Raw counts are converted to spores/m^3 of air. Counts of fungal fragments and pollens are not computed in the total. Spores lacking unique characteristics for identification are reported as "Unidentified spores". Spores showing features of specific groups are recorded under the respective groups such as "Unidentified Basidiospores or Unidentified Ascospores". Spores occurring in chains are counted individually. Spores of *Aspergillus* and *Penicillium* (and others such as *Acremonium*, *Paecilomyces*) are indistinguishable.

A scale of 0 to 5 is used to rate abundance of non-fungal material, with 5 indicating the largest amount. Large amounts of non-fungal material may obscure small spores. Therefore, counts from samples with 4-5 non-fungal material may be treated as undercounts. Except for blanks, samples with no detected spores are recorded as "less than the analytical sensitivity " (AS). Results are not corrected for blanks. Estimation of the measurement of uncertainty is available upon request.

Comments/Observations (if any):

Notes:
1. The laboratory is not responsible for sample collection.
2. The report applies to the samples submitted to the laboratory and, the result(s) relate only to sample(s) tested.
3. The report shall not be reproduced except in full, without written approval of the laboratory.
4. Services are subject to Pinchin Ltd. Standard Terms and Conditions for Laboratory Services.

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Certificate of Analysis

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PROJECT NO: 312422

DATE ANALYSED: August 18, 2022 **ANALYST:** Lubov Beliakov, CMS (PhD) **LAB REFERENCE NO:** m276625

Customer Sample No:	4579894			4579891			4579961			4579985			4580076			4579930					
Lab Sample ID:	m276625-1			m276625-2			m276625-3			m276625-4			m276625-5			m276625-6					
Description	Outdoor			First Floor Hallway			First Floor Area 102			Room 108			Second Floor Area			Third Floor Office Hallway					
Total Air Volume (L)	150			150			150			150			150			150					
% of Sample Counted	20.8			25.4			25.4			25.4			25.4			25.4					
Fungal spores identified	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3	raw ct.	%	ct./m^3
Alternaria/Ulocladium-like													1	0	26						
Ascospores, non-specified	183	33	5900	215	40	5600	48	31	1300	36	30	940	123	34	3200	85	30	2200			
Aspergillus/Penicillium-like	1	0	32	16	3	420	4	3	110	7	6	180	10	3	260						
Basidiospores, non-specified	307	55	9800	251	47	6600	86	56	2300	64	54	1700	194	53	5100	170	60	4500			
Bipolaris/Drechslera/ Exserohilum/Helminthosporium																					
Botrytis																					
Chaetomium-like																					
Cladosporium	29	5	930	42	8	1100	10	6	260	10	8	260	21	6	550	19	7	500			
Coprinus	29	5	930										2	1	52	2	1	52			
Epicoccum													3	1	79	1	0	26			
Fusarium-like																					
Ganoderma	6	1	190	5	1	130	4	3	110				5	1	130	6	2	160			
Myxomycetes/Periconia/Rusts/Smuts	2	0	64	2	0	52				2	2	52	3	1	79	2	1	52			
Non-specified spores	1	0	32	1	0	26	2	1	52				2	1	52						
Oidium-like																					
Pithomyces-like				1	0	26															
Polythrincium																					
Stachybotrys																					
Pollens																					
Fungal fragments				2		52	1		26	2		52	9		240	1		26			
Non-fungal material	1			1			2			2			3			2					
Spores/sample	558			533			154			119			364			285					
TOTAL SPORES/M^3			18000			14000			4100			3100			9500			7500			
A.S. (SPORES/M^3)			32			26			26			26			26			26			

Note: 1. Samples analysed at 600X magnification. 2. A.S. = Analytical Sensitivity
3. Total spores/m^3 and counts/m^3 reported to two significant figures where applicable

m2766625

PINCHIN

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Mississauga, ON L5N 6C3
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1.855.PINCHIN www.pinchin.com

Environmental Microbiology Laboratory
Chain of Custody Form

REPORT RESULTS TO				
Contact: Lauren Hughes			Dept: IEQ	
Company: Pinchin			Tel: 9022376628	Fax:
Mailing Address: 42 Dorey Ave			Email: LPHughes@pinchin.com	
City: Dartmouth	Prov: NS	Postal Code: B3B 0B1	Customer Job / P.O. #: 312422	
Special Instructions: [redacted]			Project: Emmerson Hall	
Report Language: English ☐ French ☐		No. Samples Submitted: 6	Invoice To: AP@pinchin.com	

ANALYSIS TYPE	TAT	ANALYSIS TYPE	TAT
Choose one analysis type only. Each analysis requires one COC. (Note 5-Days are Business Days)			
DME Spore Count & Identification	☐ 3hr ☐ 24hr ☒ 5 Days	DME Mould Bulk/Tape	☐ 3hr ☐ 24hr ☐ 5 Days
DME Particulate Air Quantitative	☐ 3hr ☐ 24hr ☐ 5 Days	DME Particulate Bulk/Tape/Air Qualitative	☐ 3hr ☐ 24hr ☐ 5 Days
Fungal Quantification & Identification (Anderson/RCS/ Settle Plate)	☐ 10 - 12 Days	Bacteria (Quantification/Gram Staining)	☐ 2 Days
Heterotrophic Plate Counts (HPC)	☐ 24hr	E.coli/Total Coliforms	☐ 24hr
Legionella: Culturing	☐ 10 - 12 Days	Legionella: qPCR	☐ 24hr
Other (please specify):			

Sample#	Description	Date Sampled	Vol (L) or Area (cm^2)	FOR LAB USE ONLY LAB #
4579894	Outdoor [redacted]	August 9, 2022	150L	m2766625-1
4579891	First Floor Hallway	August 9, 2022	150L	-2
4579961	First Floor Area 102	August 9, 2022	150L	-3
4579985	Room 108	August 9, 2022	150L	-4
4580076	Second Floor Area	August 9, 2022	150L	-5
4579930	Third Floor Office Hallway	August 9, 2022	150L	-6

CHAIN OF CUSTODY			FOR LAB USE ONLY:		3:11
Collected by: Lauren Hughes			Received by: AD	Date/Time: 8/11/22	
Relinquished by: LH	Date/Time: August 10, 2022		Sample Condition Upon Receipt:	Acceptable ☑	Other (explain) ☐
Method of Shipment: Courier					

D8/15/22

Authorized by: _____ **Date:** _____
Customer Signature MUST Accompany Request. Customer accepts Pinchin Ltd. Standard Terms and Conditions for Laboratory Services (see over)

Distribution: White = Laboratory, Yellow = Customer Copy

APPENDIX II

Results of Direct-Reading Indoor Air Quality Measurements

Client Name: Sonco Campus Canada
Site Address: Emmerson Hall 31 University Avenue, Wolfville
Pinchin File: 312422
Date 2022-08-09

Location No: 0 **Location Name: Outdoor**

Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 11:59 AM	Design	<1	355	0.007	0.003	70.6	24.3	<1
08/09 12:18 PM	Design	<1	351	0.002	0.001	71.6	23.9	<1

Location No: 1 **Location Name: Main Area** **Floor: 1**

Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 01:51 PM	Low	1	358	0.001	<0.001	59.9	27.2	<1

Location No: 2 **Location Name: Room 108** **Floor: 1**

Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 01:53 PM	Low	1	415	0.001	<0.001	61.7	26.8	<1

Location No: 3 **Location Name: 108B** **Floor: 1**

Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 01:55 PM	Low	<1	512	0.003	0.002	64.2	26.7	<1

Location No: 4 **Location Name: 1st Floor Hallway** **Floor: 1**

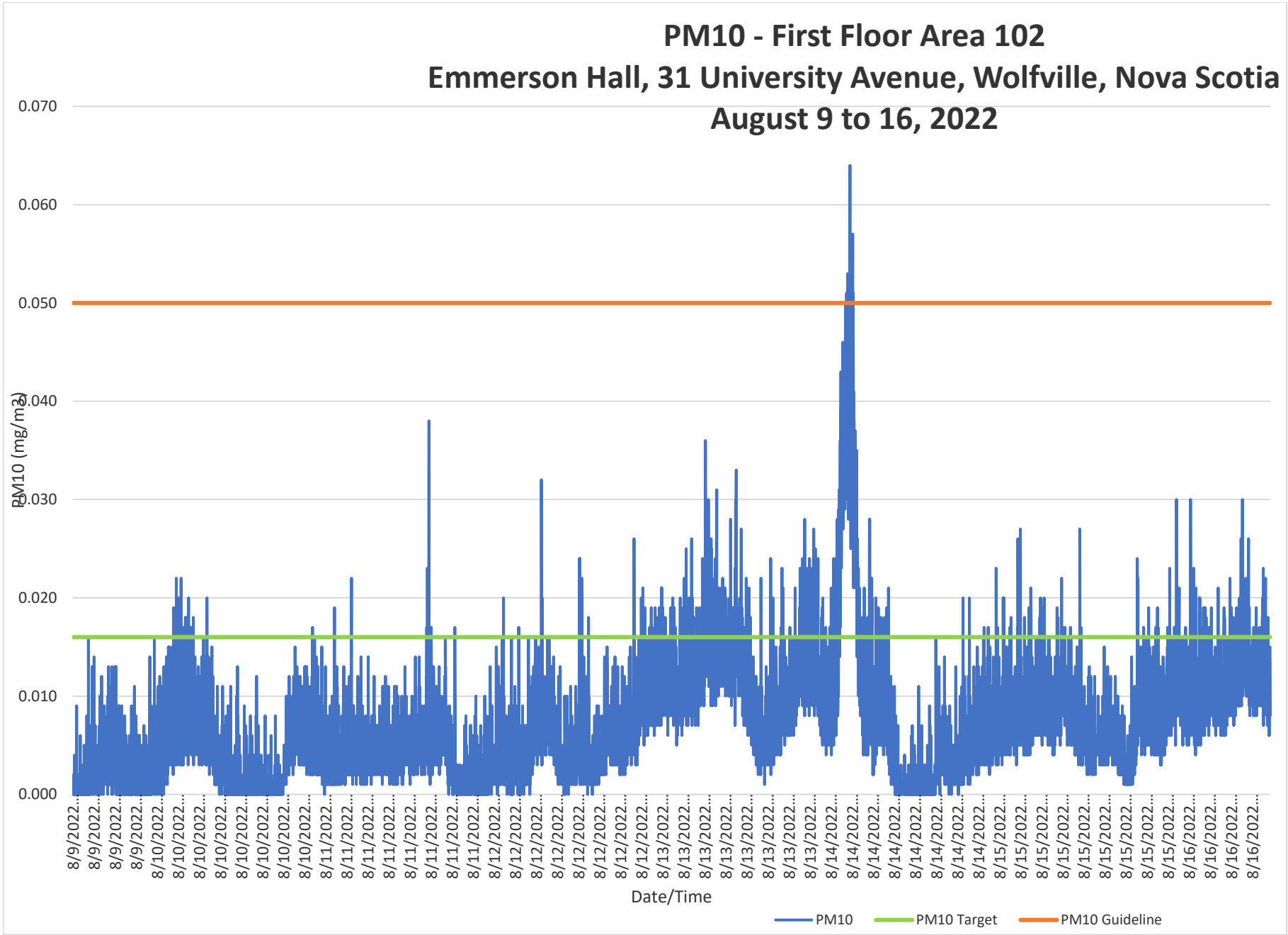
Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 01:56 PM	Design	1	419	0.002	<0.001	62.3	26	<1

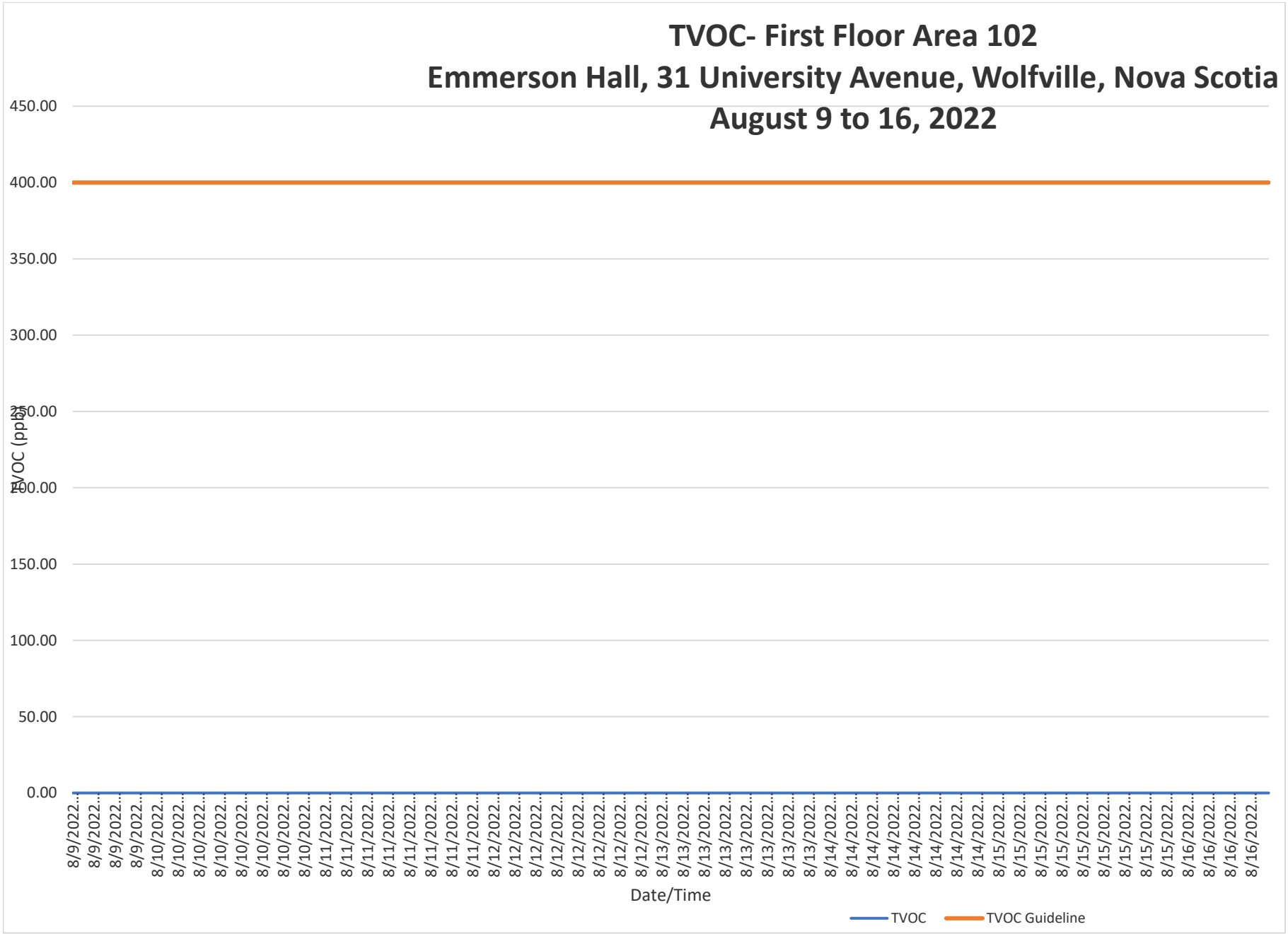
Location No: 5	Location Name: 2nd Floor Hallway			Floor: 2				
Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 01:58 PM	Design	<1	453	0.016	0.002	62.5	26.5	<1
08/09 01:59 PM	Low	1	447	0.003	0.001	60.7	26.9	<1

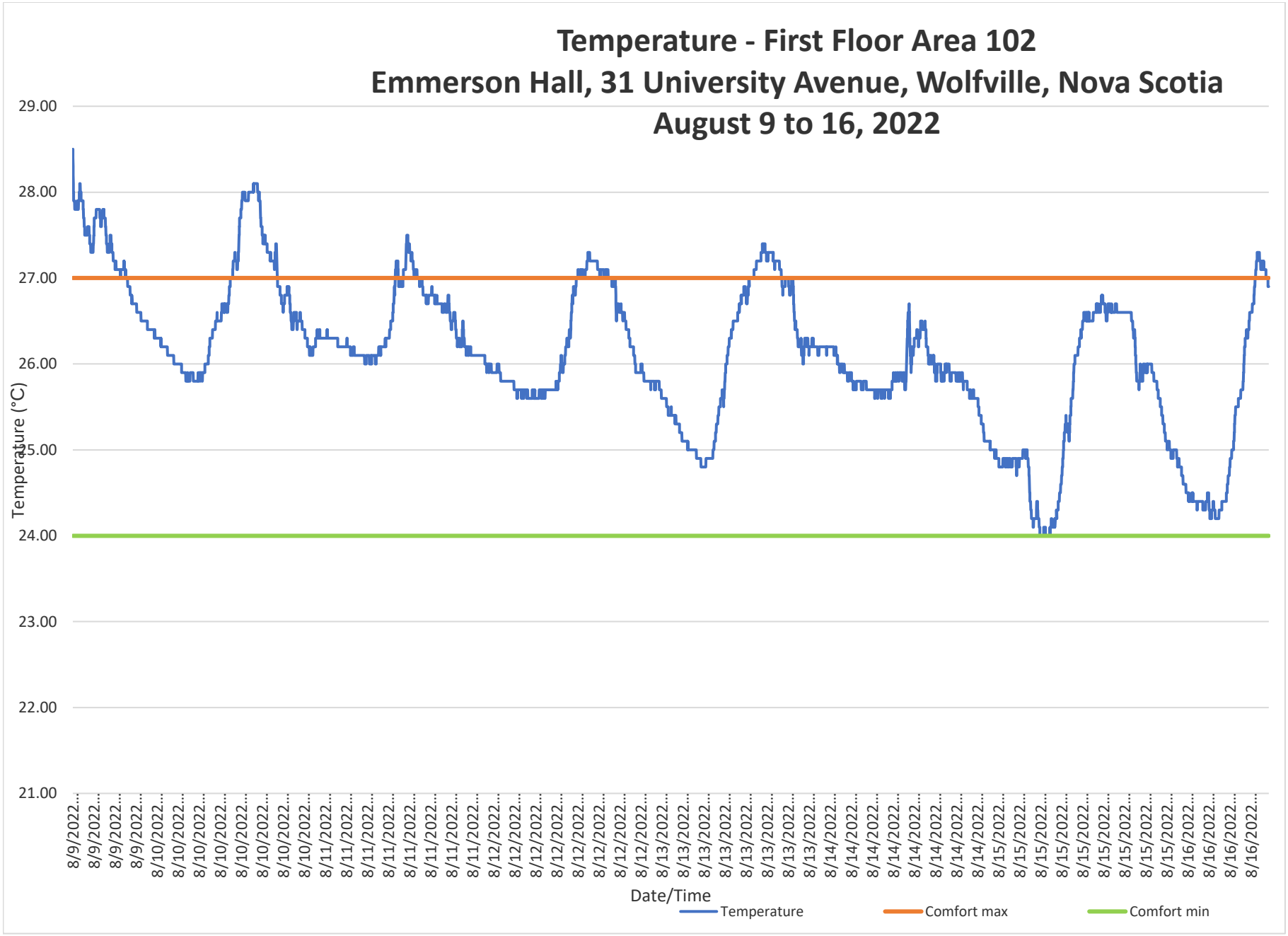
Location No: 6	Location Name: 3rd Floor Hallway			Floor: 3				
Time	Occupant Density	CO (ppm)	CO2 (ppm)	PM10 (mg/m3)	PM2.5 (mg/m3)	RH (%)	Temp (C)	TVOC (ppb)
08/09 02:02 PM	Design	1	530	0.004	0.001	58	28.3	<1
08/09 02:03 PM	Design	1	503	0.006	0.002	55.3	28.7	<1

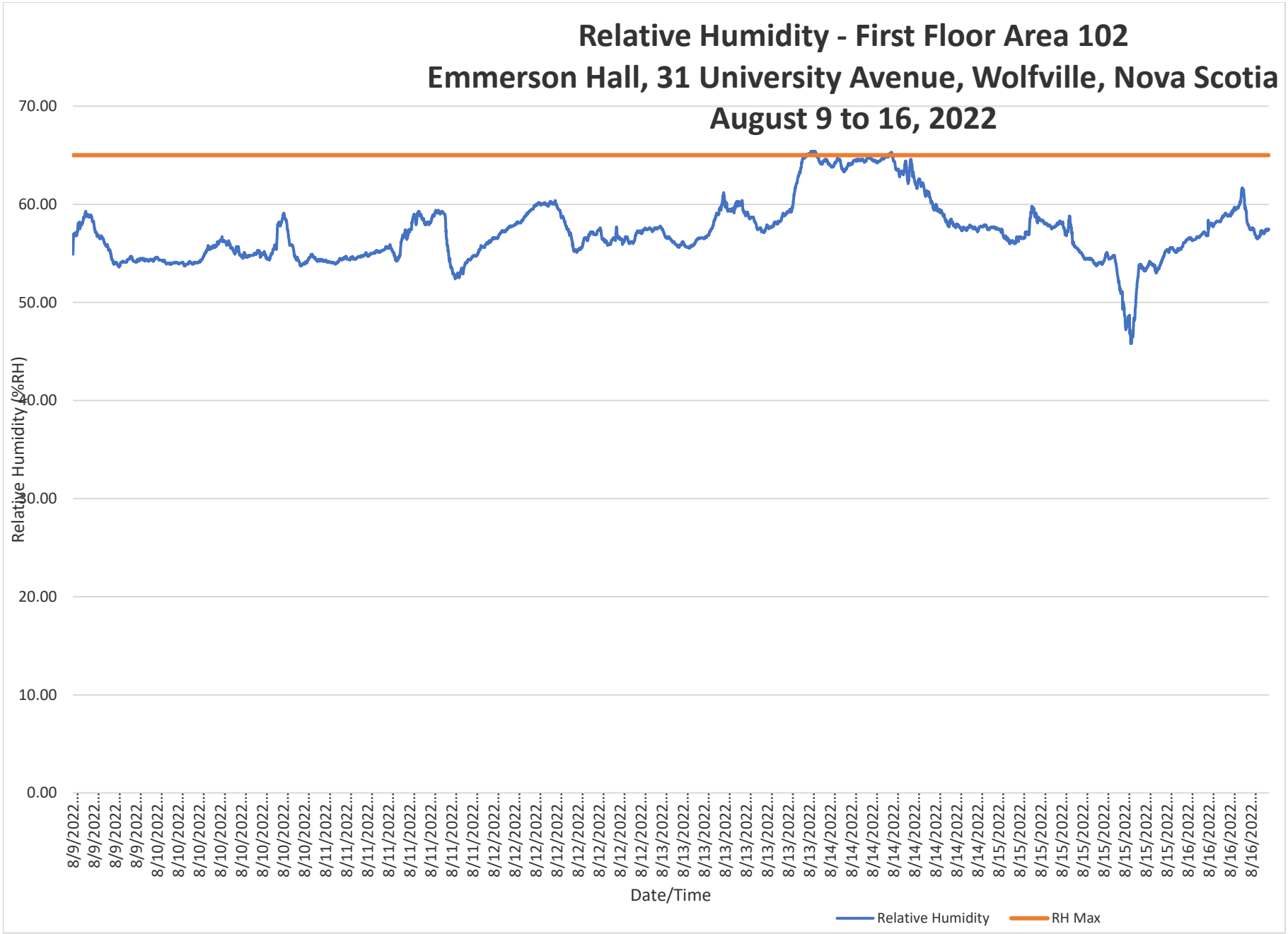
APPENDIX III

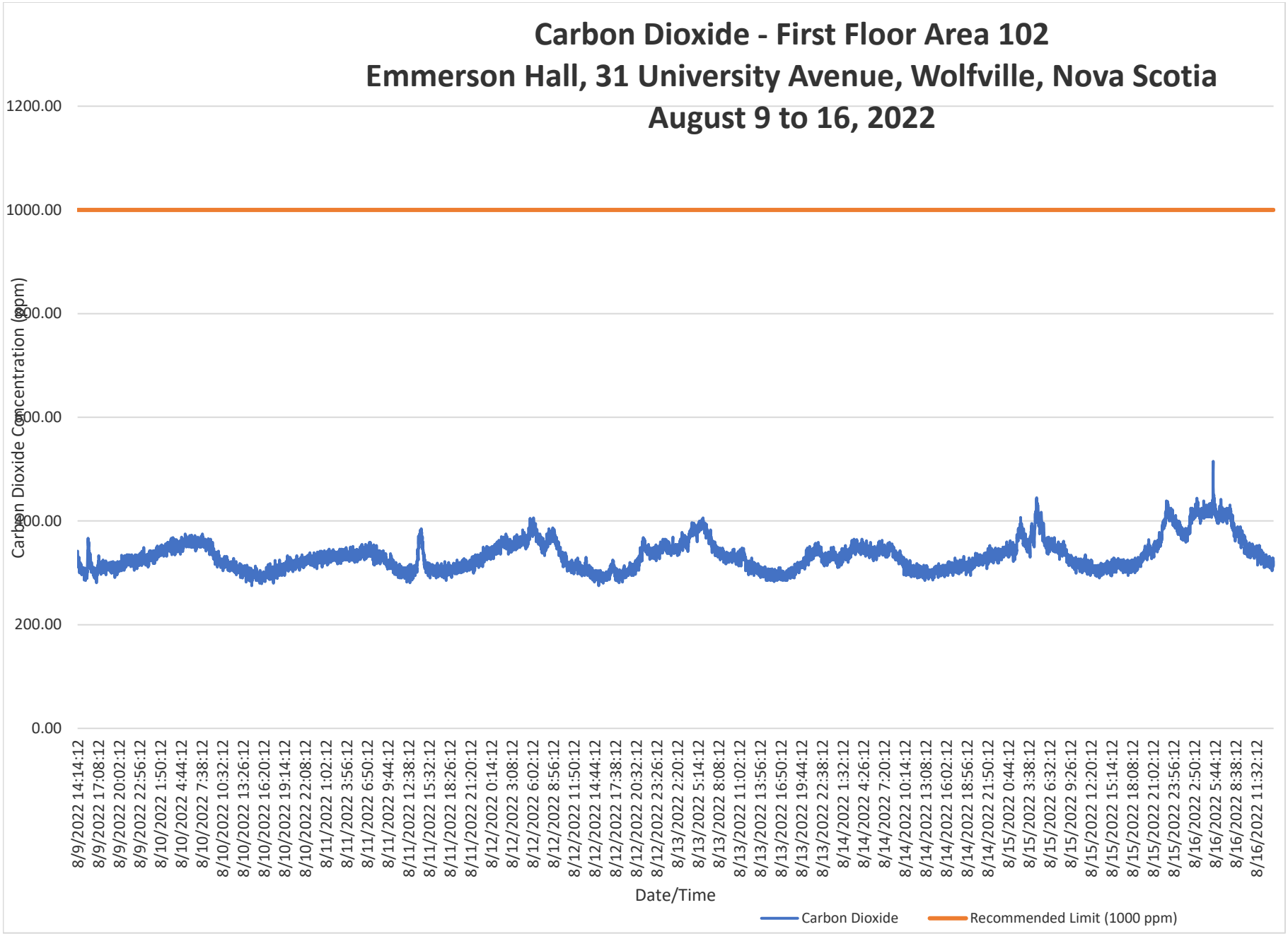
Results of Datalogging Indoor Air Quality Measurements

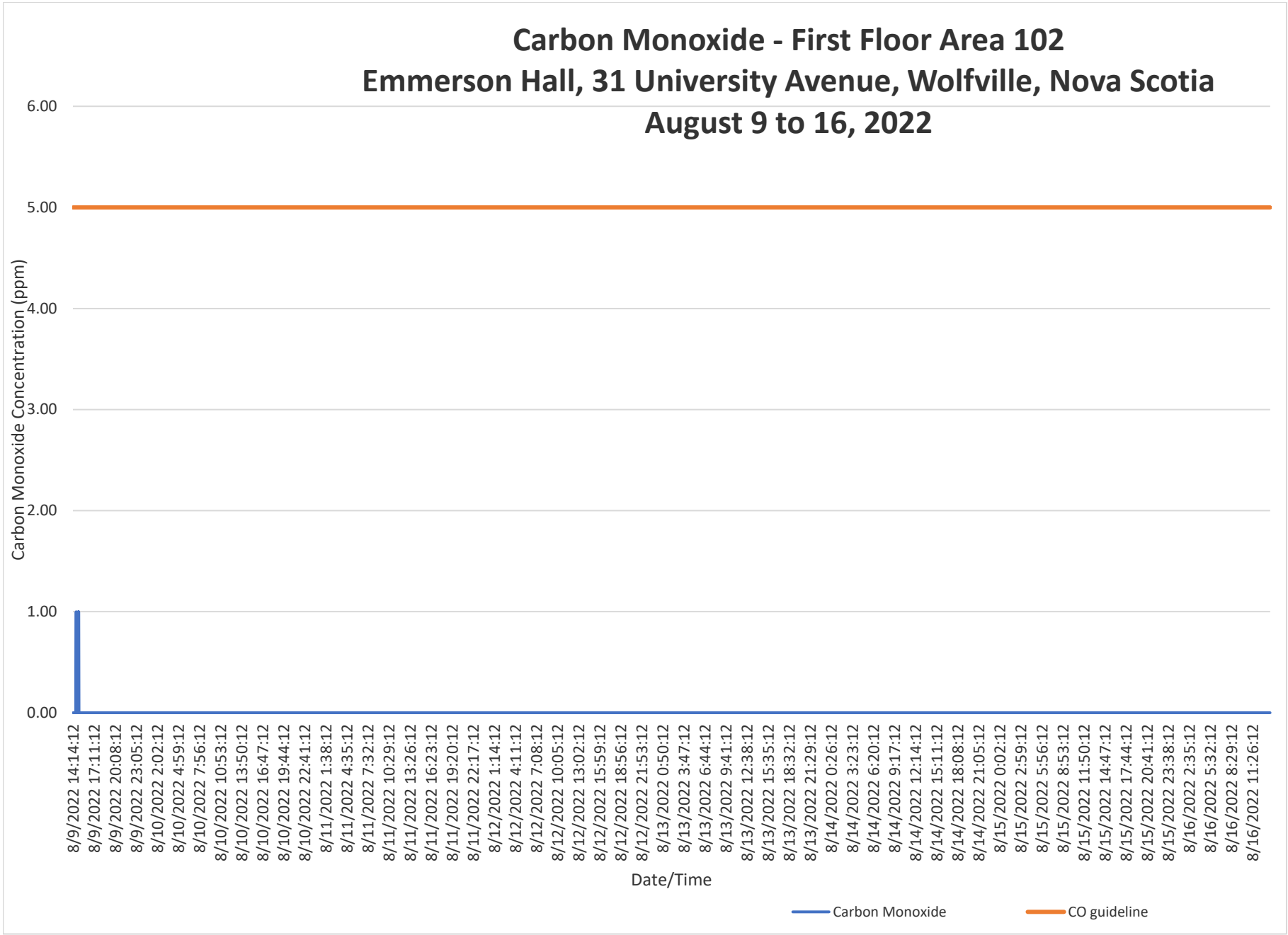

PM10 - First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
PM10 (mg/m3)
8/9/2022...
8/10/2022...
8/11/2022...
8/12/2022...
8/13/2022...
8/14/2022...
8/15/2022...
8/16/2022...
Date/Time
PM10
PM10 Target
PM10 Guideline

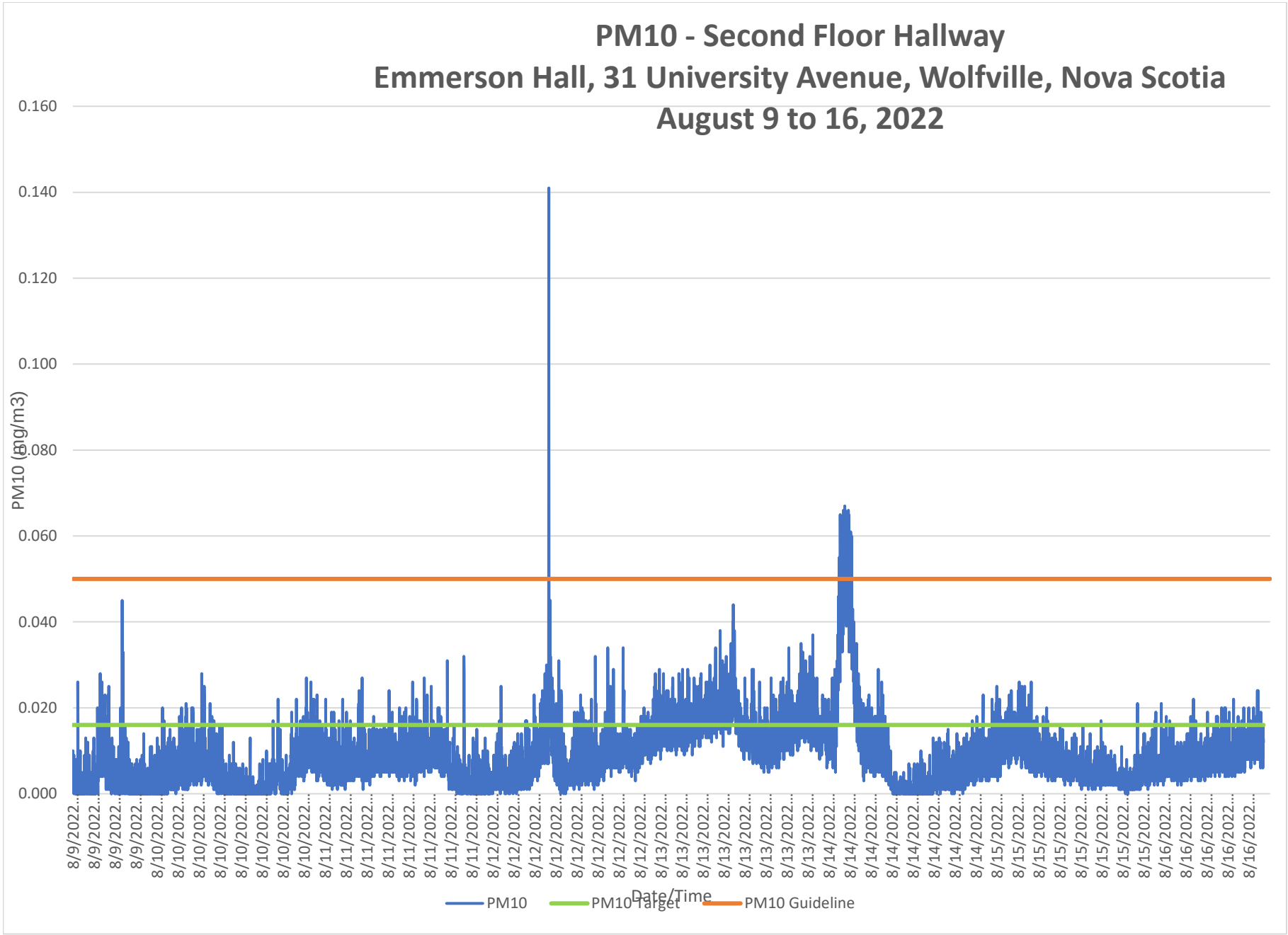

TVOC- First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
TVOC (ppb)
Date/Time
TVOC
TVOC Guideline

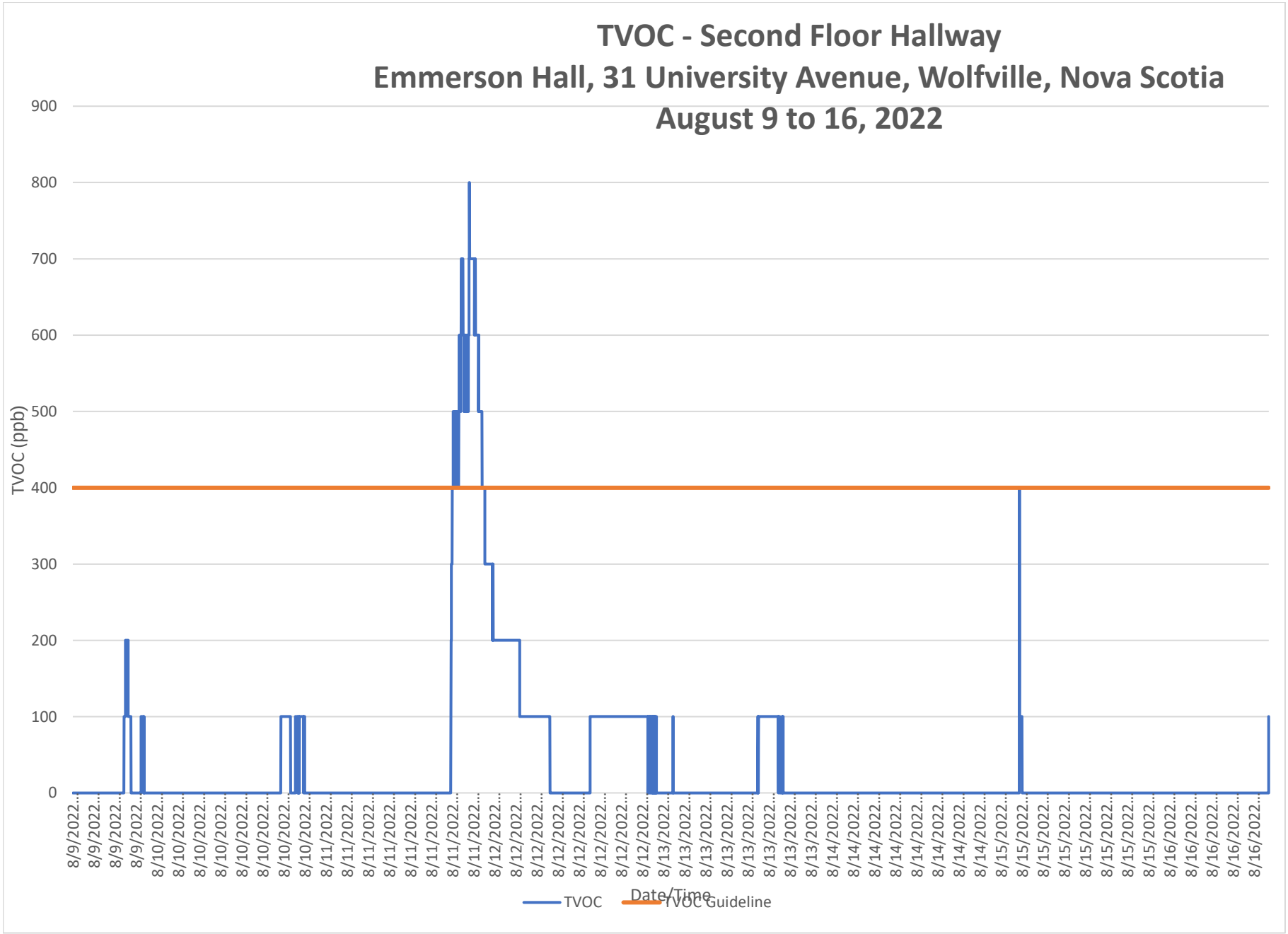

Temperature - First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
29.00
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
Temperature (°C)
Date/Time
Temperature
Comfort max
Comfort min

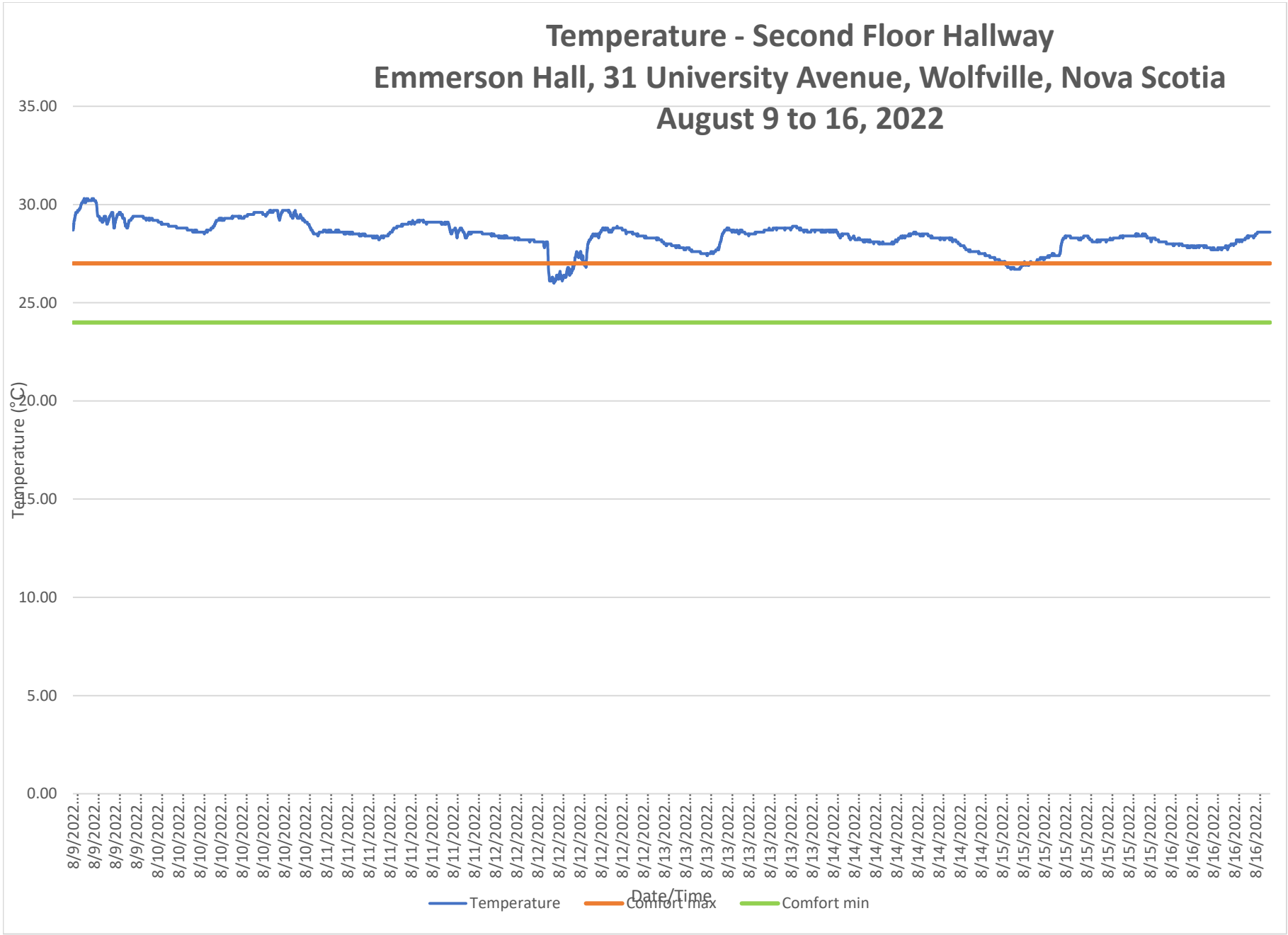

Relative Humidity - First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Relative Humidity (%RH)
Date/Time
Relative Humidity
RH Max

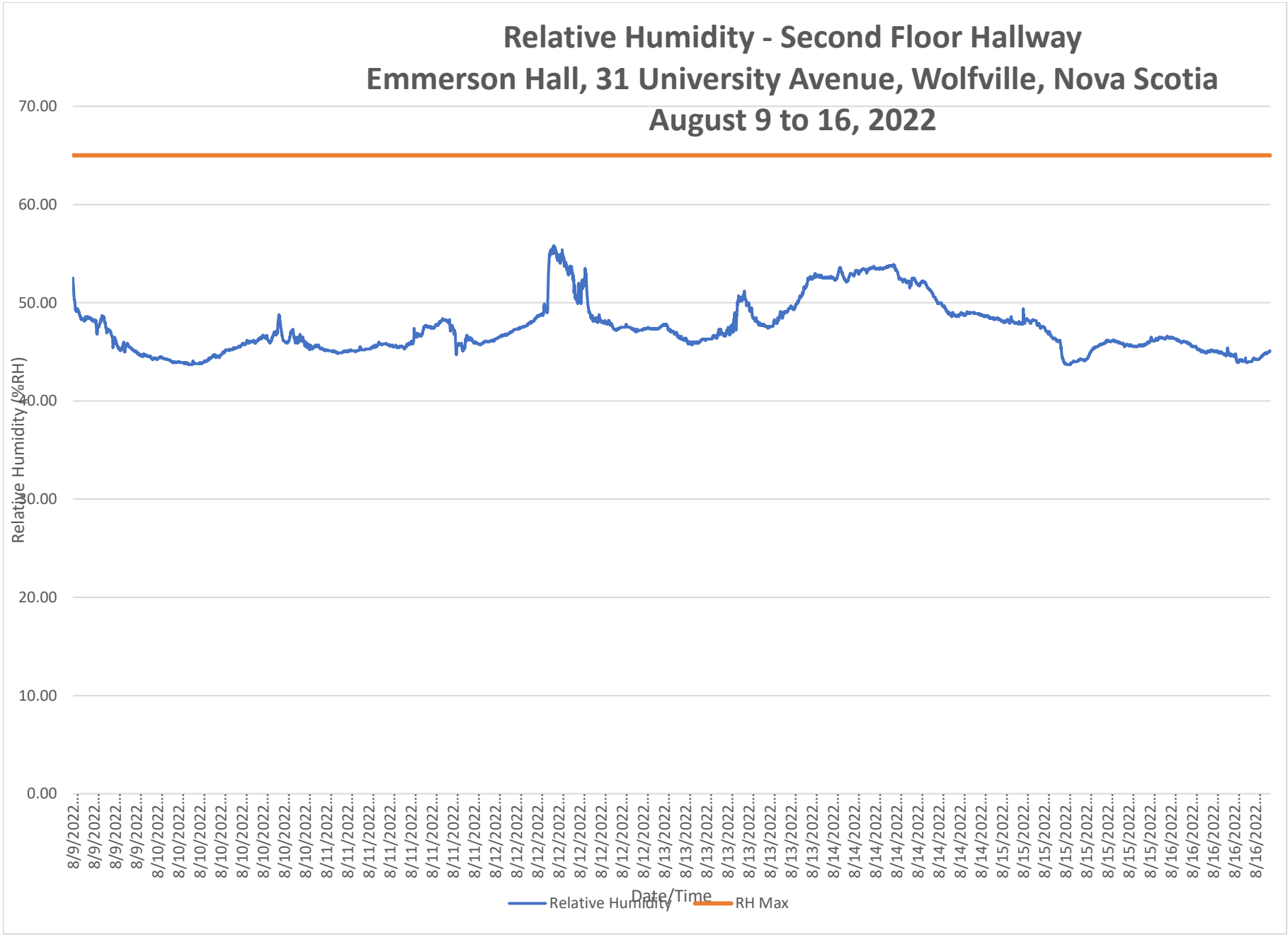

Carbon Dioxide - First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Carbon Dioxide Concentration (ppm)
8/9/2022 14:14:12
8/9/2022 17:08:12
8/9/2022 20:02:12
8/9/2022 22:56:12
8/10/2022 1:50:12
8/10/2022 4:44:12
8/10/2022 7:38:12
8/10/2022 10:32:12
8/10/2022 13:26:12
8/10/2022 16:20:12
8/10/2022 19:14:12
8/10/2022 22:08:12
8/11/2022 1:02:12
8/11/2022 3:56:12
8/11/2022 6:50:12
8/11/2022 9:44:12
8/11/2022 12:38:12
8/11/2022 15:32:12
8/11/2022 18:26:12
8/11/2022 21:20:12
8/12/2022 0:14:12
8/12/2022 3:08:12
8/12/2022 6:02:12
8/12/2022 8:56:12
8/12/2022 11:50:12
8/12/2022 14:44:12
8/12/2022 17:38:12
8/12/2022 20:32:12
8/12/2022 23:26:12
8/13/2022 2:20:12
8/13/2022 5:14:12
8/13/2022 8:08:12
8/13/2022 11:02:12
8/13/2022 13:56:12
8/13/2022 16:50:12
8/13/2022 19:44:12
8/13/2022 22:38:12
8/14/2022 1:32:12
8/14/2022 4:26:12
8/14/2022 7:20:12
8/14/2022 10:14:12
8/14/2022 13:08:12
8/14/2022 16:02:12
8/14/2022 18:56:12
8/14/2022 21:50:12
8/15/2022 0:44:12
8/15/2022 3:38:12
8/15/2022 6:32:12
8/15/2022 9:26:12
8/15/2022 12:20:12
8/15/2022 15:14:12
8/15/2022 18:08:12
8/15/2022 21:02:12
8/15/2022 23:56:12
8/16/2022 2:50:12
8/16/2022 5:44:12
8/16/2022 8:38:12
8/16/2022 11:32:12
Date/Time
Carbon Dioxide
Recommended Limit (1000 ppm)

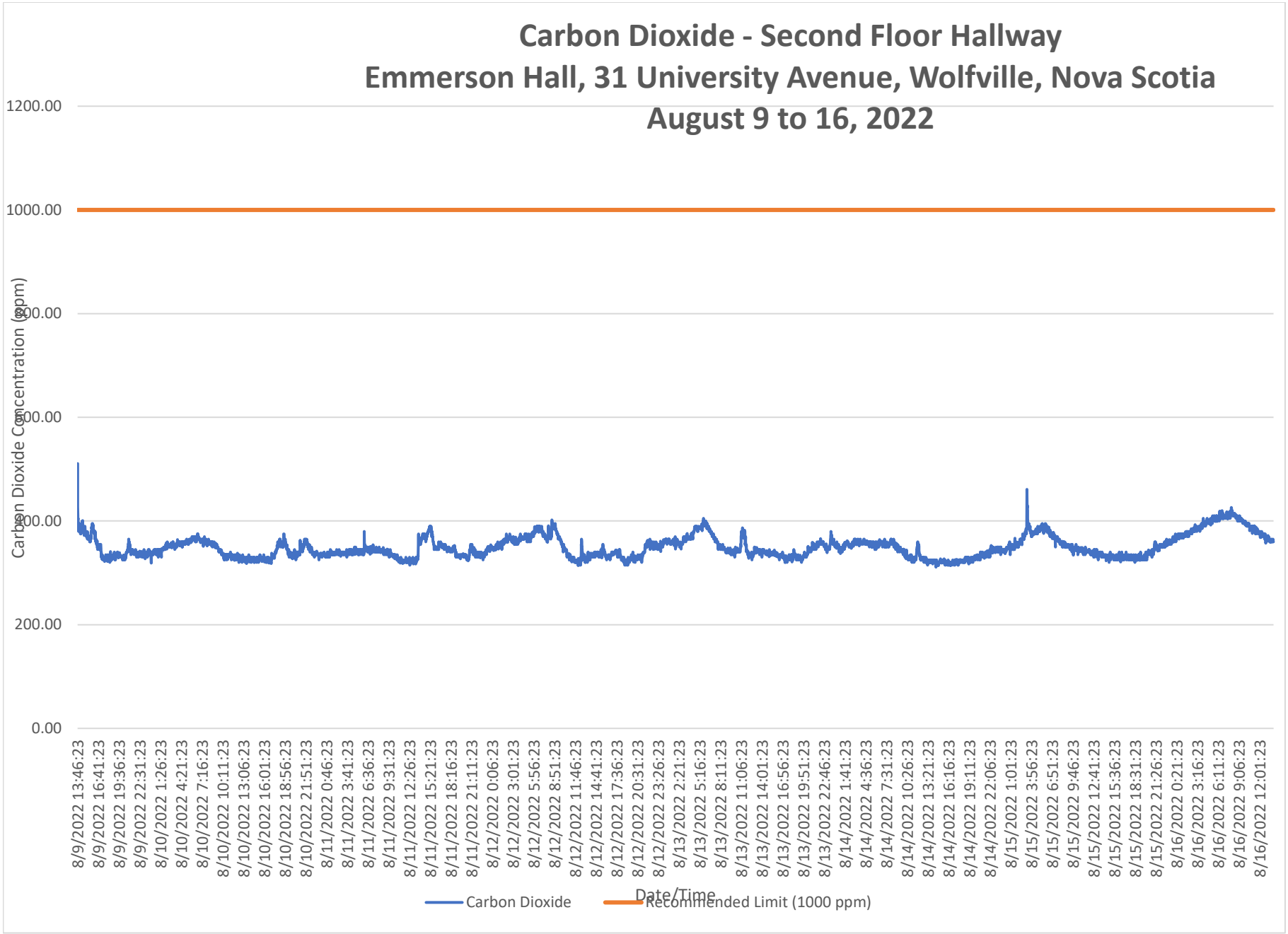

Carbon Monoxide - First Floor Area 102
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
Carbon Monoxide Concentration (ppm)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8/9/2022 14:14:12
8/9/2022 17:11:12
8/9/2022 20:08:12
8/9/2022 23:05:12
8/10/2022 2:02:12
8/10/2022 4:59:12
8/10/2022 7:56:12
8/10/2022 10:53:12
8/10/2022 13:50:12
8/10/2022 16:47:12
8/10/2022 19:44:12
8/10/2022 22:41:12
8/11/2022 1:38:12
8/11/2022 4:35:12
8/11/2022 7:32:12
8/11/2022 10:29:12
8/11/2022 13:26:12
8/11/2022 16:23:12
8/11/2022 19:20:12
8/11/2022 22:17:12
8/12/2022 1:14:12
8/12/2022 4:11:12
8/12/2022 7:08:12
8/12/2022 10:05:12
8/12/2022 13:02:12
8/12/2022 15:59:12
8/12/2022 18:56:12
8/12/2022 21:53:12
8/13/2022 0:50:12
8/13/2022 3:47:12
8/13/2022 6:44:12
8/13/2022 9:41:12
8/13/2022 12:38:12
8/13/2022 15:35:12
8/13/2022 18:32:12
8/13/2022 21:29:12
8/14/2022 0:26:12
8/14/2022 3:23:12
8/14/2022 6:20:12
8/14/2022 9:17:12
8/14/2022 12:14:12
8/14/2022 15:11:12
8/14/2022 18:08:12
8/14/2022 21:05:12
8/15/2022 0:02:12
8/15/2022 2:59:12
8/15/2022 5:56:12
8/15/2022 8:53:12
8/15/2022 11:50:12
8/15/2022 14:47:12
8/15/2022 17:44:12
8/15/2022 20:41:12
8/15/2022 23:38:12
8/16/2022 2:35:12
8/16/2022 5:32:12
8/16/2022 8:29:12
8/16/2022 11:26:12
Date/Time
Carbon Monoxide
CO guideline

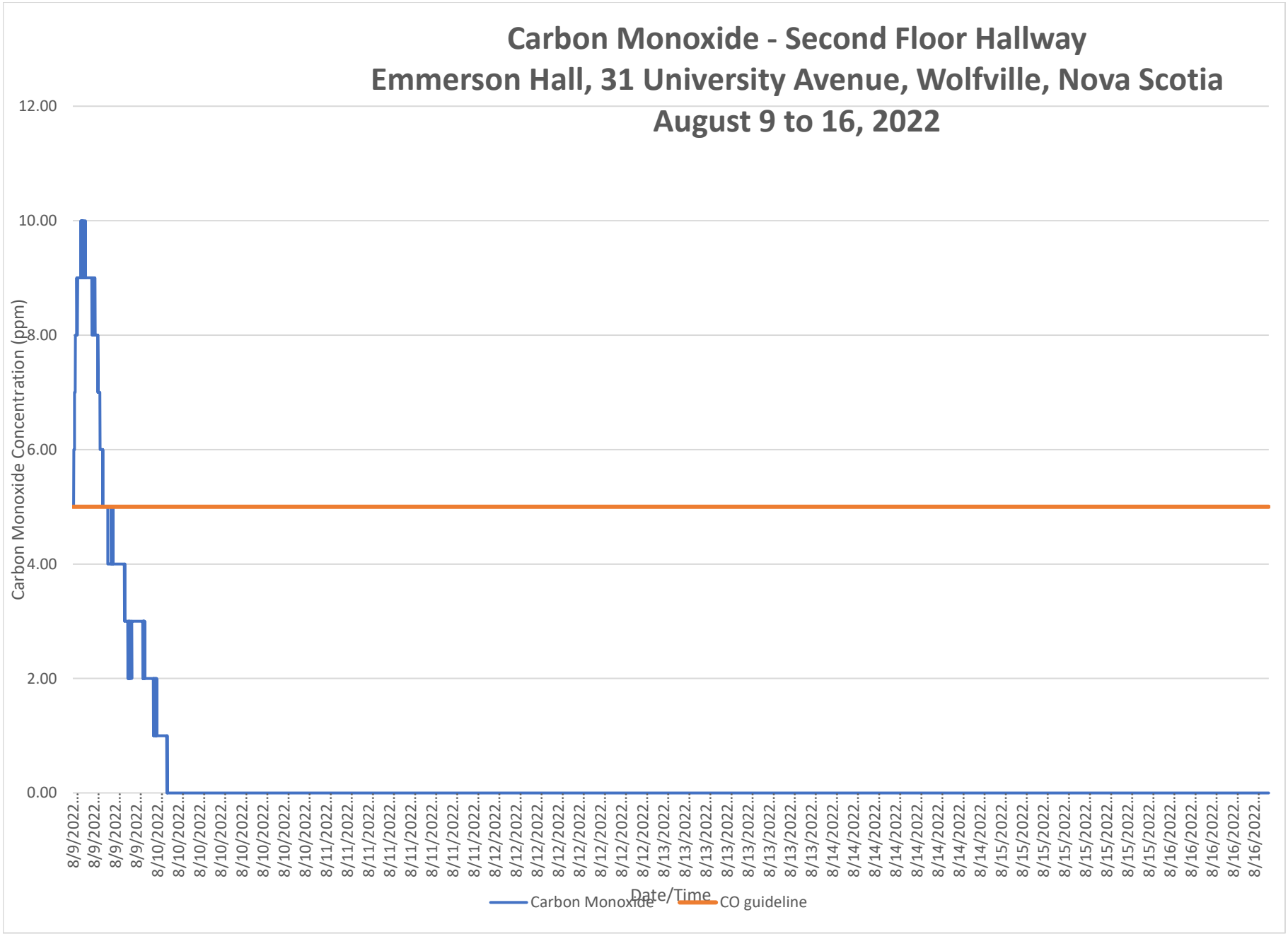

PM10 - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
PM10 (mg/m3)
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
8/9/2022...
8/10/2022...
8/11/2022...
8/12/2022...
8/13/2022...
8/14/2022...
8/15/2022...
8/16/2022...
Date/Time
PM10
PM10 Target
PM10 Guideline


TVOC - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
TVOC (ppb)
900
800
700
600
500
400
300
200
100
0
8/9/2022...
8/10/2022...
8/11/2022...
8/12/2022...
8/13/2022...
8/14/2022...
8/15/2022...
8/16/2022...
Date/Time
TVOC
TVOC Guideline


Temperature - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Temperature (°C)
8/9/2022...
8/10/2022...
8/11/2022...
8/12/2022...
8/13/2022...
8/14/2022...
8/15/2022...
8/16/2022...
Date/Time
Temperature
Comfort max
Comfort min


Relative Humidity - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Relative Humidity (%RH)
8/9/2022...
8/10/2022...
8/11/2022...
8/12/2022...
8/13/2022...
8/14/2022...
8/15/2022...
8/16/2022...
Date/Time
Relative Humidity
RH Max


Carbon Dioxide - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Carbon Dioxide Concentration (ppm)
8/9/2022 13:46:23
8/9/2022 16:41:23
8/9/2022 19:36:23
8/9/2022 22:31:23
8/10/2022 1:26:23
8/10/2022 4:21:23
8/10/2022 7:16:23
8/10/2022 10:11:23
8/10/2022 13:06:23
8/10/2022 16:01:23
8/10/2022 18:56:23
8/10/2022 21:51:23
8/11/2022 0:46:23
8/11/2022 3:41:23
8/11/2022 6:36:23
8/11/2022 9:31:23
8/11/2022 12:26:23
8/11/2022 15:21:23
8/11/2022 18:16:23
8/11/2022 21:11:23
8/12/2022 0:06:23
8/12/2022 3:01:23
8/12/2022 5:56:23
8/12/2022 8:51:23
8/12/2022 11:46:23
8/12/2022 14:41:23
8/12/2022 17:36:23
8/12/2022 20:31:23
8/12/2022 23:26:23
8/13/2022 2:21:23
8/13/2022 5:16:23
8/13/2022 8:11:23
8/13/2022 11:06:23
8/13/2022 14:01:23
8/13/2022 16:56:23
8/13/2022 19:51:23
8/13/2022 22:46:23
8/14/2022 1:41:23
8/14/2022 4:36:23
8/14/2022 7:31:23
8/14/2022 10:26:23
8/14/2022 13:21:23
8/14/2022 16:16:23
8/14/2022 19:11:23
8/14/2022 22:06:23
8/15/2022 1:01:23
8/15/2022 3:56:23
8/15/2022 6:51:23
8/15/2022 9:46:23
8/15/2022 12:41:23
8/15/2022 15:36:23
8/15/2022 18:31:23
8/15/2022 21:26:23
8/16/2022 0:21:23
8/16/2022 3:16:23
8/16/2022 6:11:23
8/16/2022 9:06:23
8/16/2022 12:01:23
Date/Time
Carbon Dioxide
Recommended Limit (1000 ppm)


Carbon Monoxide - Second Floor Hallway
Emmerson Hall, 31 University Avenue, Wolfville, Nova Scotia
August 9 to 16, 2022
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Carbon Monoxide Concentration (ppm)
Date/Time
Carbon Monoxide
CO guideline