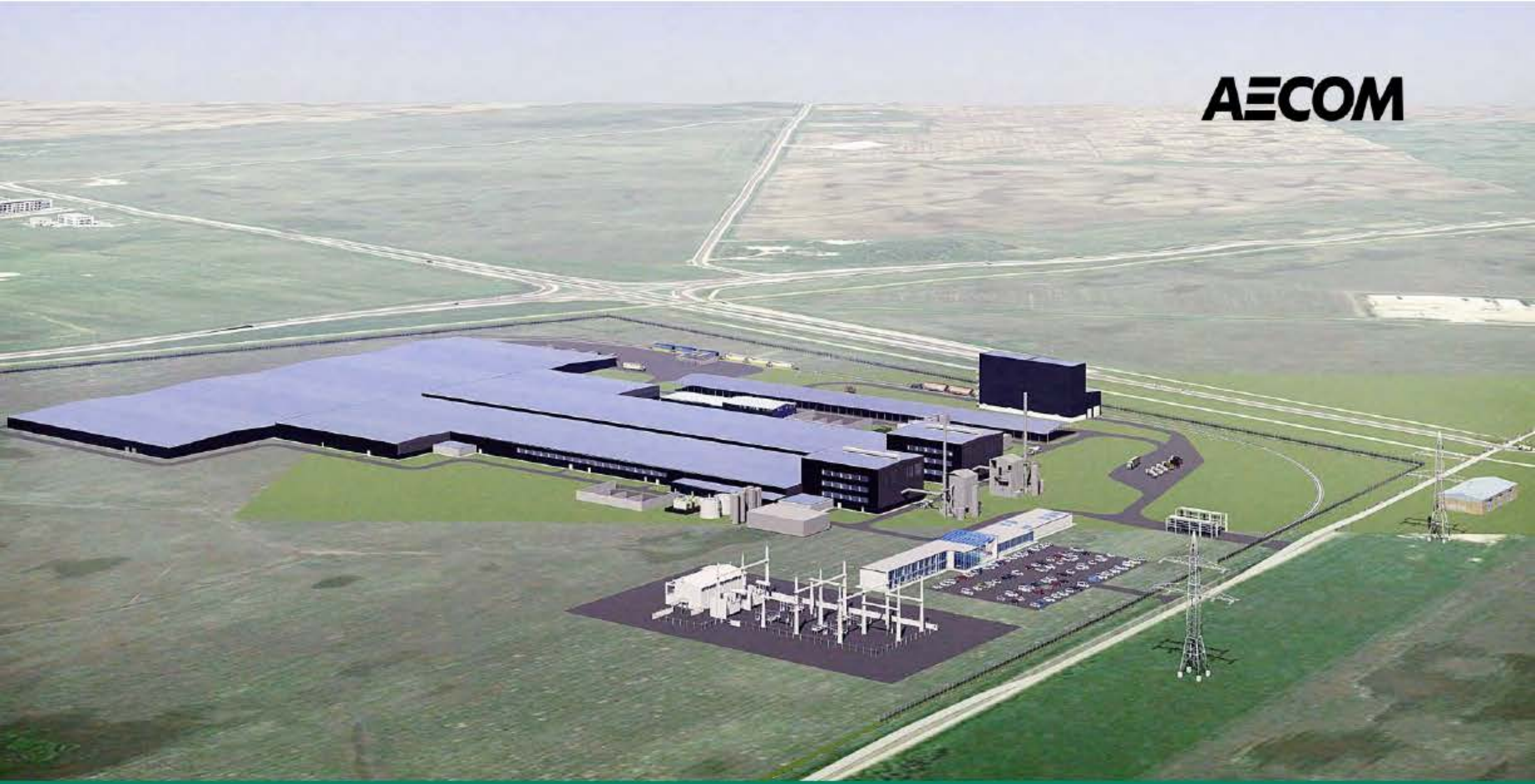

Air Quality Assessment Report

Solar Glass Manufacturing Facility in Selkirk, Manitoba

Canadian Premium Sand Inc.

60625356

October 2022

Delivering a better world

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AECOM: 2015-04-13

Quality Information

Prepared by

[redacted]

Piotr Staniaszek, Ph.D.
Senior Air Quality Specialist
Global Air Quality Modelling Specialty Lead
M: 403-463-9682
E: Piotr.Staniaszek@aecom.com

Checked by

[redacted]

Randy Rudolph, M.Sc.
Senior Air Quality Scientist
Randy.Rudolph@aecom.com

AECOM Canada Ltd. APEGA Permit to Practice No.: P10450

Distribution List

# Hard Copies	PDF Required	Association / Company Name
	✓	Canadian Premium Sand Inc.
	✓	AECOM Canada Ltd.

Prepared for:

Canadian Premium Sand Inc.
2000, 715 5th Avenue SW
Calgary, AB T2P 2X6

Prepared by:

Piotr Staniaszek, Ph.D.
Senior Air Quality Specialist
Global Air Quality Modelling Specialty Lead
M: 403-463-9682
E: Piotr.Staniaszek@aecom.com

AECOM Canada Ltd.
48 Quarry Park Blvd. SE., Suite 300
Calgary, AB T2C 5P2
Canada

T: 403.254.3301
F: 403.351.1678
www.aecom.com

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List of Units

μg/m³ .... Microgram per cubic metres
g .... Gram
g/hp-h .... Grams per horsepower per hour
g/L .... Grams per litre
g/MMBtu ...... Grams per Metric Million British Thermal Unit
g/s .... Grams per second
g/s/m² .... Grams per second per square metres
GW .... Giga Watt
GW-h .... Giga Watt per hour
hp .... Horsepower
K .... Kelvin
kg .... Kilogram
kg/d .... Kilogram per day
kg/h .... Kilogram per hour
kg/L .... Kilogram per Litre
kg/t .... Kilogram per tonne
km .... Kilometres
km/d .... Kilometres per day
km/h .... Kilometres per hour
kW-hr .... Kilo Watt per hour
L .... Litre
L/h .... Litres per hour
lb/hp-h .... Pound per horsepower per hour
m .... Metres
m/s .... Metres per second
m² .... Square metres
m³ .... Cubic metres
mm .... Millimetres
MMBtu .... Metric Million British Thermal Unit
Mm/y .... Millimetres per year
Mt .... Million of tonnes
ppm .... Parts per million
ppb .... Parts per billion
t .... Tonnes
t/h .... Tonnes per hour
t/y .... Tonnes per year
VKT .... Vehicle kilometers travelled

1. Introduction

1.1 Overview

Canadian Premium Sand Inc. (CPS) is applying for an Environment Act Licence from Manitoba Environment, Climate and Parks (MECP), to construct and operate a CPS Solar Glass Manufacturing Facility (solar glass plant) located in the City of Selkirk, Manitoba, Canada. The solar glass manufacturing facility (the 'Project') is proposed to be built on industrial zoned land between Easton Drive, Walker Avenue, Main Street, and Provincial Trunk Highway (PTH) No. 4. This facility will produce glass for use in the manufacturing of solar panels with the primary ingredient being high purity, low iron silica wet sand sourced from CPS' Wanipigow Sand Extraction Project (quarry project) near Seymourville, Manitoba.

CPS's intention is to use silica sand extracted from CPS's Wanipigow Sand Extraction Project near Seymourville, Manitoba as the source of high-quality silica sand required for the type of glass CPS will be manufacturing at the proposed solar glass manufacturing facility (plant) in the City of Selkirk. The Wanipigow Sand Extraction Project currently has an Environment Act Licence (No. 3285).

CPS plans to commence glass production with a single **Phase 1 facility** producing approximately 600 to 800 tonnes per day (t/d) but intends to increase that capacity up to, but not exceeding, approximately 1,200 t/d within a few years by constructing a second **Phase 2 facility** adjacent to the **Phase 1 facility**.

It is currently planned that construction of the **Phase 1 facility** will commence in early 2023 with glass production being realized in mid-2025. The full build-out of the **Phase 1** and **Phase 2 facility** is expected to occur within approximately five years of the completion of the **Phase 1 facility** (i.e., by 2030). Each facility is expected to remain in operation for an estimated 30 years and will be operational 24 hours a day, seven days a week, 365 days per year with shutdowns being planned at approximately 15-year intervals for furnace maintenance.

A component of the solar glass plant environmental assessment information requirements was to perform an air quality assessment to determine the potential impact of possible emissions from the solar glass plant on the off-site air quality. This report focusses on the assessment during the operations phase for the complete **Phase 1** and **Phase 2 facility**. The air quality assessment is divided into an air dispersion modelling assessment and greenhouse gas (GHG) emissions assessment.

Key components of the Project that are relevant for the air quality impact assessment include:

- **Batch Plant Building**: Offloading of material from rail cars and trucks which is then blended in certain proportions to be used in furnaces.
- **Railway Input:** Operation of locomotives delivering material from off-site and a switch locomotive around the batch plant
- **Covered Conveyor**: Transport of blended raw material from the batch plant building to the production building
- **Paved Access Roads**: Along Walker Avenue to the solar glass plant and staff parking lot
- **Internal Roads:** Internal transport among the solar glass plant, batch plant building, and loading area
- **Loading Area**: Operation of Kalmar forklifts from warehouse to loading area and then loading onto B-Train trucks
- **Production Building Vent**: Consisting of the conveyor inside of the building, unloading of conveyed material, and operation of forklifts for mixing material and transporting finished glass to warehouse

- **Warehouse Vent**: Loading of pallets into containers by forklift and transporting containers to the loading area
- **Furnace Stacks:** Two 46 m furnace exhaust stacks

The model developed for this study considered emissions from material transfer points, stacks/vents, fully covered material storage areas, paved internal and access roads, and equipment/vehicle exhausts. The AERMOD model was used to predict ambient air concentrations outside the Project footprint. Modelled concentrations were compared with the *Manitoba Ambient Air Quality Criteria* (MAAQC 2005).

A GHG assessment was completed based on the Project components that would contribute appreciably to GHG emissions including:

- Furnace emissions based on estimated annual natural gas usage
- Emissions from the mobile fleet considering annual diesel/gasoline consumption from on-site equipment and
- Indirect emissions from electricity use based on estimated consumption and the GHG intensity of the grid.

2. Site Description

2.1 Project Location

The Project will be located on land zoned as ‘Heavy Industrial’ near the northeastern border of the City of Selkirk (**Figure 1**). The proposed Project site is flat and surrounded primarily by agriculture, with some nearby small industrial facilities and warehouses.

The latitude and longitude co-ordinates of the proposed solar glass plant are 50°; 10’, 07” N and 96°; 53’ 06” W (UTM Zone 14U 651047 m E; 5559510 m N).

2.2 Flat Glass Process Description

The proposed solar glass plant layout is illustrated in **Figure 2**.

Glass manufacturing is a high temperature, energy-intensive activity, resulting in the emission of combustion by-products and the high-temperature oxidation of atmospheric nitrogen. Most emissions are from batch material melted in a furnace heated by natural gas. The composition of the batch is summarized in **Table A3** (**Attachment A**).

The molten glass is drawn through patterned rollers which flatten the glass into a long ribbon and imprint a permanent prismatic pattern to further improve light transmissivity. This process generates most emissions due to contact between molten, hot glass and equipment lubricants. The glass ribbon is cooled in a controlled manner inside an ‘Annealing Lehr’ which relieves internal stresses within the glass. The cooling process generates emissions related to combustion because the glass product is maintained originally at 500 to 550°C. Cooled glass is cut to size before moving on to ‘post processing’ which is specific to customer requirements, but usually includes coating with an anti-reflective layer, trimming the edges and drilling holes.

The main compounds emitted from glass producing plants are:

- Sulphur oxides – modelled as sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Particulate matter less than 2.5 µm diameter ($PM_{2.5}$)
- Particulate matter less than 10 µm diameter (PM_{10})
- Total suspended particulates (less than 30 µm diameter) (TSP)
- Fluorides (HF)
- Ammonia (NH_3)
- Hydrogen chloride (HCl)
- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrogen Oxide (N_2O)

The emissions of SO_2 in waste gases from glass furnaces depend on amount of sodium sulphide used for glass oxidation and sulphur content in used natural gas. Ultra-low sulphur diesel results in very low SO_2 emissions from transport and on-site equipment fuel combustion.

Nitrogen oxides are generated by high temperatures (including oxidation of atmospheric nitrogen), by decomposition of nitrogen compounds in batch materials, and oxidation of nitrogen contained in fuels. Transport and on-site equipment also emit NO_X.

Legend

Project Site Area

General Features

Highway

Existing Railway

Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PROJECT SITE LOCATION

0 0.5 1 1.5 2
Kilometres
Datum: NAD 1983 UTM Zone 14N

Aug, 2022	PN#: 60663147	1:50,000 * when printed 11 x17

Figure 1

AECOM

Data Sources Canvec MLI
Imagery Bing Maps
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Project Site Layout
- Proposed Rail Spur
- Conveyor

Building Outlines

- Warehouse
- Furnace Area - Phase 1
- Furnace Area - Phase 2
- Production Area
- Batch Plant

Source Locations

- Loading Area
- Access Road
- Conveyour Transfer Points
- Furnace Stack
- Vent
- Railway
- Switch Locomotives
- Internal Roads

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

SOLAR GLASS PLANT PLANT AND EMISSION

0 50 100 150 200
Metres

Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:5,000 *when printed 11 x17	AECOM

Figure 2

Data Sources Canvec MLI
Imagery Bing Maps
Key Map Esri World Topographic Map

Produced glass is transported from the production area to warehouse storage. The finished sheets are packaged and stacked in the containers at the warehouse in preparation for delivery. All buildings including the conveyor will be fully enclosed minimizing dust from sand and batch material handling. These emissions are mainly in coarser size fractions (i.e., total suspended particulate matter or 'TSP'). Hot processes emit particulates with sizes below 1 μm diameter, but they readily agglomerate into larger particles.

The sources of NH_3, HCl and HF emissions are normally related to impurities present in the raw materials (e.g., sodium or calcium chloride). Their emissions in transport and on-site equipment are negligible compared to furnace emissions.

For this study, it was assumed that full operation of the solar glass plant includes both **Phases 1 and 2**, which represents higher emissions than **Phase 1** alone.

3. Regulations, Guidelines, and Air Quality Criteria

3.1 Regulations and Guidelines

Modelling followed the *Draft Guidelines for Air Quality Dispersion Modelling Manitoba* (MCWS 2006), supplemented (where needed) by guidelines from Alberta (AEP 2021) and the United States (US EPA 2021). Predicted model results were compared against the *Manitoba Ambient Air Quality Criteria* (MAAQC 2005).

A summary of the documents used is shown in **Table 1**.

Table 1: Air Quality Related Regulations and Guidelines

Guideline	Reference	Rationale
Draft Guidelines for Air Dispersion Modelling in Manitoba	MCWS (2006)	This guideline is a resource that provides consistency in dispersion modelling across all regulatory applications.
Alberta Air Quality Model Guideline	AEP (2021)	This dispersion modelling guideline provides guidance on appropriate surface characteristics and receptor grids to supplement the Manitoba guidelines.
Manitoba Ambient Air Quality Criteria (MAAQC)	MAAQC (2005)[1]	Manitoba provides a listing of Ambient Air Quality Criteria and Guidelines for various air pollutants.
US EPA AERMOD Implementation Guide	US EPA (2021)	This guideline is a resource that helps with the use of the related air quality modelling modules and programs (AERMOD, AERMAP, AERMET, AERSURFACE, AERSCREEN) and the required additional information

Notes: 1. The link to this site can be found at the most current Manitoba government website: https://www.gov.mb.ca/sd/pubs/climate-air-quality/factsheet_airquality_monitoring.pdf

3.2 Air Quality Criteria

The evaluation of ambient air quality typically relies on comparison of modelled concentrations to regulatory thresholds (standards/objectives/criteria). The regulatory thresholds are designed by the local, provincial, or federal authority to be conservative and protective of air quality. The *Maximum Acceptable Level Concentration* provided by Manitoba Ambient Air Quality Criteria (MAAQC 2005) were used in this assessment.

The applicable air quality criteria are summarized in **Table 2**.

Table 2: Ambient Air Quality Criteria

Compound[1]	Averaging Period	MAAQC (µg/m^3)
Particulate Matter with a diameter of 2.5 micrometres and less ($PM_{2.5}$)	24-hour	30
Particulate Matter with a diameter of 10 micrometres and less (PM_{10})	24-hour	50
Total Suspended Particulates (TSP)	24-hour Annual	120 70
Carbon Monoxide (CO)	1-hour 8-hour	35,000 15,000
Nitrogen Dioxide (NO_2)	1-hour 24-hour Annual	400 200 100

Compound[1]	Averaging Period	MAAQC (µg/m³)
Sulphur Dioxide (SO_2)	1-hour 24-hour Annual	900 300 60
Ammonia (NH_3)	1-hour	1,400
Fluorides (HF)	24-hour 7-days 30-days 70-days	0.85 0.55 0.35 0.20
Hydrogen Chloride (HCl)	1-hour	100

Notes: 1. All values are from the "Maximum Acceptable Level" Concentration provided by MAAQC (2005).

4. Dispersion Modelling Methodology

The air emissions from the solar glass plant were assessed based on information provided by CPS. These air emissions were used in AERMOD to predict maximum ground-level concentrations.

4.1 The Choice of Air Dispersion Model

Air dispersion models are important tools that can be used to estimate and assess the likelihood of airborne contaminants from the facility impacting a particular location such as the nearest residences. Dispersion models mathematically predict the behaviour of emitted plumes by accounting for: emission rates, physical characteristics of the release, geometry and location of the sources as related to receptor locations, terrain effects, meteorology, and atmospheric dispersion.

An approved regulatory dispersion model used in Manitoba is AERMOD as outlined in the *Draft Guidelines for Air Quality Dispersion Modelling in Manitoba (MCWS, 2006)*. Given the likelihood that the highest modelled concentrations will occur in the near field (within 1 km), AERMOD (Model Version 18081) was chosen for this assessment, and also because of its ability to account for:

- Directional and seasonal variations in land use
- Building induced plume downwash, which can affect the sources plume rise
- Dispersion in a mixed urban/forested environment
- Terrain influences

Based on the *Draft Guidelines for Air Quality Dispersion Modelling in Manitoba* (MCWS, 2006) the area within 3 km of the Solar Glass Plant was considered rural.

In addition, AERMET (Version 21112) and AERMAP (Model Version 9.6.5), AERMOD's meteorological and terrain pre-processors, were employed to process meteorological data and terrain data inputs for AERMOD.

Modelling was conducted in accordance with the 2006 *Draft Guidelines for Air Quality Dispersion Modelling in Manitoba (MCWS 2006)*, where applicable. Where the Guidelines did not address a particular modelling element, the Alberta *Air Quality Modelling Guideline (AEP 2021)* and the US EPA *AERMOD Implementation Guide (US EPA 2021*) were used as guidance.

4.2 Dispersion Model Boundaries

The modelled ground-level concentrations from the Project and comparison with MAAQC were investigated within the spatial and temporal boundaries as described in **Sections 4.2.1** and **4.2.2**.

4.2.1 Spatial Boundary

The study area for this assessment was the zone of influence of the Project-related air emissions, including potential sensitive receptors nearest to the Project site, set to 20 km by 20 km around the solar glass plant. The appropriateness of this boundary selection was confirmed by the model outputs which showed that maximum concentrations were found within less than 1 km of the site. Model receptor points are described in **Section 4.6**.

4.2.2 Temporal Boundary

Temporal boundaries for this assessment were developed in consideration of continuous operations and emissions from the 30-year life of the Project.

The temporal boundary includes several time-averaging periods in accordance with the time periods outlined for the identified MAAQC presented in **Table 2**.

4.3 Dispersion Model Meteorology

The dispersion of air pollutants is affected by local meteorological patterns. The wind direction controls the path that air pollutants follow from the point of emission to the receptors. In addition, wind speeds affect the time taken for pollutants to travel from source to receptor and the distance over which air pollutants travel. As a result, wind speeds also impact the dispersion of air pollutants; therefore, it is important to consider local meteorological patterns when assessing potential air quality effects from an emission source. The site specific, five years (2017-2021) of WRF-preprocessed meteorological data, AERMET ready, 4 km resolution, was purchased from Lakes Environmental.

Figure 3 presents a windrose comprised of the meteorological data used in the model (Jan 1, 2015 – Dec 31, 2019); the windrose indicates the predominant winds are southerly and **Figure 4** shows that the winds are calm approximately 0.3% of the time. Calm is defined as hours with wind speed less than the threshold velocity of the anemometer (0.5 m/s).

AERMOD does not have the ability to model calm winds. As such, these events were not assessed as part of the dispersion modelling analysis. Conversely, AERMOD is conservative (over-predicts) during very low non-calm periods.

AERMET produces surface scalar parameters and vertical profiles of meteorological data that are used as an input for AERMOD. To quantify the boundary layer parameters needed by AERMOD, AERMET also requires specification of site-specific land use characteristics including surface roughness (z_o), albedo (r) and Bowen ratio (B_o). These site characteristics are used by AERMET, along with the meteorological data to help characterize the atmospheric boundary layer and dispersion.

The boundary layer parameters are calculated on an hourly basis and are contained in AERMET's surface file. The surface file is read into AERMOD and then these values are used to quantify the atmospheric dispersion. The land use surface characteristics surrounding the Facility were quantified for this Project based on specific land use surface characteristics provided to AERMET.

US EPA has developed a tool called AERSURFACE to determine the site characteristics based on digitized land cover data in accordance with the AERMOD Implementation Guide (US EPA 2021). The following four seasonal categories are supported by AERSURFACE, with the applicable months of the year specified for this assessment.

1. "Spring": when vegetation is emerging or partially green. This applies for 1–2 months after the last killing frost (May – June)
2. "Summer": when vegetation is lush and healthy (July – August)
3. "Autumn": periods when freezing conditions are common, deciduous trees are leafless, crops are not yet planted or are already harvested (bare soil exposed), grass surfaces are brown, and no snow is present (September, October) and
4. "Winter": for snow-covered surfaces and subfreezing temperatures (November – April).

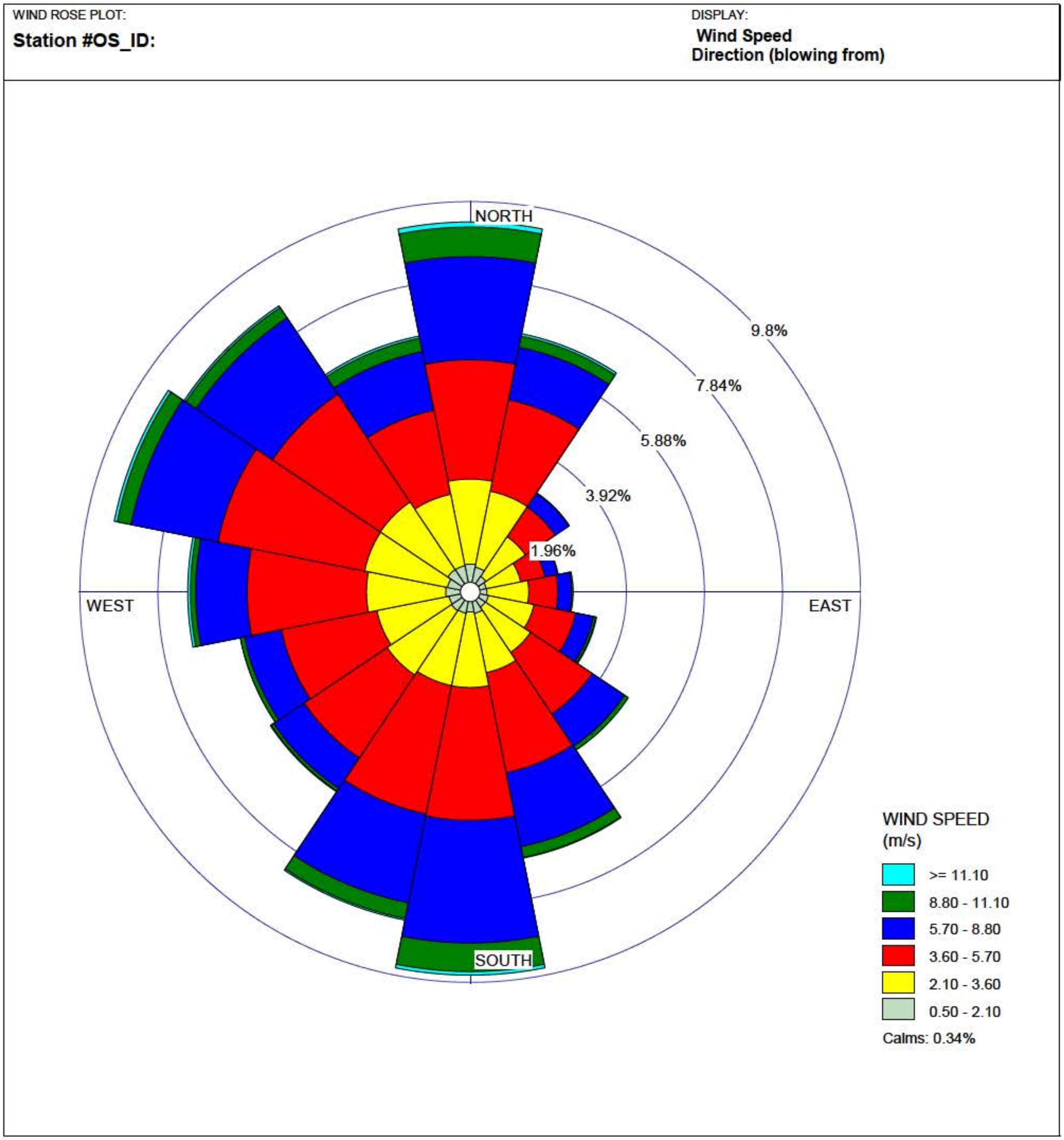


Figure 3: Windrose of Meteorological Data at CPS Solar Glass Plant Location (January 1, 2017-December 31, 2021)

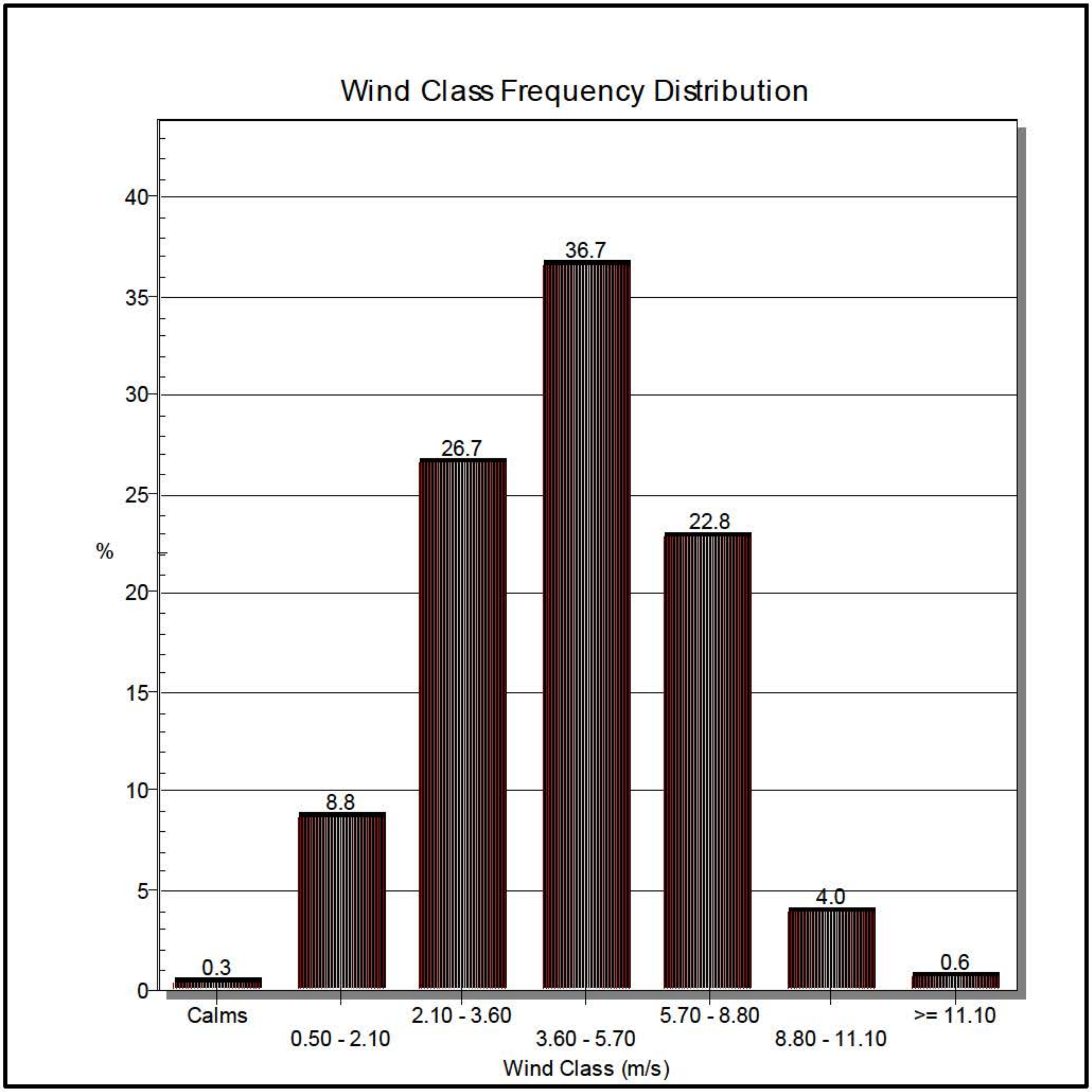


Figure 4: Wind Class Frequency Distribution of Meteorological Data (January 1, 2017, to December 31, 2021)

The calculated albedo, Bowen ratio, and surface roughness values for this specific assessment were based on GeoBase digital land use data (NRCan 2020a). Digital terrain files with a 1:50,000 scale (NRCan 2020b) were used to generate elevations for receptors and sources.

4.4 Background Ambient Air Quality

Background air quality information is added to modelled conditions to appropriately assess the cumulative impacts of the Project. The background concentrations of the modelled parameters were obtained from the Winnipeg Ellen Street, Flin Flon, and Brandon Air Quality Stations. The stations were selected based on their distance from the Project and data availability (Ellen Street station does not have SO_2 and NH_3 measurements).

Hourly, 8-hour, and daily averaging periods used 90th percentile measured concentrations from the most recent years with valid (>75% completeness). The annual background is the average of annual averages in the 3-year record. Based on AENV (2021), values above 90th percentile hourly average concentrations were removed from calculation of annual concentrations. The ambient background air quality data are summarized in **Table 3**. There are no measurements of HF and HCl in Manitoba and the background was assumed to be zero.

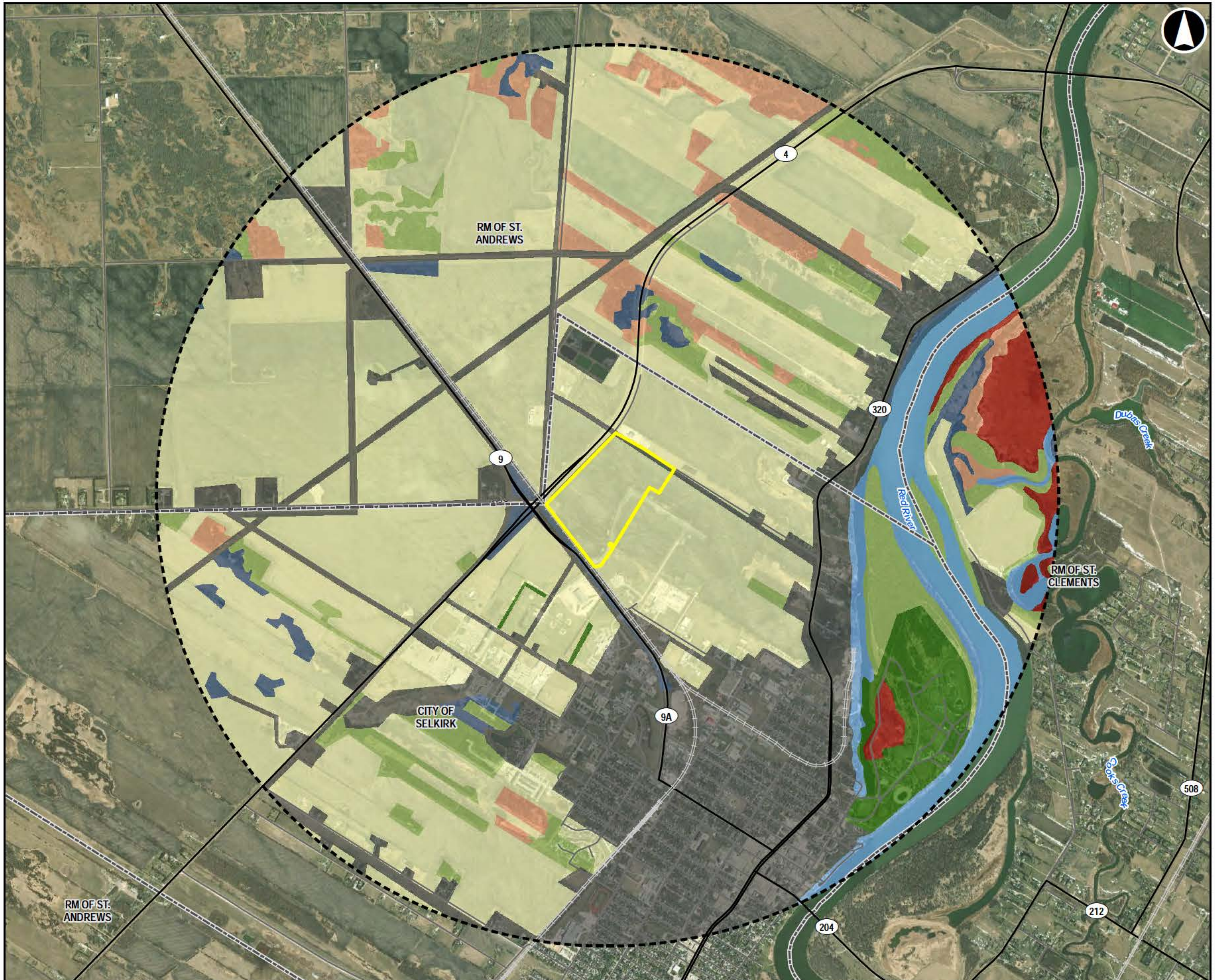
Table 3: Ambient Background Air Quality Concentrations[(1)]

Pollutant	Data Source Location	Averaging Period	Ambient Background Air Quality (µg/m^3)	Objective and/or Guideline (µg/m^3)
$PM_{2.5}$	Ellen Street, Winnipeg (2018, 2019, 2021[(4)])	24-hour	6.7	30
PM_{10}	Ellen Street, Winnipeg (2019, 2020[(4)], 2021[(4)])	24-hour	9.0	50
TSP [(2)]	Ellen Street, Winnipeg (2019, 2020, 2021)	24-hour Annual mean	18 11	120 70
CO	Ellen Street, Winnipeg (2018)	1-hour 8-hour	173 115	35,000 15,000
NO_2	Ellen Street, Winnipeg (2019, 2020, 2021)	1-hour 24-hour Annual Mean	24 17 11	400 200 100
SO_2[3]	Flin Flon (2018)	1-hour 24-hour Annual mean	4.5 4.1 2.0	900 300 60
NH_3[5]	Brandon (2021)	1-hour	13.2	1,400

Notes: 1. The 90th percentile for all averaging periods were applied to the background concentrations.
*2. No data was available for TSP background concentration. PM_{10} background concentration was used to calculate TSP=2*PM_{10} instead.*
3. Flin Flon Station data was used for SO_2 since the data from Ellen Street Station was not available.
4. Measurements of $PM_{2.5}$ and PM_{10} are switched for these two years. It means majority of PM_{10} observations are lower than $PM_{2.5}$ observations. It was prudent to switch their places. In 2020 there was only 43% $PM_{2.5}$ data available. There were many observations below zero, indicating serious problem with measurements.
5. Brandon Station data was used for NH_3 since the data from Ellen Street Station was not available.

4.5 Land Use and Terrain Characteristics

Figure 5 provides the land use identified within 3 km of the solar glass plant, where approximately one half the land use is agricultural. The surface roughness, albedo and Bowen ratios for land use and seasons are default values outlined in the AB Modelling Guideline (AEP 2021).



Legend

- Project Site Area
- 3 km Buffer

Land Use

- Fields (Agriculture)
- Forested
- Marsh Muskeg
- Meadow
- Protection Forest
- Developed
- Water
- Willow/Alder

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

LAND USE WITHIN 3 km OF THE SOLAR GLASS PLANT LOCATION

0 250 500 750 1,000
Metres

Datum: NAD 1983 UTM Zone 14N

Jul, 2022	PN#: 60663147	1:25,000 *when printed 11 x17	AECOM

Figure 5

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

4.6 Receptors

The receptor grid was designed to ensure the model captures the maximum modelled concentrations associated with the facility emissions. A Cartesian receptor grid, centered between the two furnace stacks, was established to capture the maximum modelled ground-level concentrations associated with the emission sources. The modelled receptor grid with the following spacing and distances was used, as per the Draft Guidelines for Air Dispersion Modelling in Manitoba (MCWS, 2006):

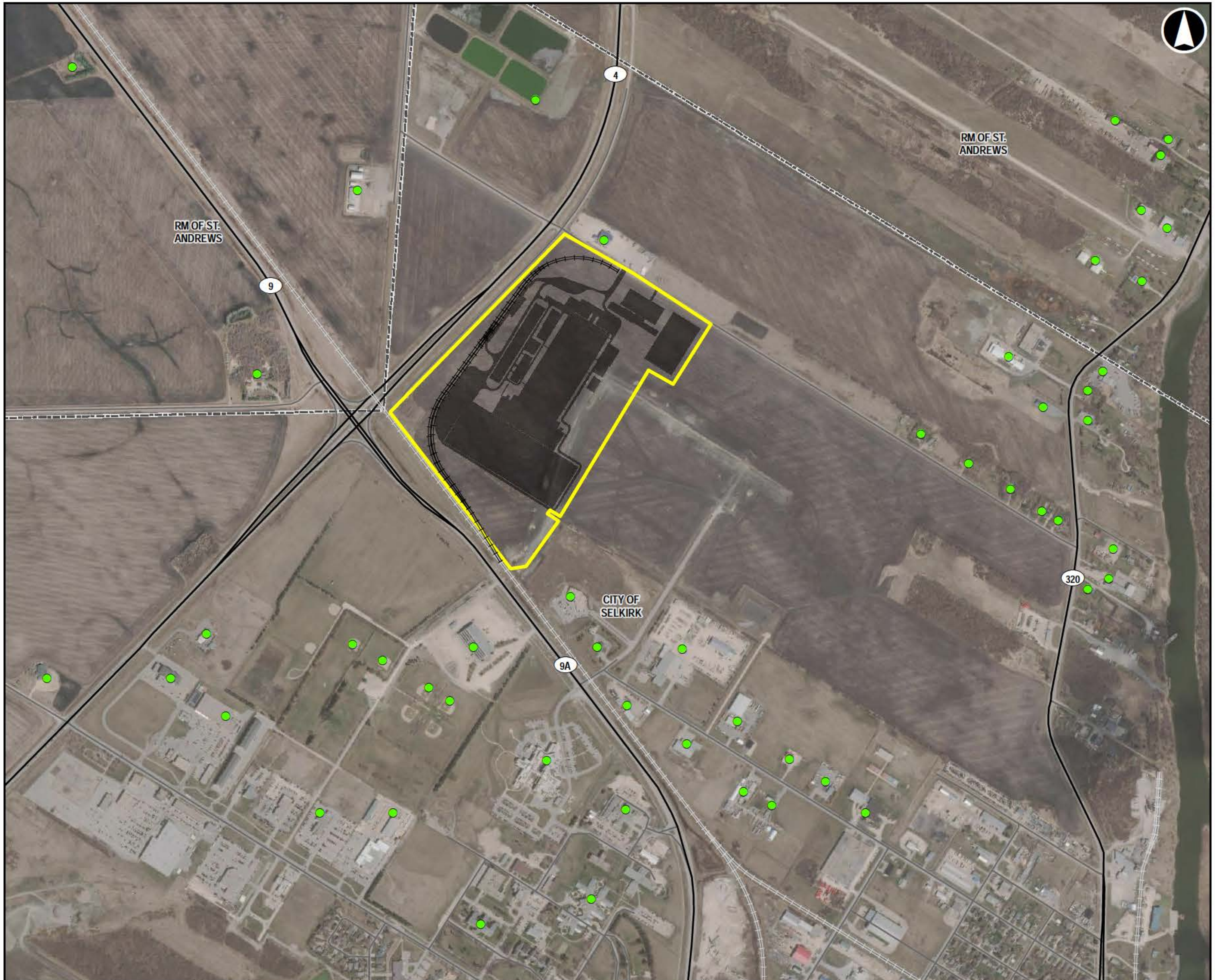
- 20 m receptor spacing at the solar glass plant boundary
- 50 m receptor spacing within 0.5 km of the furnace stacks
- 100 m receptor spacing within 1.0 km of the furnace stacks
- 250 m receptor spacing within 2 km of the furnace stacks
- 500 m spacing within 5 km of the furnace stacks

Sensitive receptors were also identified and **Table 4** lists their co-ordinates and distance from the furnace stacks.

Table 4: Sensitive Receptor Details

Discrete Receptor	Receptor ID	Distance from the Plant (m)	UTM Co-ordinate	
			(mE)	(mN)
Easton Place Pharmacy	R1	751	650984	5558761
Selkirk Veterinary Services	R2	892	651050	5558618
Selkirk Recreational Complex	R3	904	650716	5558668
Selkirk Selects Gymnastics Club No. 965	R4	1,213	652232	5559251
Selkirk WWTP	R5	1,135	652168	5559335
Selkirk Airport Hangars closest	R6	1,327	652370	5559609
Selkirk Airport Building	R7	1,580	652616	5559693
Selkirk Airport Hangars Further	R8	1,458	652480	5559773
1009 Main Street (320 Highway)	R9	1,436	652481	5559585
Truck Lines (950 Main Street) 320 Hwy	R10	1,347	652382	5559332
House No. 960 Main Street 320 Hwy	R11	1,312	652340	5559287
Bryant TNT Plumbing & Heating	R12	1,312	652330	5559238
No. 50 Vimy Avenue	R13	1,501	652352	5558768
Black Cat Wear Parts	R14	1,539	652401	5558779
Selkirk Regional Health Centre	R15	1,179	650922	5558337
Shopping Center (e.g., Home Hardware)	R16	1,433	650492	5558188
Dealers (Ford, Dodge)	R17	1,515	650298	5558192
Canadian Tire	R18	1,453	650069	5558435
Canalta Hotel	R19	1,488	649,914	5558545
Westside Honda	R20	1,368	649992	5558638
Cloverdale Road Farm	R21	894	650168	5559345
Whiskey Ditch Road Farm	R22	716	650400	5559818
H.D. Repair & Welding Inc.	R23	177	651050	5559686
Niki's Boats	R24	1,513	652420	5558876
Walker Avenue No.1	R25	919	651900	5559169
Walker Avenue No.2	R26	1,050	652013	5559100
Walker Avenue No.3	R27	1,185	652138	5559047
Walker Avenue No.4	R28	1,291	652223	5558977
Walker Avenue No.5	R29	1,342	652263	5558943
Red River Messenger Courier Inc.	R30	1,285	651550	5558327
Manitoba Hydro	R31	914	651232	5558615
Terraco	R32	1,041	651125	5558471

Discrete Receptor	Receptor ID	Distance from the Plant (m)	UTM Co-ordinate	
			(mE)	(mN)
Selkirk General Hospital - EMS	R33	1,306	651092	5558204
Red River College	R34	1,525	651039	5557985
Red Bomb Fireworks	R35	1,509	651761	5558180
4 Av Earls Greenwood Ave	R36	1,427	651657	5558220
Greenwood Avenue Green Roof	R37	1,384	651509	5558205
Greenwood Ave No.1	R38	1,328	651458	5558247
Warehouse Greenwood Ave No.2	R39	1,100	651416	5558473
Sterling Press Inc. 850 Greenwood Ave	R40	1,169	651273	5558363
Cloverdale Road No.1 (from Hwy 9)	R41	893	650169	5559343
RRC Polytech - Interlake Campus	R42	1,645	650745	5557892
Baseball Diamonds No.1	R43	1,089	650598	5558517
Baseball Diamonds No.2	R44	1,093	650678	5558480
Baseball Diamonds No.3	R45	1,065	650481	5558607
Baseball Diamonds No.4	R46	1,077	650393	5558653
Crossroad Church	R47	1,769	649574	5558530
Residence Hwy 9 North	R48	1,549	649645	5560169
Wastewater Treatment Ponds	R49	585	650873	5560068
Red Roof House by Airport No. 1	R50	1,455	652413	5560009
Red Roof House by Airport No. 2	R51	1,484	652525	5559641
Red Roof House by Airport No. 3	R52	1,570	652562	5559920
Green Roof House by Airport	R53	1,573	652553	5559963



Legend

- Sensitive Receptor
- Project Site Area
- Project Site Layout
- Proposed Rail Spur

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

SENSITIVE RECEPTORS LOCATION

0 100 200 300 400
Metres

Datum: NAD 1983 UTM Zone 14N

Jul, 2022	PN#: 60663147	1:10,000 *when printed 11 x17

Figure 6

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

4.7 Nitrogen Dioxide Modelling

In this assessment, conversion of NO_x to NO_2 is estimated using the Ozone Limiting Method (OLM). In general, high temperature combustion processes primarily produce NO that can be converted to NO_2 in the atmosphere through reactions with tropospheric ozone:

$$NO + O_3 \rightarrow NO_2 + O_2$$

The OLM states that if the ambient ozone concentration is greater than 90% of the predicted NO_x, then it is assumed that all the NO_x is converted to NO_2. Otherwise, the NO_2 concentration is equal to the sum of the ozone and 10% of the predicted NO_x concentration. That is:

$$\text{If } [O_3] > 0.9\,[NO_x], \text{ then } [NO_2] = [NO_x]$$
$$\text{Otherwise, } [NO_2] = [O_3] + 0.1\,[NO_x]$$

These guidelines were established through the consideration of lowest observable effect levels on sensitive receptors.

Predicted concentrations of NO_x were converted to NO_2 using ozone values measured at the Ellen Street Station provided in **Table 5**. NO_2 concentrations are also reported using the total conversion method (TCM: all NO_x is converted to NO_2).

Table 5: Ozone Concentrations at the Ellen Street Station

Statistics	Ozone Concentration (ppb)				
	2018	2019	2020	2021	Average
Data Completion (%)	100	99	73	96	98
Maximum 1- hr	71.3	42.0	38.9	1,832	496
90^{th} Percentile 1 -hr	40.9	21.7	19.8	21.6	26.0
90^{th} Percentile 24-hr	38.1	20.2	18.7	19.6	24.2
Annual Average	22.8	12.5	11.5	12.7	14.9

4.8 Building Effects

Buildings or other solid structures may affect the airflow in the vicinity of a source and cause building downwash, in the form of eddies, on the downwind side of a building. The eddies cause a plume from a stack source, located within a horizontal distance about five times the height (or projected width, whichever is lower) of a nearby building or structure, to be forced to ground much sooner than it would be if a building or structure were not present. The effect can greatly increase the ground-level concentrations downstream of the building or structure and result in decreased concentrations farther from the source. In consequence, including building effects for stacks away from the plant boundary could be less conservative and for stacks and buildings close to plant boundary could be more conservative.

The Building Profile Input Program (BPIP) Plume Rise Model Enhancements (PRIME) algorithms, which are integrated into the AERMOD model, are designed to incorporate the two fundamental features associated with building downwash: enhanced plume dispersion due to the turbulent wake, and reduced plume rise caused by a descending plume in the lee of the building and the increased entrainment in the wake.

The influence of building geometry on local airflow, and therefore on emissions, was calculated for the two furnace stacks and three buildings closest to stacks using the US EPA BPIP PRIME pre-processor. The building information is presented in **Table 6** and **Figure 2**.

Table 6: Used in BPiP PRIME Building Dimensions

Building	UTM 14 (m) for Center Point		Elevation (m ASL[1])	Building Height (m)	Building Length (m)	Building Width (m)
	W	N				
Furnace Area 1	650.991	5,559,478	224	15	42	36
Furnace Area 2	651,043	5,559,446	224	15	42	36
Batch Plant	650,835	5,559,523	224	32	61	13

5. Project Emissions

5.1 Sources and CAC Emissions

The air quality modelling assessment was based on the Project description information provided by CPS and published emission factors to capture potential emissions from the solar glass plant. The details of emission calculations (including samples of calculations) are provided in **Attachment A**. The following section summarizes emission scenarios, source parameters and emissions used for modelling of **Phase 1** and **Phase 2** of the Project. These air emissions were used in the AERMOD dispersion model to assess maximum predicted TSP, PM_{10}, $PM_{2.5}$, NO_2, CO, SO_2, HF, HCl, and NH_3 ground-level concentrations.

The following emission sources were identified at the solar glass plant (**Figure 2**):

- **Furnace Stacks: Table 7** lists stack locations and parameters and **Table 8** summarizes emissions from the two furnace stacks.
- **Railway:** Operations along one kilometer of track within the solar glass plant boundary was modelled**.** It was assumed that a line locomotive arrives two or three times a week at 6:00 am, from the southwest along the northern project boundary, bringing soda ash, limestone flint, dolomite flint, and feldspar and will leave along the western and southern plant boundaries.
- **Railway around Batch Plant:** From 6:00 am to 10:00 pm (16 hours), a switch locomotive will move rail cars which will be unloaded at rail offloading attached to batch plant.
- **Access Road** from PTH 4 along paved Walker Avenue:
  a) Wet sand from the quarry will be transported by 26 to 44 trips within a 16-hour day, five days a week. This is the worst-case scenario since the same amount of material needs to be moved over five days instead of seven days (40% increase of traffic and emissions).
  b) 218 trips/year of flat-deck trucks delivering bagged batch additives (sodium sulphur plus small quantities of iron oxide [Portafer] and chrome oxide [Portachrome]) and 8 trips/year of flat-deck trucks delivering carbon to the batch plant. For modelling, it was assumed that there is one flat-deck delivery each day (rather than the anticipated 226 trips annually).
  c) Six trips per day will deliver pallets or racks for transporting finished product.
  d) In addition, there will be other traffic (fuel delivery, company vehicles, visitors).
  e) All final product (solar glass) will be transported offsite by 20-t trucks five days a week.
  f) Four times daily (6:00 am, 7:00 am, 2:00 pm, and 10:00 pm) there will be employee shift traffic between PTH 4 and the parking area.
- **Internal Roads:** Within the solar glass plant, trucks will travel between the gate, batch plant, and loading areas. A fleet of fork-lifts will operate between the production area, warehouse, and the loading area. On-site diesel combustion emissions were modelled using NONROAD model emission factors (US EPA, 2008, 2010, 2022) and fugitive particulate emissions using US EPA (1996, 2011). Internal and access road diesel combustion emissions were calculated using the MOVES model assuming that there will be total of 8 trucks travelling (and/or idling) per hour for 16 hours per day for 365 days a year (128 trips of trucks per day). This number of trips was calculated for increased traffic of B-Train trucks delivering wet sand from the quarry and 20-t trucks with final product, using 5 days a week for this activity instead of 7 days a week. For this reason, the number of B-Train truck trips was increased from 19 to 31 trips/day, depending on month of a year, for 7 day per week operations to 26 to 44 trips/day for 5 day/week operations. The number of trips for final product transport was increased from 48 trips/day (for 7 days/week cycle) to 68 trips/day for 5 days/week cycle. Including all other traffic, the average number of trips was increased from 81 to 111 trips/day. Diesel combustion emissions are conservatively high. Details are provided in **Attachment A**. The maximum nominal truck load of 40 t

was also used for B-Train trucks, increasing fugitive dust from truck traffic, and increasing amount of sand delivered to the Plant (resulting in conservatively high particulate emissions for unloading). An annual average truck load was 30 t/truck.

- **Batch Plant Vent**: A portion of emissions associated with rail and truck offloading of material occurs here, as well as emissions from material blending (unloading of material, loading onto the conveyor). Since the facility will be working 24 hours and 365 days a year, wet sand transport will vary depending on month, and deliveries will be made 16 hours per day, a silo will store excess wet sand (up to 10 days storage).
- **Conveyor**: Blended material from the batch plant is loaded onto and transported by a fully covered conveyor to the production building (during both **Phase 1** and **Phase 2**). It was assumed that there are eight conveyor transfer points between the batch plant and the production area and six transfer points inside the production building. The conveyor was assumed to operate 24 hour a day.
- **Production Building Vent**: The covered conveyor will bring the mixture into the production building where it is unloaded. Two GP55N (5 t) forklifts add cullet (broken glass) to the mixture. Produced glass is transported from the production area (production vent emissions) area to storage (warehouse vent) by four DP70N1 (8 t) forklifts. It was assumed that all these forklifts are working 24-hours a day.
- **Warehouse Vent**: Loading of product pallets into containers by three GP45N forklifts. The containers are handled by two 50 t Kalmar dcf500-12 forklifts. It was assumed the Kalmar forklifts operate 75% of the time at the loading area and 25% of the time inside the warehouse. The Kalmar forklifts will operate 16 hours daily inside the warehouse (6:00 am to 10:00 pm). Emissions from two GP45N (4 t) forklifts used for maintenance and service were added to warehouse vent emissions. All equipment (except Kalmar forklifts) works 24 hours per day.
- **Loading Area**: The Kalmar forklifts will travel from the warehouse to the loading area and load product containers onto 20-t trucks (68 trucks daily), 25% of the time inside the warehouse and 75% of the time carrying and loading containers.

5.2 Additional Model Assumptions

The source model input parameters, emission source locations, and emissions are summarized in **Table 7** to **Table 11**. The following assumptions were used in modelling:

- All transport emission sources except the railway sources and commutes traffic were based on 16-hour operations 365 days per year. For truck transport, the maximum possible number of trucks within one hour was determined (3 trucks/hour) and this maximum was used to calculate emissions and model them for 16 hours. As a result, instead of 27 to 44 trips daily with wet sand and 1 trip with material for batch plant, it was assumed there will be 48 truck trips daily. This approach was adopted to calculate realistic maximum hourly emissions of SO_2, NO_2, and CO.
- All emission sources were assumed to operate simultaneously. Emissions assumed 16-hour operation for 68 20-t trucks transporting final product (five days a week cycle) and delivery of pallets and containers (flatbed trucks). There will be at most five trucks/hour and therefore 80 daily trips were modelled. However, in fact they will be no more than 74 trips within these 16 hours for 5 days a week cycle (and 54 trips/day for 7 days a week cycle); therefore, the maximum 1-hour predictions of SO_2, NO_2, and CO will be realistic but 24-hour and annual averages will be conservative.
- The conveyor will work 24 hours 365 days in a year.
- Particulates emissions from material loading – unloading and mixing (batch house vent, production vent, and for conveyor) were reduced by 70% since those areas are fully enclosed (NPI, 2012).
- The furnace emissions are modelled as maximum levels guaranteed by furnace manufacturer (e.g., 1.5 kg of NO_X per 1 t of glass). The stacks parameters and emissions were provided by CPS. NO_X,

SO_2, and particulate emissions reflect the net emissions downstream of the emissions control equipment that CPS expects the use for the Air-fired glass melting furnace currently considered in design. These limits are intended to represent the latest emissions control technology and be aligned with the CPS' mission and vision to be "World Class" in their environmental stewardship. The control equipment would be aligned with U.S. BACT (Best Available Control Technology), which also considers some level of economic viability. The intent would be to manage the process to meet these limits.

- Batch mix materials will be received by train two or three times a week. Conservatively, train and switch locomotive emissions were modelled for 365 days a year.
- 44 trips /16 hours = 2.75 B-Trains/h transporting wet sand from the quarry and 1 trip /16 hours = 0.06 flat deck trucks/h delivering big bags with batch material additives for batch plant (or oil tanker or similar heavy-duty truck) – total 2.81 trips/h and 3 trips/hour were modelled
- 68 trips /16 hours = 4.25 trucks (20 t)/h with final product and 6 trips /16 hours = 0.375 flat deck trucks/h delivering racks and/or pallets – total 4.625 trips per hour and 5 trips/hour were modelled.
- 20 trips of company cars and 6 trips of company trucks 16 hours = 1.625 company vehicles/h. Two vehicles/h to account for this and all other light traffic at and around the solar glass plant (e.g., lower-emitting visitor cars and/or light trucks).

The following approaches to mitigation of particulate emissions were incorporated into the model:

- All raw material and conveyor are inside of fully covered enclosures.
- It was assumed that fugitive particulate emissions from material handling at enclosed areas will be reduced by 70% (NPI, 2012).
- For wind speed dependent particulate emissions, it was assumed that wet sand is coarse (fines removed at the quarry). All raw materials will be stored in silos. According to NPI (2012), emissions from fully enclosed piles should be reduced by 99%. There are no high winds inside fully enclosed buildings. According to methods described in US EPA (2006a) and EC (2022), particulate emissions from wind erosion are zero when the wind speeds are relatively low (below 10 m/s – US EPA, 2006a) and they cannot be achieved in closed areas, Wind generated emissions were considered as negligible in comparison to loading, unloading, and paved road fugitive dust emissions. Wind speed dependent emissions were not quantified and modelled.
- The unloading/loading emissions were modelled assuming an average ambient wind speed of 4.63 m/s and moisture content 3%.
- Batch material unloaded from railcars (e.g., dolomite, limestone, feldspar flint, soda ash, and sodium sulphide) could have more than 3% moisture (e.g., average moisture content in materials at municipal solid waste landfills is 12%; US EPA, 2006b).
- Mitigation for dust fugitive emissions was assumed to apply equally to all particle sizes. No mitigation was applied to vehicle exhaust emissions beyond that associated with medium age Tier 3 and Tier 4 diesel engines.
- The B-Train truck load was conservatively assumed to be 40 t/truck. The load may vary, and the average load could be 30 t/truck. Lighter trucks have lower fugitive dust emissions.

Table 12 presents hourly emission factors for increased traffic on the access road due to the commute for solar glass plant employees as well as variable emissions due to equipment working 16 hours, the switch locomotive and line locomotive. **Table 13** summarizes total Plant emissions. Emissions from the two furnace stacks are 80% to over 99% of total emissions. More detailed descriptions of all assumptions used for emission estimates are provided in **Attachment A**.

Table 7: Modelled Furnace Stacks Parameters

Point Source Name	Source ID	UTM 14 (m)		Elevation (m ASL[1])	Stack Orientation	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
		W	N						
Furnace Stack 1	FUR1	651021	5559525	224	Vertical	46	1.6	13.5	490
Furnace Stack 2	FUR2	651072	5559494	224	Vertical	46	1.6	13.5	490

Note: 1. ASL – Above Sea Level

Table 8: Modelled Furnace Stacks Emissions

Point Source Name	Source ID	Emission Rate (g/s)								
		SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP	NH_3	HF	HCl
Furnace Stack 1	FUR1	4.167	10.42	0.694	0.903	1.181	2.083	0.115	0.028	0.069
Furnace Stack 2	FUR2	4.167	10.42	0.694	0.903	1.181	2.083	0.115	0.028	0.069
TOTAL Stack Emissions (g/s)		**8.33**	**20.83**	**1.39**	**1.81**	**2.36**	**4.17**	**0.23**	**0.056**	**0.139**
TOTAL Stack Emissions (kg/d)		**720**	**1,800**	**120**	**156**	**204**	**360**	**19.8**	**4.8**	**12.0**

Table 9: Modelled Volume Source Parameters

Volume Source Name	Sources Number	Source ID	UTM 14 (m)		Elevation (mASL[1])	Effective Height (m)	Initial Sigma Y (m)	Initial Sigma Z (m)	Emission Rate (g/s/source)						Variable Emissions
			W	N					SO_2	NOx	CO	$PM_{2.5}$	PM_{10}	TSP	Yes/No
Loading Area	1	Load	650657	5559266	224	4.0	6.8	3.7	7.2E-04	0.226	0.128	0.0233	0.0260	0.0370	Yes[2]
Production Vent	1	ProdVent	650931	5559321	224	4.4	99.6	4.1	8.5E-04	0.028	0.023	0.0059	0.0319	0.0659	No
Warehouse Vent	1	WarhVent	650818	5559133	224	5.3	22.7	4.9	9.8E-04	0.098	0.076	0.0086	0.0089	0.0089	Yes[2]
Batch Plant Vent	1	BatchVent	650835	5559523	224	15.0	19.8	14.0	1.5E-04	0.006	0.007	0.0015	0.0086	0.0178	Yes[2]
TOTAL Vents and Loading Area Emissions (g/s)									**0.0027**	**0.356**	**0.233**	**0.041**	**0.085**	**0.154**	-
TOTAL Vents and Loading Area Emissions (kg/d)									**0.21**	**22.1**	**15.2**	**2.56**	**5.87**	**10.8**	-

Note: 1. ASL – Above Sea Level
*2. See **Table 10***

Table 10: Hourly Emission Factors for Loading Area and Vents (Unitless)

Hour	Loading Area	Warehouse Vent						Batch Plant		
	All Compounds	SO_2	NOx	CO	$PM_{2.5}$	PM_{10}	TSP	$PM_{2.5}$	PM_{10}	TSP
0 to 1	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
2	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
3	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
4	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
5	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1
23	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182
24	0	0.755	0.229	0.436	0.120	0.117	0.101	0.232	0.187	0.182

Table 11: Modelled Line Source Parameters (Roads and Rail)

Volume Source Name	Sources Number	Source ID	UTM 14 (m)		Elevation (mASL[1])	Effective Height (m)	Initial Sigma Y (m)	Initial Sigma Z (m)	Emission Rate (g/s/source)						Variable Emissions
			W	N					SO_2	NOx	CO	$PM_{2.5}$	PM_{10}	TSP	Yes/No
Access Road from PTH 4 to Gate	4	Haul1 to Haul4	650971 651103	5559715 5559634	224 223	2.3	23.3	2.1	1.7E-06	0.0013	0.0018	3.7E-04	0.0016	0.0034	Yes[2]
Access Road from Gate to Parking	4	Haul21 to Haul24	651149 651166	5559607 5559505	223 223	2.3	23.3	2.1	8.6E-06	4.7E-04	0.0113	1.9E-04	8.7E-04	0.0028	Yes[2]
Final Product and Batch Plant Routes from Gate to Intersection	5	Haul5 to Haul9	651106 650924	5559599 5559595	223 224	2.3	23.3	2.1	1.7E-06	0.0013	0.0018	9.0E-04	0.0038	0.0184	Yes[2]
Batch Plant Route Point before Batch	1	Haul10	650874	5559588	224	2.3	23.3	2.1	6.0E-07	6.1E-04	6.0E-04	3.3E-04	0.0014	0.0069	Yes[2]
Batch Plant Route to Final Product Route	2	Haul11 & Haul12	650784 650752	5559469 5559421	224 224	2.3	23.3	2.1	6.0E-07	6.1E-04	6.0E-04	1.4E-04	5.8E-04	0.0027	Yes[2]
Final Product and Batch Plant Routes to Intersection	5	Haul13 to Haul17	650779 650892	5559384 5559553	224 224	2.3	23.3	2.1	1.4E-06	6.9E-04	0.0015	5.8E-04	0.0025	0.0118	Yes[2]
Final Product Route to Loading Area	3	Haul18 to Haul20	650749 650677	5559338 5559282	224 224	2.3	23.3	2.1	4.1E-05	0.0074	0.0029	2.8E-04	0.0010	0.0033	Yes[2]
Railway from SW (In) toward Batch Plant	3	Train1 to Train3	651102 651010	5559614 5559651	223 224	2.5	23.3	2.3	0.0023	0.0433	0.0271	1.3E-04	0.0012	0.0012	Yes[2]
Railway around Batch Plant	5	Train4 to Train8	650960 650812	5559649 5559525	224 224	2.5	23.3	2.3	7.2E-04	0.0980	0.0664	2.3E-04	0.0022	0.0022	Yes[2]
Railway: Batch Plant to Out of the Plant	12	Train9 to Train20	650782 650682	5559485 5559012	224 224	2.5	23.3	2.3	0.0023	0.0433	0.0271	1.3E-04	0.0012	0.0012	Yes[2]
Conveyor Transfer Points	8	Conv1 to Conv8	650877 651005	5559578 5559495	224 224	5.5	1.4	1.4	0	0	0	5.3E-04	0.0035	0.0074	No
TOTAL Road Daily Maximum Emissions (kg/d)									**0.025**	**1.1**	**2.96**	**0.65**	**2.79**	**13.0**	-
TOTAL Railway Daily Maximum Emissions (kg/d)									**0.37**	**31.4**	**21.1**	**0.08**	**0.71**	**0.71**	-
TOTAL Conveyor Daily Maximum Emissions (kg/d)									**0**	**0**	**0**	**0.365**	**2.41**	**5.09**	-

Note: 1. ASL – Above Sea Level
2. See Table 12

Table 12: Hourly Emission Factors for Modelled Line Sources (Unitless)

Hour	Access Road from PTH 4 to Gate (H1 to H4)						Internal Roads	Access Road (H21 to H24)				Railroad Train 1-3; 9-20	Railroad Train 4 to 8			
	SO_2	NO_x	CO	$PM_{2.5}$	PM_{10}	TSP	All Compounds	SO_2= NO_x= CO	$PM_{2.5}$	PM_{10}	TSP	All Compounds	SO_2	NO_x	CO	$PM_{2.5}$=PM_{10} =TSP
0 to 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	5.999	1.368	7.405	1.517	1.541	1.487	1	1	1	1	1	1	4.18	1.442	1.408	1.552
7	2.992	1.146	3.552	1.204	1.214	1.192	1	0.3985	0.3945	0.3949	0.3937	0	1	1	1	1
8	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
9	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
10	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
11	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
12	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
13	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
14	6.300	1.390	7.790	1.542	1.568	1.510	1	1.060	1.050	1.051	1.047	0	1	1	1	1
15	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
16	2.992	1.146	3.552	1.204	1.214	1.192	1	0.3985	0.3945	0.3949	0.3937	0	1	1	1	1
17	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
18	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
19	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
20	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
21	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
22	5.999	1.368	7.405	1.517	1.541	1.487	1	1	1	1	1	0	1	1	1	1
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 13: Total Solar Glass Plant Maximum Daily Emissions

Sources	Emission Rate (kg/d)								
	SO_2	NO_x	CO	$PM_{2.5}$	PM_{10}	TSP	NH_3	HF	HCl
Furnace Stacks	720	1,800	120	156	204	360	19.8	4.8	12.0
Vents and Loading Area	0.23	28.6	18.9	3.22	6.54	11.5	0	0	0
Paved Roads	0.0025	1.1	3.0	0.65	2.79	13.0	0	0	0
Railway	0.37	31.4	21.1	0.08	0.71	0.71	0	0	0
Conveyor	0	0	0	0.37	2.41	5.09	0	0	0
TOTAL Plant Emission	**721**	**1,861**	**163**	**160**	**216**	**390**	**20**	**5**	**12**

5.3 GHG Emissions

The greenhouse gas (GHG) assessment was completed based on the Project components that would contribute appreciably to GHGs including:

- Furnace stacks emissions based on estimated annual natural gas usage
- Emissions from the process (batch material melting, forming of glass sheets, and cooling)
- Emissions from the non-road mobile fleet (forklifts) considering estimated annual diesel/gasoline consumption
- Emissions from line locomotive and switch locomotive
- Emissions from trucks, trucks which supply solar glass plant and trucks with final product, travelling from PTH 4 to the plant
- Indirect emissions from electricity use in operations based on estimated consumption and the GHG intensity of the grid

Table 14 summarizes estimated annual GHG emissions from the Project sources. The total annual GHG emission calculation was completed using the information provided by CPS as well as recommended emission factors from Canada's Greenhouse Gas Quantification Requirements (EC 2021), US EPA (2008, 2010, 2022) for non-road equipment, NIR (2022) for electricity indirect emissions, and the US EPA MOVES model for on-road truck emissions. Detailed GHG calculations are provided in **Attachment A**, **Section A4**.

Diesel fuel consumption was calculated using Hourly Fuel Consumption Tables from Caterpillar (2019) (Owning & Operating Cost Section).

Electricity annual consumption was calculated using factors and methods presented in CPS (2021). Annual electricity consumption was estimated as 394.54 GW. The most recent NIR (2022) emission factor for Manitoba (Table A13-8): 1.2 t of CO_{2eq}/GW-h from year 2019 (and 2020) was used to calculate indirect CO_{2eq} emissions.

Pre-COVID Manitoba and Canada-wide emissions from 2019 are provided for comparison.

Table 14: Total GHG Emissions from Operations

Emission Sources	Annual Usage Rate Value	Unit	Total Annual CO2eq Emissions (t/y)
Direct Emission			
Natural Gas Combustion Furnaces	73,584,000	m^3	141,506
Process – Batch Material Melting, Forming, Cooling	166,674	t	71,861
Transport by Trucks: Final Product, Batch Additives, Company Cars & Trucks, Commute, etc.	Variable-depending on engine size and annual utilization		127
One Line Locomotive to Transport Batch Mix Additives + One Switch Locomotive	Variable-depending on engine size and annual utilization		11,371
Non-Road Equipment (Forklifts) Exhaust	Variable-depending on engine size and annual utilization		2,942
		Total Direct	**227,807**
Indirect			
Electricity Usage	394,540,900	kW-hr	473
		Total Indirect	473
		Total Plant	***228,280***
		Manitoba, Total for 2019	***22,600,000***
		Canada Total for 2019	***738,000,000***

6. Dispersion Modelling Results

The maximum modelled ground-level concentrations resulting from the Project emissions are shown in **Table 15** to **Table 18**. **Attachment B**, **Figures B1** to **B8**, provides isopleths of:

- 1-hour and 24-hour average predictions of NO_2 **(Figure B1** and **Figure B2**)
- 24-hour predictions of $PM_{2.5}$, PM_{10}, and TSP (**Figure B3, B4** and **B5**)
- 1-hour average predictions of CO (**Figure B6**)
- 1-hour and 24-hour average predictions of SO_2 (**Figure B7** and **Figure B8**)

The remaining predictions were near background and isopleth figures are not included.

The observations from modelling assessment are:

- All predictions outside the Plant perimeter are below the MAAQC.
- Maximum concentrations of 1-hour average NO_2 (56% of MAAQC) were predicted at the location of the H.D. Repair & Welding Inc. (**Figure B1**) and maximum concentrations of 24-hour average NO_2 (54% of MAAQC) were predicted near the northwest corner of the fence line (**Figure B2**). The maximum annual average was 39% of MAAQC.
- Maximum predicted 24-hour average PM_{10} and $PM_{2.5}$ concentrations occur near the southwest corner of the fence line ($PM_{2.5}$ maximum is 70% of MAAQO; **Figure B3** and PM_{10} 72% of MAAQC; **Figure B4)**
- The maximum 24-hour average TSP concentration was predicted at the northern plant boundary near H.D. Repair & Welding Inc. (73% of MAAQC; **Figure B5**).
- The TSP maximum annual average was predicted as 26% of MAAAQC.
- The CO maximum 1-hour average (3% of MAAQC) and the CO 8-hour average maximum (3% of MAAQC) were predicted at the western plant boundary (**Figure B6**) near the northwest corner of the fence line.
- The SO_2 maximum 1-hour average (5% of MAAQC) was predicted around 70 m of the northern plant boundary (**Figure B7**), the SO_2 maximum 24-hour average (7% of MAAQC) was predicted near the southeastern corner of the plant boundary (**Figure B8**) and the maximum annual average (6% of MAAQO) was predicted at southeastern fence line.
- Maximum predicted concentrations of NH_3, HF and HCl were between 0.3% (HCl 1-hour average) and 20% (HF 70-day average) of the MAAQC.

The model predicts maximum concentrations at or near the solar glass plant boundary for worst-case emission scenario days and meteorological conditions. The worst-case emission assumptions included the line locomotive operating every day and heavy-duty vehicle trips of 128 per day rather than the expected 101 (January to March) to 118 (April to June) one-way trips per day (for the five days/week cycle). These worst-case emissions were applied to five years of meteorological data, including the specific conditions that contribute to worst-case predictions. However, it is unlikely the worst-case emissions occur coincidently with worst-case meteorology.

Furthermore, the maxima occur during winter (January and February) when more frequent stable atmospheric conditions are expected. Stable atmospheric conditions cause poor dispersion of emitted compounds and resulted in higher concentrations around the boundary than in other conditions. However, in winter, there will be fewer sand deliveries from the quarry so predicted concentrations are over-estimated. In terms of particulate emissions in winter, snow cover and frozen conditions were not incorporated into all model sources, which would also overestimate the predicted concentrations.

Finally, the model did not incorporate natural dust suppression from rain and snowfall. According to the Canadian Climate Normals (EC 2022) for Winnipeg, there are 125 days annually with precipitation 0.2 mm or above. Thus, natural dust suppression will occur about 34% of the time and contribute to further emission reduction.

Table 15: Maximum Predicted Concentrations of Particulates

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration (µg/m³)	Maximum Predicted Concentration + Background (µg/m³)	MAAQC (µg/m³)
$PM_{2.5}$	24-hour	6.7	14.4	21	30
PM_{10}	24-hour	9.0	26.6	36	50
TSP	24-hour	18	68.8	87	120
	Annual mean	11	6.5	18	70

Table 16: Maximum Predicted Concentrations of Gaseous Compounds

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration (µg/m³)	Maximum Predicted Concentration + Background (µg/m³)	MAAQC (µg/m³)
CO	1-hour	173	850	1,023	35,000
	8-hour	115	261	376	15,000
NO_s - TCM	1-hour	24	1,255	1,279	400
	24-hour	17	252	269	200
	Annual Mean	11	28	39	100
NO_2 - OLM	1-hour	24	198	222	400
	24-hour	17	91	108	200
	Annual Mean	11	28	39	100
SO_2	1-hour	4.5	36.8	41.3	900
	24-hour	4.1	16.7	20.8	300
	Annual mean	2.0	1.4	3.4	60
NH_3	1-hour	13.2	0.54	13.7	1,400
HF	24-hour	-	0.131	0.131	0.85
	7-days	-	0.076	0.076	0.55
	30-days	-	0.051	0.051	0.35
	70-days	-	0.040	0.040	0.20
HCl	1-hour	-	0.32	0.32	100

Table 17: Maximum Particulate Predictions at Sensitive Receptors

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration at Sensitive Receptors (µg/m³)		Location – Distance from Fence Line	MAAQC (µg/m³)
			Maximum	Maximum + Background		
$PM_{2.5}$	24-hour	6.7	3.5	10	H.D. Repair & Welding Inc. 30 m NE	30
PM_{10}	24-hour	9.0	19.7	29	H.D. Repair & Welding Inc. 30 m NE	50
TSP	24-hour	18	65	83	H.D. Repair & Welding Inc. 30 m NE	120
	Annual mean	11	6.5	18	H.D. Repair & Welding Inc. 30 m NE	70

Table 18: Maximum Gaseous Compound Predictions at Sensitive Receptors

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration at Sensitive Receptors (µg/m³)		Location – Distance from Furnace Stacks	MAAQC (µg/m³)
			Maximum	Maximum + Background		
CO	1-hour	173	834	1,007	H.D. Repair & Welding Inc. 30 m NE	35,000
	8-hour	115	214	329	H.D. Repair & Welding Inc. 30 m NE	15,000
NO_2 - TCM	1-hour	24	1,255	1,279	H.D. Repair & Welding Inc. 30 m NE	400
	24-hour	17	165	182	H.D. Repair & Welding Inc. 30 m NE	200
	Annual Mean	11	13	24	H.D. Repair & Welding Inc. 30 m NE	100
NO_2-OLM	1-hour	24	198	222	H.D. Repair & Welding Inc. 30 m NE	400
	24-hour	17	91	108	H.D. Repair & Welding Inc. 30 m NE	200
	Annual Mean	11	28	39	H.D. Repair & Welding Inc. 30 m NE	100
SO_2	1-hour	4.5	36	40.8	H.D. Repair & Welding Inc. 30 m NE	900
	24-hour	4.1	12.6	16.7	Easton Place Pharmacy 120 m SSE	300
	Annual mean	2.0	1.0	3.0	Easton Place Pharmacy 120 m SSE	60
NH_3	1-hour	13.2	0.35	13.6	H.D. Repair & Welding Inc. 30 m NE	1,400
HF	24-hour	-	0.086	14.2	Easton Place Pharmacy 120 m SSE	0.85
	7-days	-	0.050	0.086	Easton Place Pharmacy 120 m SSE	0.55
	30-days	-	0.033	0.050	Easton Place Pharmacy 120 m SSE	0.35
	70-days	-	0.026	0.033	Easton Place Pharmacy 120 m SSE	0.20
HCl	1-hour	-	0.21	0.21	H.D. Repair & Welding Inc. 30 m NE	100

7. Conclusions

7.1 Air Quality

The dispersion modelling assessment predicted no exceedances of the MAAQC for particulate matter (TSP, PM_{10}, and $PM_{2.5}$) and/or gases from combustion (particulates from combustion, HCl, HF, NH_3, CO, NO_2 and SO_2) at any location. It is concluded that the operations phase of the Project is likely to have minimal impacts on the air quality of the region, for the following reasons:

- The AERMOD model used in the assessment is generally considered to be conservative
- Modelling was using maximum, guaranteed by manufacturer, emission levels from furnace stacks (the main source of emissions)
- Emission rates, for material handling and transport, used in modelling, were conservative, over-estimating transportation emissions in winter months and from all sources for averaging periods greater than one hour, and
- The effects of precipitation or snow cover to reduce particulate emissions were not considered.

7.2 GHG

The Project is estimated to generate 228,280 tonnes of CO_2e annually (using maximum emissions from furnace stack operations) which is 1.0 % of the reported emissions in 2019 which were 22.6 Mt CO_2e from Manitoba (Climate Change Connection, 2020), and 0.031% of the reported 738 Mt CO_2e from Canada in 2019 (Environment Canada, 2020).

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Attachment A

Emissions Estimates Details

Table of Contents

Tables

A1. Introduction

This attachment summarizes methods used to estimate emissions from the Canadian Premium Sand Inc. (CPS) Solar Glass Manufacturing Facility (solar glass plant) during normal operations. This facility will produce glass for use in the manufacturing of solar panels, with the primary ingredient being high purity, low iron silica sand sourced from CPS' Wanipigow Sand Extraction Project (quarry project) near Seymourville, Manitoba.

Section 2.2 of the Air Dispersion Modelling report summarizes solar glass plant activities. CPS plans to commence glass production with a single **Phase 1 facility** producing approximately 600 to 800 tonnes per day but intends to increase that capacity up to, but not exceeding, approximately 1,200 tonnes per day within a few years by constructing a second **Phase 2 facility** adjacent to the **Phase 1 facility**.

It is currently planned that construction of the **Phase 1 facility** will commence in early 2023 with glass production being realized in mid-2025. The full build-out of the **Phase 1** and **Phase 2 facility** is expected to occur within approximately five years of the completion of the **Phase 1 facility** i.e., by 2030. Each facility is expected to remain in operation for an estimated 30 years and will be operational 24 hours a day, seven days a week, 365 days per year with shutdowns being planned at approximately 15-year intervals for furnace maintenance.

To provide a worst-case scenario, it was assumed that sand and final product will be transported from the solar glass plant throughout the year for five days a week between 6 am and 10 pm (16 hours/day). Transport might be extended to 7 days a week and emissions will be lower, since the same amount of material will be moved over 7 days instead of 5 days (40% decrease of traffic, and emissions). The number of trips per day for wet sand delivery varies from 27 to 44 one-way trips for 5 days/week cycle and from 19 to 31 one-way trips a day for 7 days/week cycle. The maximum number of trips with wet sand from the quarry (44), planned for April to June, was chosen as the worst case and modelled for 365 days a year (instead of the 261 days/year transport will occur). Similarly, transport of final product will occur on 48 trips/day for the 7 days/week cycle but was modelled for 68 trips/day for a 5 days/week cycle.

Besides wet sand, the solar glass plant will receive other batch material by rail including dolomite, feldspar, and soda ash, and some glass additives). Delivery will occur by rail 2 to 3 times a week with up to 24 rail cars (80 t/car). Some additives will be delivered by flat-deck truck in big bags (e.g., sodium sulphide, carbon). Conservatively, it was assumed there will be 3 trucks per hour delivering sand and big bags to the plant (16 hours per day).

Solar glass (final product) will be transported in containers offsite by 20-t trucks (maximum 68 trips/day – 5 days/week). Product and package supplies (containers and racks) will be transported using up to 6 20-t trucks/day for 7 days per week and 16 hours per day.

The following compounds were modelled and assessed. Fugitive dust particulate emissions include:

- Particulate matter with diameter less than 2.5 μm ($PM_{2.5}$)
- Particulate matter with diameter less than 10 μm (PM_{10})
- Particulate matter with diameter less than 30 μm – Total Suspended Particulates (TSP)

Diesel combustion equipment and solar glass plant furnace stacks will emit particulate and gases, of which the following compounds were modelled.

From diesel combustion and furnace stacks:

- Sulphur Dioxide (SO_2),
- Nitrogen Oxides (NO_X),

- Carbon Monoxide (CO),
- Particulate emissions, mainly PM_{10} and $PM_{2.5}$, from diesel combustion or furnace stacks, and
- Greenhouse Gases (GHG), mainly Carbon Dioxide (CO_2), Methane (CH_4), and Nitrogen Oxide (N_2O).

From furnace stacks only:

- Hydrogen Chloride (HCl)
- Fluorides (HF) and
- Ammonia (NH_3).

Emissions have been estimated based on available information, and were calculated using conservative assumptions, which represent the highest hourly, daily, and annual values.

A2. Supporting Information for Dust Emission Calculations

A2.1 Material Properties

Table A1 summarizes the material properties used for the emission estimates.

Table A1: Material Properties

Property / Material	Moisture Content (%)	Silt Loading (g/m^2)
Wet Sand Transported from Quarry Project	3	-
Wet Sand and other Material Handled at Solar Glass Plant	3	-
Silt Loading (sL) for Paved Roads Inside the Plant	-	0.6
Silt Loading (sL) for Paved Access Roads	-	0.2

It was assumed that processed at quarry project wet sand has an 3% moisture content. It was also assumed that all materials unloaded from rail also has 3% moisture content, although some materials may have higher moisture content (soda ash, sodium sulphur, and carbon).

For paved internal roads, the default silt loading of 0.6 g/m^2 was used assuming less than 500 average daily traffic (ADT) counts on the road. For the access roads, a silt loading of 0.2 g/m^2 was used since there will also be local traffic on this road (ADT from 500 to 5,000; US EPA, 2011).

A2.2 Hours of Operation

The proposed solar glass plant will operate three daily shifts. Loading of final product to 20-t trucks will occur 16 hours a day (two shifts), 7 days/week, but the loading volume was increased for modelling to reflect a five days/week cycle. Modelled and anticipated hours of operations are summarized in **Table A2**.

Table A2: Modelled and Anticipated Hours of Operation

Operation / Time	Hours/Day Working	Hours/Day Modelled
Wet Sand Transported from Quarry Project by B-Train Trucks	16	17
Loading Area (Forklift Kalmar dcf500-12)	16	17
Delivery of Pallets or Racks for Transport of Glass by Flat Deck Trucks	4	17
Conveyour Between Batch Plant and Production Area	16	24
Unloading of Material from Railcars at Batch Plant	16	17
Unloading of Material from B-Train (Flat Deck) Trucks	16	17
Line Locomotive – Train with Supplies (6:00 am) – 2 or 3 Times per Week	1	1
One Switch Locomotive around Batch Plant	16	17
One Flat Deck Trucks with Sodium Sulphate or Coal or Other Supplies	1	17
Blue Collar Employees Commute (6:00 am, 2:00 pm, and 10:00 pm)	3	3
White Collar Employees Commute (7:00 am and 4:00 pm)	2	2
Two Furnace Stacks, Three Vents	24	24

Most fugitive dust emissions were based on anticipated working hours but spread over 17 or 24 hours (for example, for the conveyor or loading area). Shift change occurs twice daily for two hours (6:00 am and 10:00 pm) and the modelled hours of operation were extended to include these two hours (17 hours instead 16 hours). Hourly emissions were calculated using 16 hours and daily emissions were increased for commuting to 17 hours. Emissions were modelled using time-dependent factors in AERMOD.

Gaseous emissions were calculated using the maximum number of trucks on site in one hour - 8 trucks per hour will be travelling in and out of the Plant at peak hours. Modelled predictions of CO, SO_2, and NO_2 are reported as maximum 1-hour averages.

A2.3 Batch Material Production

The maximum daily solar glass production is 960 t/day. Batch material to support this production is delivered by 80 t railcar loads, 40 t B-Train loads, and 20 t Flat Deck loads. Some material like carbon, sodium sulphide, hydrated lime, urea, and coating is not delivered every day. Modelling assumed a daily delivery of one Flat Deck truck. Rail deliveries larger than daily furnace requirements will be stored at the batch plant.

Table A3 summarizes the annual and maximum daily material production for the solar glass plant. The Daily Maximum value for train transport assumes 80-t rail cars and one train transporting material to the Plant twice a week to maximize daily and hourly maximum emissions. If there are three trains/week, each would bring less material to the Plant and emissions will be lower.

Maximum daily wet sand transported to the Plant assumes the maximum number of truck trips for five days a week and 16 hours a day, making delivered sand higher than daily and annual demand. In addition, using 3 trucks per hour to deliver sand (3 trucks/h * 16h * 40 t/truck = 1, 760 t/d), increased unloading emissions. Further explanation and discussion of this conservative approach are found in Section 3.2.

Table A3: Batch Material Balance

Material	Annual Maximum (t/y)	Daily Maximum (t/d)
Batch Material Mixed at Batch Plant and Used in Sand Glass Plant Furnaces		
Wet Sand Flint	258,149	707.3
Soda Ash	78,463	215.0
Dolomite Flint	69,246	189.7
Limestone Flint	18,834	51.6
Feldspar Flint	9,217	25.3
Sodium Sulphide	3,960	10.8
Carbon	131	0.36
Total Batch Loaded on Conveyour Unloaded at Plant	**480,448**	**1,200**
Cullet	43,800	109
Total Material Used in Furnace	**524,248**	**1,309**
Total Produced Solar Glass Panels (over 20% loss)	**350,400**	**960**
Total Produced Solar Glass Panels Loaded on Trucks	**350,400**	**960**
Batch Material Transported to Sand Glass Plant		
Wet Sand Flint - Transported from Quarry Project	258,149	1,760
Soda Ash - Delivered by Train (3 railcars)	78,463	800
Dolomite Flint – Delivered by Train (3 railcars)	69,246	240
Limestone Flint – Delivered by Train (1 railcar)	18,834	720
Feldspar Flint – Delivered by Train (1 railcar)	9,217	160
Sodium Sulphide / Carbon etc. – Delivered by Flat Deck Truck	3,960 / 131	20
Total Batch Material Delivered to Plant Daily, by Train	-	**1,440**
Total Material Delivered to Plant Daily, by Trucks	-	**1,780**
Total Material Unloaded at Batch Plant	-	**3,700**

A3. Fugitive Dust Emissions

A3.1 Loading/Unloading Emissions

The emission factor formula for loading, unloading, and transfer points at conveyor was sourced from AP 42 Section 13.2.4 (Aggregate Handling and Storage Piles; US EPA, 2006a):

$$TSP\left(\frac{kg}{t}\right) = \frac{0.0016 * 0.74 * \left[\frac{U}{2.2}\right]^{1.3}}{\left[\frac{M}{2}\right]^{1.4}}$$

$$PM_{10}\left(\frac{kg}{t}\right) = \frac{0.35}{0.74} * TSP\left(\frac{kg}{t}\right)$$

$$PM_{2.5}\left(\frac{kg}{t}\right) = \frac{0.053}{0.74} * TSP\left(\frac{kg}{t}\right)$$

Where:

- U is mean wind speed (4.63 m/s)
- M is moisture content (%) (**Table A1**)

Loading / unloading emissions are wind speed dependent. However, all loading and unloading areas are fully covered and winds speeds will be low. The average wind speed in the AERMET meteorological file (4.63 m/s) was conservatively used to calculate emissions. At higher wind speeds (43% winds are higher than the average) there are more favourable for dispersion conditions and the maximum predictions of particulates can be found further away from the source and lower in magnitude. The equations have a US EPA "A" rating (excellent) for aggregate handling.

Following is an example emission calculation of TSP emissions from loading/unloading of wet sand or products delivered by rail:

$$TSP\left(\frac{kg}{t}\right) = \frac{0.0016 * 0.74 * \left[\frac{4.63\frac{m}{s}}{2.2}\right]^{1.3}}{\left[\frac{3.0}{2}\right]^{1.4}} = 0.00177$$

For 16 hours per workday, maximum emissions for unloading of wet sand (1,760 t/d) from trucks and batch mix material from Flat Deck truck (20 t/d) and train (1,920 t/d) are:

$$TSP\ (kg/d) = 0.00177\ kg/t * 3{,}700\ t/d = 6.54$$

For 24 hours per workday, maximum emissions for loading of batch mixture on conveyor (1,200 t/d) are:

$$TSP\ (kg/d) = 0.00177\ kg/t * 1{,}200\ t/d = 2.12$$

According to Australian Emission Estimation Technique Manual for Mining (NPI, 2012), due to the enclosure of material handling activities there is a 70% reduction in particulate emissions for miscellaneous transfer and conveying and for rail loading/unloading and a 99% reduction for loading onto stockpiles and for wind erosion from stockpiles. Conservatively, a 70% reduction was used for all fugitive particulate sources in enclosed areas and the maximum fugitive emission from batch plant was:

$$TSP(kg/d) = (6.54 + 2.12)\ kg/d * (1 - 0.7) = 2.60\ kg/d$$

Table A4 presents the maximum 16-hour emissions for material unloading from trucks and train, and 24-hour emissions calculated for conveyor loading, unloading, and transfer points assuming 70% emission reduction due to enclosure.

Table A4: Loading and Unloading Maximum 24-Hour Average Emissions

Operation	TSP 24/16-Hour Maximum (kg/d)	PM_{10} 24/16-Hour Maximum (kg/d)	$PM_{2.5}$ 24/16- Hour Maximum (kg/d)
Batch Plant Unloading of Wet Sand and Batch Mix Compounds	1.96	0.928	0.140
Batch Plant Loading of Batch Mix Compounds on Conveyor	0.64	0.301	0.046
Eight Conveyour Transfer Points between Batch Plant and Production Building	5.09	2.407	0.365
Unloading from Conveyour, Loading to Furnace	1.27	0.602	0.091
Six Transfer Points inside Processing Plant Building	3.82	1.805	0..273
TOTAL DAILY Emissions from Loading / Unloading	**12.8**	**6.04**	**0.64**

A3.2 Vehicle Parameters (for Wheel Entrainment Emissions)

Table A5 summarizes the number of daily truck trips by month for a work cycle of 5 days/week for sand travel and final product transport and 16 hours/day. A 5 days/week cycle results in a more conservative emission estimate since the same amount of material transported in a 7-day week is transported in five days. The data was supplied by CPS.

Table A5: Maximum Number of Truck Trips for the Worst-Case (Work Cycle of 5 Days/Week and 16 Hours/Day)

Month	Wet Sand from Quarry	Packing and Additives (e.g., Carbon)	Finished Product	Total One-Way Trips per Day	Total One-Way Trips per Hour	Total Two-Way Trips per Day	Total Two-Way Trips per Hour
January	26.9	7	67.2	101.1	6.3	202.2	12.6
February	26.1	7	67.2	100.3	6.3	200.6	12.5
March	26.1	7	67.2	100.3	6.3	200.6	12.5
April	43.2	7	67.2	117.4	7.3	234.8	14.7
May	43.2	7	67.2	117.4	7.3.	234.8	14.7
June	43.2	7	67.2	117.4	7.3	234.8	14.7
July	38.9	7	67.2	113.1	7.1	226.2	14.1
August	38.9	7	67.2	113.1	7.1	226.2	14.1
September	38.9	7	67.2	113.1	7.1	226.2	14.1
October	38.9	7	67.2	113.1	7.1	226.2	14.1
November	38.9	7	67.2	113.1	7.1	226.2	14.1
December	28.9	7	67.2	103.1	6.4	206.2	12.9

Conservatively, the period from April to June was used for road emission estimation, rounding the number of one-way truck trips with wet sand to 44 per day and truck trips with finished product to 68 one-way trips per day. It was assumed during the worst-case hour, 8 trucks operate somewhere at the plant, three of them delivering material to

Batch Plant and five delivering pallets and containers (packing) and/or leaving the Plant with finished product. It was also assumed that two company cars or light trucks travel on the access road and/or any internal roads each hour for 16 hours a day.

Table A6 summarizes parameters of vehicles travelling on the access roads and internal roads. Emissions depend on total vehicle kilometres travelled (VKT).

Table A6: Parameters of Vehicles Transporting Material on Roads (during 16-hour day)

Vehicle	Total Modelled VKT (per Day)	One-Way Trips/Day	Vehicle Load (t)	Average Vehicle Weight (t)
Access Roads				
B-Train Trucks with Wet Sand from Quarry Project (Loaded & Empty)	19.34	44	40	43.5
Flat Deck Truck – Pallets or Racks	2.67	6	20	26.0
Flat Deck Truck – Raw Material	0.44	1	20	26.0
Trucks with Solar Glass Product	30.29	68	20	43.5
Company Cars or Trucks	13.18	26	0.08	2
Blue Collar Commute	83.84	3	0.08	2
White Collar Commute	21.84	2	0.08	2
Inside Roads				
B-Train Trucks from Gate to Batch Plant – Loaded with Wet Sand	14.50	44	40	63.5
B-Train Trucks from Batch Plant to Gate – Empty	29.00	44	0	23.5
Flat Deck Truck – Raw Material to Batch Plant Loaded	0.33	1	20	36.0
Flat Deck Truck –from Batch Plant Empty	0.66	1	0	16.0
Trucks Transport of Solar Glass from Gate to Loading Area (Empty & Loaded)	98.43	68	20	26.0
Flat Deck Trucks to Deliver Racks and Pallets (Loaded & Empty)	8.69	6	20	26.0
Company Cars or Trucks	52.74	26	0.08	2
Kalmar Forklift from Warehouse to Loading Area	7.4	37	50	80.3

Model assumptions included:

- A Flat Deck truck will deliver materials to the batch plant once daily, although for full annual production of solar glass, less than 229 trips per year are needed.
- There will be from 27 to 44 daily B-Train deliveries of wet sand (for 5 days a week) - 44 trips were modelled 365 days a year.
- Shipping of 1,360 t per day of final product was modelled with 68 trips per day (20 t load), 365 days a year, although only maximum of 48 truck trips per day (960 t/d of final product transport) are needed. The higher number of trips is the result of assuming that transport will occur five days a week instead of seven.

A3.3 Paved Road Fugitive Dust Emissions

Transportation emissions from cars and trucks on paved access and internal roads were calculated using equations in US AP 42, Section 13.2.1 (Paved Roads) (US EPA 2011):

$$TSP\left(\frac{g}{VKT}\right) = 3.23 * (sL)^{0.91} * \left(\frac{W}{0.9072}\right)^{1.02}$$
$$PM_{10}\left(\frac{g}{VKT}\right) = \frac{0.62}{3.23} * TSP\left(\frac{g}{VKT}\right)$$
$$PM_{2.5}\left(\frac{g}{VKT}\right) = \frac{0.15}{3.23} * TSP\left(\frac{g}{VKT}\right)$$

where:

- *sL* - is the silt loading of the road surface (**Table A1**)
- *W* – is average weight of vehicle fleet (**Table A5**)

We assume that there will be 3 trucks/hour transporting material to batch plant. However, there will be 44 trips per day of B-Train trucks and one trip per day of Flat Deck truck. To account for that we scale VKT's using proportion: 3 trucks/hour *44 B-Train trucks/day / (45 one-way trips/day). For example, the VKT for the B-Trains transporting wet sand on the access road is 19.34 km/d = 0.206 km/trip * 3 trucks/h * 16 h one-way * 2 return * 44 B-Train/ (44 B-Train + 1 Flat Deck). Similarly, VKT for 1 Flat Deck with additives delivered to batch house is 0.44 km/d = 0.206 km/trip* 3 trucks/h *16 h one way*2 return * 1 Flat Deck/(44 B-Train + 1 Flat Deck).

The emission factor for the B-Train trucks on access road is (silt loading 0.2 g/m^2 and average weight 43.5 t):

$$TSP\left(\frac{g}{VKT}\right) = 3.23 * (0.2)^{0.91} * \left(\frac{43.5}{0.9072}\right)^{1.02} = 38.7$$

Using VKT = 19.34 km/d (**Table A5**):

38.7 (g/VKT) * 19.34 km/d / (1000 g/kg) = 0.51 kg/d

Table A7 summarizes emission factors and **Table A8** summarizes emissions from solar glass plant access and internal roads.

Table A7: Fugitive Emission Factors (g/VKT) for on Access and Internal Roads

Source	Unit	TSP	PM_{10}	$PM_{2.5}$
Access Roads				
Emission Factor for B-Trains Empty, Loaded	g/VKT	38.7	7.43	1.80
Emission Factor for Flat Deck Empty, Loaded	g/VKT	22.9	4.39	1.06
Emission Factor for Commuting Cars Light Trucks or Company Vehicles	g/VKT	1.63	0.313	0.076
Internal Roads				
Emission Factor for B-Trains Loaded	g/VKT	154.6	29.68	7.18
Emission Factor for B-Trains Empty	g/VKT	56.1	10.77	2.61
Emission Factor for Flat Decks Empty, Loaded	g/VKT	62.2	11.94	2.89
Emission Factor for Flat Decks Loaded	g/VKT	86.7	16.64	4.03
Emission Factor for Flat Decks Empty	g/VKT	37.9	7.28	1.76
Emission Factor for Company Vehicles	g/VKT	4.43	0.85	0.206
Emission Factor for Kalmar Forklift Empty, Loaded	g/VKT	184.0	35.32	8.54

Table A8: Emissions (kg/d) on Access Road and Internal Roads

Source	Unit	TSP	PM_{10}	$PM_{2.5}$
Access Roads				
Emissions – B-Trains with Wet Sand from Quarry Project	kg/d	0.748	0.144	0.0347
Emissions – Flat Deck with Material to Batch Plant	kg/d	0.010	0.002	0.0005
Emissions – Flat Deck with Pallets Racks to Loading Area	kg/d	0.061	0.012	0.0028
Emissions – 20 t Trucks with Solar Glass Finished Product	kg/d	0.693	0.133	0.0322
Emissions Company Cars, Light Trucks	kg/d	0.022	0.004	0.0010
Emissions – Commuters (Cars, Light Trucks)	kg/d	0.172	0.033	0.0080
TOTAL Emissions from Access Road	**kg/d**	**1.71**	**0.327**	**0.079**
Internal Roads				
Emission - B-Trains Loaded Wet Sand to Batch Plant	kg/d	2.243	0.574	0.139
Emission - B-Trains Empty from Batch Plant	kg/d	1.627	0.312	0.076
Emission – 20 t Trucks Empty, Loaded Solar Glass to Loading Area	kg/d	5.651	1.085	0.262
Emission - Flat Decks Empty, Loaded with Racks, Pallets	kg/d	0.548	0.105	0.025
Emission - Flat Deck Loaded with Material to Batch Plant	kg/d	0.029	0.005	0.001
Emission - Flat Deck Empty from Batch Plant	kg/d	0.025	0.005	0.001
Emission – Company Cars, Light Trucks	kg/d	0.234	0.045	0.011
Emission - Kalmar Forklift Empty, Loaded*	kg/d	1.021	0.261	0.063
TOTAL Emissions from Internal Roads	**kg/d**	**11.72**	**2.39**	**0.579**

*Note: * Loading area emissions*

A3.4 Wind Generated Emissions from Stockpiles

According to methods described in US EPA (2006a) and EC (2022), particulate emissions from wind erosion are zero when the wind speeds are relatively low (below 10 m/s – US EPA, 2006a). Wind-generated emissions were therefore considered negligible compared to loading, unloading, and paved road fugitive dust emissions.

Furthermore, according to NPI (2012), emissions from fully enclosed piles should be reduced by 99%. The particulates emitted due to wind erosion of batch mix material stockpiles were not modelled because stockpiles will be inside silos where airflow is controlled, and speeds are low.

A4. Emissions from Combustion

The following section outlines the approach to estimate diesel combustion emissions from the Project equipment such as excavators, loaders, bulldozer, grader, and trucks and includes emission factors, parameters, and maximum hourly emissions of SO_2, NOx, CO, THC (VOC), $PM_{2.5}$, PM_{10}, and TSP.

A4.1 Non-Road Diesel Combustion Emissions

Table A9 lists Project diesel-powered non-road equipment based on Source Classification Code (SCC) with age (tier), power, and fuel consumption to calculate emissions from combustion. The list of equipment was provided by CPS.

Table A9: Source Classification Code (SCC) Parameters, Power, Age, and Fuel Consumption of Diesel-Powered Non-Road Equipment

SCC	Equipment	Fleet Size	Tier	Engine Net Power (hp)	Fuel Consumption (L/h)
2270003020	Batch Plant - Big-Bag Handling GP45N (4 t) Forklift	1	4	97	8
2270003020	Production – Finished Good Transport DP70N1 (8 t)	4	4	100.6	8
2270003020	Production – Cullet Handling GP55N (5 t) Forklift	2	4	97	8
2270003020	Warehouse (Workshop) – Service GP45N (4 t) Forklift	2	4	97	8
2270003020	Warehouse – Loading of Pallets into Container GP45N	3	4	97	8
2270003020	Warehouse – Kalmar dcf500-12 Container Loading	2	3	350	20

Fuel consumption was used to calculate GHG emissions.

The equipment production year indicates the engine efficiency (tier), based on equipment specifications. Usually, newer engines have lower emissions. **Table A10** summarizes Brake Specific Fuel Consumption (BSFC) values and engine Load Factors (LF). BSFC is a measure of the fuel efficiency of a combustion engine which burns fuel and produces rotational power. The methodology for the calculation of emission factors in NONROAD model was taken from US EPA (2022). Steady state, zero-hour emission factors (EF_{raw}) and BSFC listed in the emission database on the NONROAD model website (part of the archive for the Motor Vehicle Emission Simulator - MOVES) are already adjusted by the Transient Adjustment Factor (TAF). Transient mode of engine operation better reflects engine load, speed of vehicle and other parameter changes (e.g., during loader transit, lifting material, un-loading and moving). The transient mode emission factors (EF_{raw}) are obtained by multiplying steady state emission factors (E_{ss}) by TAF.

Engine Load Factor (LF) is defined as portion of the rated engine power that is utilized during engine operation. This factor is specific to the equipment type and independent of engine size and rated engine power.

Table A10: Load Factors (LF) and Brake Specific Fuel Consumption (BSFC) of Diesel-Powered Equipment

Equipment	LF	BSFC (lb/hp-h)
Batch Plant - Big-Bag Handling GP45N (4 t) Forklift	0.59	0.412
Production – Finished Good Transport DP70N1 (8 t)	0.59	0.371
Production – Cullet Handling GP55N (5 t) Forklift	0.59	0.412
Warehouse (Workshop) – Service GP45N (4 t) Forklift	0.59	0.412
Warehouse – Loading of Pallets into Container GP45N	0.59	0.412
Warehouse (Loading Area) – Kalmar dcf500-12 Container Loading	0.59	0.371

In US EPA (2010), Equation 1 and Equation 2 (Page 6) were used to calculate emission factors for CO, NO_X, and HC (which was assumed equivalent to THC in in this document). Diesel combustion emission factors of NO_X, CO, and THC adjusted for deterioration are calculated by the following equation (Page 6; Equation 1, US EPA 2010):

$$EF_{adjusted}\ (g/hp\text{-}h) = EF_{raw} * DF$$

Where:

- EF_{raw} – Emission Factor NO_X, CO, or THC (g/hp-h from data in US EPA 2008)
- DF – Deterioration Factor (unitless) (function of the technology type and age of the engine) for NO_X, CO, and THC.

$$DF = 1 + A * \frac{(cumulative\ hours * LF)}{median\ life\ at\ full\ load\ in\ hours}$$

Where *A* is relative deterioration factor (% of emission increase / % of useful life). The maximum deterioration factors (*DF*) were used in the calculation assuming all Project equipment has worked more hours than their median life.

Table A11 lists relative deterioration factors for nonroad diesel engines, dependant on Tiers (Table A6, page A16, US EPA 2010).

Table A11: Relative Deterioration Factor (A) of Nonroad Diesel Powered Equipment

Compound	Tier 1	Tier 2	Tier 3 & 4
THC	0.036	0.034	0.027
CO	0.101	0.101	0.151
NO_X	0.024	0.009	0.008
PM_{10}	0.473	0.473	0.473

An example of calculations for adjusted emission factor for NO_X emitted by the Kalmar dcf500-12 (Tier 3, net power 350 hp) is:

$$EF_{adjusted}\ (g/hp\text{-}h) = 2.61 * 1.008 = 2.631$$

The diesel combustion emission factor for SO_2 was from the following equation (Equation 7 at Page 24 of US EPA 2010):

$$SO_2 = \{[BSFC * 453.6 * (1 - soxcnv) - THC] * 0.01 * 2 * 0.0015\}$$

Where:

- BSFC – Brake Specific Fuel Consumption (lb/hp-h)
- 453.6 – Conversion factor from pounds to grams
- soxcnv – Fraction of fuel sulphur converted to direct PM (0.02247 for Tier 3 and Tier 4 engines)
- THC – Total Hydrocarbon
- 0.01 – Conversion factor from weight percent to weight fraction
- 2 – Grams of SO_2 formed from a gram of sulphur
- 0.0015 – Weight percent of sulphur in ultra-low sulphur diesel (15 ppm)

An example of calculations for the adjusted emission factor for SO2 emitted by the Kalmar forklift (Tier 3, net power 350 hp) is:

$$SO_2 = \{[0.367 * 453.6 * (1- 0.02247) – 0.134] * 0.01 * 2 * 0.0015\} = 0.0049 \text{ g/hp-h}$$

SO_2 adjusted emission factors are calculated using ultra low sulphur diesel - ULSD (15 ppm sulphur). **Table A12** summarizes deterioration-adjusted emission factors used to calculate combustion emissions from diesel equipment.

Table A12: Deterioration-Adjusted Emission Factors

Equipment	THC (g/hp-h)	SO_2 (g/hp-h)	NO_x (g/hp-h)	CO (g/hp-h)	TSP = PM_{10} (g/hp-h)	$PM_{2.5}$ (g/hp-h)
Big-Bag Handling GP45N (4 t) Forklift	0.134	0.0055	0.282	0.414	0.014	0.013
Finished Good Transport DP70N1 (8 t) Forklift	0.134	0.0049	0.282	0.150	0.014	0.013
Cullet Handling GP55N (5 t) Forklift	0.134	0.0055	0.282	0.414	0.014	0.013
Service GP45N (4 t) Forklifts	0.134	0.0055	0.282	0.414	0.014	0.013
Loading of Pallets into Container GP45N	0.134	0.0055	0.282	0.414	0.014	0.013
Kalmar dcf500-12 Container Loading	0.175	0.0049	2.631	1.485	0.272	0.263

Table A13 summarizes diesel combustion emissions calculated for equipment used in the modelling. The maximum hourly emissions (g/s) presented in **Table A13** were calculated for particulates, NO_X, CO, and THC using following equation:

$$\text{Emission (g/s)} = LF * EF_{adjusted} * PR * EN / (3600 \text{ s/h})$$

Where:

- LF – Load Factor from **Table A10**
- $EF_{adjusted}$ – Adjusted Emission Factor (g/hp-h) from **Table A12**
- PR – Engine Power Rating (hp) (**Table A9**)
- EN – Number of Engines (**Table A9**)

An example of calculations for emissions of NO_X emitted by two Kalmar dcf500-2 forklifts within one hour (Tier 3, net power 350 hp) is:

$$\text{Emission (g/s)} = 0.59 * 2.631 \text{ g/hp-h} * 350 \text{ hp} * 2 \text{ forklifts} / (3600 \text{ s/h}) = 0.3018$$

The maximum hourly emissions (g/s) presented in **Table A13** were calculated for SO_2 using following equation:

$$\text{Emission (g/s)} = EF_{adjusted} * PR * EN / (3600 \text{ s/h})$$

Where:

- $EF_{adjusted}$ – Adjusted SO_2 Emission Factor (g/hp-h) from **Table A12**
- PR – Engine Power Rating (hp) (**Table A9**)
- EN – Number of Engines (**Table A9**)

An example of calculations for the adjusted emission factor for SO_2 emitted by two Kalmar Forklifts (Tier 3, net power 350 hp) is:

$$\text{Emission (g/s)} = 0.00493 \text{ g/hp-h} * 350 \text{ hp} / (3600 \text{ s/h}) = 0.00096$$

Kalmar forklift diesel combustion emissions were conservatively modelled for 24 hours a day at the loading area, assuming the forklift is at this area ¾ of the time. The remaining ¼ of the time it will work inside the warehouse for 14 hours a day (warehouse vent emissions were modelled using 24-hour variable factors -higher at day and lower at night). The higher, 24-hour, Kalmar forklift diesel combustion emissions may account for other unaccounted sources (e.g., additional forklifts doing some activities at the plant site).

Table A13: Modelled Emissions from Diesel Combustion of Non-Road Equipment

Equipment	THC (g/s)	SO_2 (g/s)	NO_x (g/s)	CO (g/s)	TSP = PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Big-Bag Handling GP45N (4 t) Forklift	0.00212	0.00015	0.0045	0.0066	0.00022	0.00021
Finished Good Transport DP70N1 (8 t) Forklift	0.08800	0.00055	0.0186	0.0099	0.00089	0.00087
Cullet Handling GP55N (5 t) Forklift	0.00424	0.00030	0.0090	0.0132	0.00043	0.00042
Service GP45N (4 t) Forklifts	0.00424	0.00030	0.0090	0.0132	0.00043	0.00042
Loading of Pallets into Container GP45N	0.00637	0.00044	0.0135	0.0198	0.00065	0.00063
Kalmar dcf500-12 Container Loading	0.01502	0.00072	0.2264	0.1278	0.02336	0.02246
TOTAL						
Hourly Maximum TOTAL (g/s)	**0.120**	**0.0025**	**0.281**	**0.1905**	**0.0260**	**0.0250**
Daily Maximum TOTAL (kg/d)	**7.65**	**0.184**	**23.4**	**15.60**	**2.20**	**2.12**

A4.2 Paved Road Diesel Combustion Emissions

Combustion emissions from trucks are based on the US EPA MOVES model (https://www.epa.gov/moves) which considers vehicle type as well as driving conditions.

Table A14 summarizes truck and car parameters used to calculate 1-hour maximum emissions for travel on the access road and internal roads. Emissions were calculated assuming an average travel speed of 10 km/h.

Table A15 summarizes diesel combustion factors and **Table A16** summarizes emissions from paved road traffic. The fleet was assumed to be 50% cars and 50% light trucks for commuters and an average emission factor was used to calculate emissions. Commuter vehicles were assumed not to idle. There are also company trucks (6 trips/day) and cars (20 one-way trips/day) driven at the Plant and access road. The applied emission factor was a weighted average of six trucks and 20 cars.

Table A14: Trucks and Cars Maximum Parameters During 1-Hour of Solar Glass Plant Operation

Transport / Parameter	Distance One Way (m)	One Way Trips / Day	Max. Trips / Hour	Max. Idling Time (Minutes) per Vehicle per Hour
Access Road				
44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant	206	44	3	0
68 - B-Train Trucks with Solar Glass Product and Six – Flat Deck Trucks with Pallets and Racks	206	74	5	0
Commuters at 6:00 am and 10:00 pm	412	266	133	0
Commuters at 2:00 pm	412	141	141	0
Commuters at 7:00 am and 4:00 pm	412	106	53	0
Company Trucks and Cars	206	26	2	0

Transport / Parameter	Distance One Way (m)	One Way Trips / Day	Max. Trips / Hour	Max. Idling Time (Minutes) per Vehicle per Hour
Internal Roads				
44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant - Loaded	309	45	3	10
44 - B-Train Trucks & One Flat Deck Truck from Batch Plant - Empty	618	45	3	10
68 - B-Train Trucks with Solar Glass Product and Six – Flat Deck Trucks with Pallets and Racks – Loaded & Empty	670	74	5	10
Company Trucks and Cars	824	26	2	10

Table A15: Diesel Combustion Emission Factors for Paved Internal and Access Roads

Transport / Compounds	THC	SO_2	NO_x	CO	TSP = PM_{10}	$PM_{2.5}$	GHG_{eq}
Travel (10 km/h) Long-Haul Trucks: B-Train Trucks (g/VKT)	0.6693	0.0083	14.2201	6.075	1.5356	0.3552	2,480.66
Idling Long-Haul Trucks: B-Train Trucks (g/Vehicle/h)	0.0121	0.0001	0.2577	0.0975	0.0149	0.0049	42.01
Travel (10 km/h) Commercial Trucks: 20 t & Flat Deck Trucks (g/VKT)	0.3775	0.0054	0.5403	6.3661	1.3456	0.1802	837.27
Idling Long-Haul Commercial Trucks: 20 t & Flat Deck Trucks (g/Vehicle/h)	0.0121	0.0001	0.2577	0.0975	0.0149	0.0049	42.01
Travel (10 km/h) Passenger Car (g/VKT)	0.2447	0.0040	0.1226	5.8281	0.1380	0.0202	613.71
Travel (10 km/h) Passenger Truck (g/VKT)	0.3726	0.0050	0.3728	6.0857	0.1441	0.0257	772.59
Average for Commuters (g/VKT)	0.3086	0.0045	0.2477	5.9569	0.1410	0.0230	693.15
Travel Company cars & trucks (weighted average) (g/VKT)	0.2742	0.0043	0.1803	5.8876	0.1394	0.0215	650.37
Idling Company cars & trucks (weighted average) (g/VKT)	0.0050	0.0001	0.0026	0.0893	0.0025	0.0004	11.63

Table A16: Maximum 1-Hour Average Diesel Combustion Emissions from Paved Road Traffic (g/s)

Transport / Compounds	THC	SO_2	NO_x	CO	TSP = PM_{10}	$PM_{2.5}$	GHG_{eq}
Access Road							
Travel 44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Loaded / Empty (g/s)	2.28E-04	2.83E-06	4.78E-03	2.09E-03	5.26E-04	1.21E-04	0.839
Travel 68 – 20 t Trucks with Solar Glass Product and Six – Flat Deck Trucks with Pallets and Racks Empty / Loaded (g/s)	2.16E-04	3.07E-06	3.09E-04	3.64E-03	7.70E-04	1.04E-04	0.479
Commuters at 6:00 am or 10:00 pm (g/s)	4.70E-03	6.87E-05	3.77E-03	9.07E-02	2.15E-03	3.50E-04	10.550
Commuters at 2:00 pm (g/s)	4.98E-03	7.29E-05	4.00E-03	9.61E-02	2.28E-03	3.71E-04	11.185
Commuters at 7:00 am or 4:00 pm (g/s)	1.87E-03	2.74E-05	1.50E-03	3.61E-02	8.55E-04	1.39E-04	4.204
Travel Company Cars (20) and Trucks (6)	6.28E-05	9.76E-07	4.13E-05	1.35E-03	3.19E-05	4.92E-06	0.149
Inside Roads							
Travel 44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Loaded (g/s)	1.71E-04	2.12E-06	3.58E-03	1.57E-03	3.94E-04	9.05E-05	0.629
Idling 44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Loaded (g/s)	1.67E-06	1.94E-08	3.50E-05	1.35E-05	2.06E-06	6.67E-07	5.75E-03
Travel 44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Empty (g/s)	3.41E-04	4.25E-06	7.17E-03	3.13E-03	7.89E-04	1.81E-04	1.259

Transport / Compounds	THC	SO_2	NO_x	CO	TSP = PM_{10}	$PM_{2.5}$	GHG_{eq}
Idling 44 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Empty (g/s)	1.67E-06	1.94E-08	3.50E-05	1.35E-05	2.06E-06	6.67E-07	5.75E-03
Travel 68 – 20 t Trucks with Solar Glass Product and Six – Flat Deck Trucks with Pallets and Racks Empty / Loaded (g/s)	7.02E-04	9.96E-06	1.00E-03	1.18E-02	2.50E-03	3.35E-04	1.557
Idling 68 – 20 t Trucks with Solar Glass Product and Six – Flat Deck Trucks with Pallets and Racks Empty / Loaded (g/s)	1.56E-06	2.21E-08	2.16E-06	2.20E-05	2.63E-06	3.74E-07	3.44E-03
Travel Company Cars (20) and Trucks (6)	2.51E-04	3.90E-06	1.65E-04	5.39E-03	1.28E-04	1.97E-05	0.595
Idling Company Cars (20) and Trucks (6)	4.61E-07	7.06E-09	2.41E-07	8.27E-06	2.34E-07	3.52E-08	1.08E-03
TOTAL Maximum 1-Hour Emission (g/s)	**6.96E-03**	**1.00E-04**	**2.11E-02**	**1.25E-01**	**7.42E-03**	**1.23E-03**	**16.71**
TOTAL Daily (16 h/d) Maximum Emissions (kg/d)	**0.179**	**0.0025**	**1.039**	**2.933**	**0.326**	**0.0542**	**465**

A4.3 Rail Emissions

Combustion emissions from one switch locomotive (EMD GP39-2) working 16 hours a day and one line locomotive (GE AC6000CW) working one hour a day are based on US CFR 1 (2022). Locomotives will operate 2 or 3 times a week. The line locomotive arrives at the plant in early morning, leaves railcars with batch material at the batch plant, and departs within one hour. The switch locomotive moves railcars around the batch plant (during unloading of compounds for batch mix). It was assumed the switch locomotive idles 90% of the time and travels 10% of the time within each hour. The switch locomotive works 16 hours a day, and it is modelled using hourly variable emission factors in AERMOD. **Table A17** summarizes locomotive parameters used to calculate emissions.

Table A17: Locomotive Parameters

Locomotive	Total Engine Power (hp)	Idle Load (%)	Travel Load (%)	Distance Travelled (km)	Fuel Consumption (l/h)
Switch Locomotive – Batch Plant	2,300	5	20	0.25	1,015
Line Locomotive	6,000	5	20	1.00	12,918

Table A18 summarizes locomotive emission factors, assuming Tier 0 engines. The emission factor for SO_2 was calculated using sulphur content in diesel 15 mg/kg (15 ppm). Assuming diesel density 0.85 kg/l (at 15°C), the emission factor is 0.01275 g/l. Emissions of $PM_{2.5}$ were estimated as 11% of PM_{10} using proportion taken from the MOVES model for heavy-duty diesel trucks travelling 50 km/h.

Table A18: Locomotive Emission Factors (Tier 0)

Locomotive	HC (VOC) (g/hp-h)	SO_2 (g/l)	NO_x (g/hp-h)	CO (g/hp-h)	TSP = PM_{10} (g/hp-h)	$PM_{2.5}$ (g/hp-h)
Switch Locomotive Travel	2.1	0.01275	11.8	8.0	0.26	0.038
Line Locomotive Travel	1.0	0.01275	8.0	5.0	0.22	0.032

Table A19 summarizes locomotive emissions. One-hour average emissions assumed 90% idling and 10% travelling. Daily emissions assumed the switch locomotive works 16 hours per day and the incoming (and outgoing) line locomotive emits for one hour.

Table A19: Locomotive Diesel Combustion Emissions

Locomotive	HC (VOC) (g/s)	SO_2 (g/s)	NO_X (g/s)	CO (g/s)	TSP = PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Switch Locomotive Travel	0.268	0.0036	1.508	1.022	0.0332	0.0036
Line Locomotive Travel	0.333	0.0458	2.667	1.667	0.0733	0.0079
Switch Locomotive Idling	0.067	0	0.377	0.256	0.0083	0.0009
Line Locomotive Idling	0.083	0	0.667	0.417	0.0183	0.0020
Switch Locomotive 1-hour Average (Idling 90%, Travel 10%)	0.087	0.0036	0.490	0.332	0.0108	0.0012
Line Locomotive 1-hour Average (Idling 90%, Travel 10%)	0.108	0.0458	0.867	0.542	0.0238	0.0026
Daily Total Emissions (kg/d)	**5.41**	**0.372**	**31.3**	**21.1**	**0.708**	**0.077**

A4.4 Furnace Emissions

Furnace stack parameters are summarized in **Table A20** and emissions in **Table** A21. Parameters and emissions were provided by CPS. NO_X, SO_2, and particulate emissions reflect the net emissions downstream of the emissions control equipment that CPS expects for both the Air-fired and Oxygen-fired glass melting furnaces currently considered in design. Targeted maximum post-control equipment process factors guaranteed by manufacturer are:

- NO_X .... 1.5 kg/t of glass
- SO_2.............. 0.6 kg/t of glass
- CO............... 0.1 kg/t of glass
- TSP .... 0.3 kg/t of glass
- PM_{10} .... 0.17 kg/t of glass
- $PM_{2.5}$ .... 0.13 kg/t of glass
- HCl .... 0.01 kg/t of glass
- HF .... 0.004 kg/t of glass
- NH_3.............. 10 ppm

These limits are intended to represent the latest emissions control technology and be aligned with the CPS' mission and vision to be "World Class" in their environmental stewardship. These limits would apply to both Air-fired and Oxygen-Fired furnaces. The control equipment would be aligned with U.S. BACT (Best Available Control Technology), which also considers some level of economic viability. The intent would be to manage the process to meet these limits, regardless of type of furnace.

An Air-fired furnace requires a system to convert SO_2 gas to a particulate, followed by a baghouse or ESP to collect the particulate, and ammonia injection to convert NO_X to nitrogen and water vapor to achieve theses limits.
An Oxygen-fired furnace would require the same SO_2 and particulate treatment but may not need NO_X conversion to meet the target limits.

Emissions were calculated using a maximum daily load of 1,200 t of batch material melted in two furnaces. It is conservative approach, since the limits are normally used for tonnes of glass produced (960 t/d). This conservativeness gives some operational flexibility for the solar glass plant operation.

Example of calculations:

- 1.5 kg of NO_X per metric ton of melted glass * 1,200 t/d = 1,800 kg/d *1,000 g/kg / (24 h*3600 s/h) = 20.83 g/s / (2 stacks) = 10.42 g/s/stack

Table A20: Furnace Stack Parameters

Parameter	Furnace Stack #1	Furnace Stack #2
UTM 14 - East (m)	651021	651072
UTM 14 - North (m)	5559525	55594494
Base Elevation (mASL[1])	224	224
Stack Height (m)	46	46
Stack Diameter (m)	1.6	1.6
Stack Gas Exit Velocity (m/s)	13.5	13.5
Stack Top Temperature (K)	490	490
Stack Top Temperature (°C)	217	217

Note 1 ASL – Above Sea Level

Table A21: Furnace Emissions for Oxy-Fired or Air-Fired Combustion

Compound	Furnace Stack #1 (g/s)	Furnace Stack #2 (g/s)	TOTAL – Both Stacks[1] (g/s)	TOTAL – Both Stacks (kg/d)
SO_2	4.167	4.167	8.333	**720**
NO_X	10.42	10.42	20.833	1,800
CO	0.694	0.694	1.389	120
$PM_{2.5}$	0.903	0.903	1.806	156
PM_{10}	1.181	1.181	2.361	204
TSP	2.083	2.083	4.167	360
NH_3	0.115	0.115	0.230	19.8
HF	0.028	0.028	0.056	4.8
HCl	0.069	0.069	0.139	12.0

Note 1: There may be rounding discrepancies

A5. Summary of Total Emissions

Table A22 summarizes the total maximum daily emissions from Project operations, including fugitive particulate emissions and gaseous emissions. Stacks are the highest emission sources of all compounds: 99.9% of SO_2, 80% of CO, 95% of NO_X and PM_{10}, 94% of $PM_{2.5}$, and 98% of TSP.

Table A22: Maximum Daily Emissions Used for Modelling

Emissions	SO_2 (kg/d)	NO_x (kg/d)	CO (kg/d)	TSP (kg/d)	PM_{10} (kg/d)	$PM_{2.5}$ (kg/d)
Stack Emissions (Point Sources)						
Two Furnace Stacks Total	720	1,800	120	360	204	156
Maximum Daily TOTAL for Stacks	**720**	**1,800**	**120**	**360**	**204**	**156**
Vents and Loading Area (Volume Sources)						
Batch Plant Vent Diesel Combustion	0.013	0.39	0.57	0.019	0.019	0.018
Batch Plant Vent Fugitive Emissions	0	0	0	2.598	1.229	0.186
Warehouse Vent Diesel Combustion	0.078	6.285	5.299	0.542	0.542	0.525
Warehouse Vent Fugitive Emissions	0	0	0	0.102	0.020	0.009
Production Area Vent Diesel Combustion	0.073	2.384	1.991	0.114	0.114	0.111
Production Area Vent Fugitive Emissions	0	0	0	5.090	2.407	0.365
Loading Area Diesel Combustion	0.062	19.558	11.038	2.018	2.018	1.958
Loading Area Fugitive Emissions	0	0	0	1.021	0.196	0.047
Maximum Daily TOTAL for Vents and Loading Area	**0.23**	**28.6**	**18.9**	**11.5**	**6.54**	**3.22**
Road Emissions (Line Sources)						
Access Road Diesel Combustion	0.0013	0.35	1.68	0.282	0.14	0.026
Access Road Fugitive Emissions	0	0	0	1.706	0.33	0.079
Inside Roads Diesel Combustion	0.0012	0.69	1.28	0.683	0.18	0.023
Inside Roads Fugitive Emissions	0	0	0	10.356	2.14	0.516
Maximum Daily TOTAL for Road Emissions	**0.0025**	**1.1**	**2.96**	**13.0**	**2.79**	**0.65**
Railway Emissions (Line Sources)						
One Switch Locomotives 16 hours / day	0.207	28.23	19.14	0.622	0.622	0.067
One Line-Locomotives 1 hour each / day	0.165	3.12	1.95	0.086	0.086	0.009
Total Daily Railway Emissions	**0.372**	**31.35**	**21.1**	**0.71**	**0.71**	**0.08**
Conveyour Emissions (Volume Sources)						
Eight Transfer Points from Batch Plant to Production Areas	0	0	0	5.09	2.41	0.365
Total Daily Conveyour Emissions	**0**	**0**	**0**	**5.09**	**2.41**	**0.365**
TOTAL Glass Plant Emissions	**721**	**1,861**	**163**	**390**	**216**	**160**

A6. GHG Annual Emissions

A6.1 Non-road Diesel Annual Combustion Emissions of GHG

Table A23 summarizes GHG emission factors used to calculate combustion emissions from the Project diesel combustion equipment. The emissions of CO_2 were calculated using factors from Table 2-2 and emissions of CH_4 and N_2O using factors from Table 2-6 of EC (2021). **Table A24** presents the global warming for GHG from diesel combustion equipment, assuming 100 years horizon, from IPCC (2018).

Table A23: GHG Emission Factors Used for Emission Calculations

Compound	Emission Factors EC (2021) (g/L)
CO_2	2,681
CH_4	0.073
N_2O	0.23 (Tier 4) 0.02 (Tier 3)

Table A24: GHG Global Warming Potentials (100-year Horizon)

Compound	100 Year Global Warming Potential IPCC (2018)
CO_2	1
CH_4	25
N_2O	298

In calculation of equipment working hours, it was assumed that all equipment except the Kalmar forklift will operate 24 hours each day. The Kalmar forklift will work 14 hours a day.

Using emission factors from **Table A23** and fuel consumption from **Table A9**, GHG emissions were calculated and summarized in **Table A25.** Following is an example calculation for two Kalmar dcf500-12 forklifts:

- CO_2 (t/y) = 2,681 g/L * 2 forklifts * 16 h/d * 20 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 626
- CH_4 (t/y) = 0.073 g/L * 2 forklifts * 16 h/d * 20 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 0.017
- N_2O (t/y) = 0.02 (Tier 3) g/L *3 loaders * 24 h/d * 17 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 0.005
- GHG (t/y of CO_{2eq}) = 626 t/y + 25*0.017 t/y +298*0.005 t/y = 628

Table A25: GHG Emissions from Non-Road Equipment

Equipment	Annual Diesel Consumption (L/y)	CO_2 (t/y)	CH_4 (ty)	N_2O (t/y)	GHG (CO_{2eq}) (t/y)
Big-Bag Handling GP45N (4 t)	70,080	188	0.005	0.016	193
Finished Good Transport DP70N1 24 h – 365 days	280,320	752	0.020	0.064	771
Cullet Handling GP55N (5 t) 24 h – 365 days	140,160	376	0.010	0.032	386
Service GP45N (4 t) Forklifts 24 h – 365 days	140,160	376	0.010	0.032	386
Loading of Pallets GP45N 24 h – 365 days	210,240	564	0.015	0.048	578
Kalmar dcf500-12 Loading	233,600	626	0.017	0.005	628
Total	**1,074,560**	**2,881**	**0.078**	**0.198**	**2,942**

A6.2 Paved Road Diesel Combustion Emissions of GHG

Annual GHG emissions from B-Train trucks transporting sand to the solar glass plant are summarized in **Table A26.** The total number of trips per year was obtained by division of annual solar glass plant sand demand (776 t/day*365 days) by the B-Train payload 40 t (283,240 t/year/40 t = 7,081 trips/year). The total distance for wet sand transport (from Highway 4 to different parts of the plant) is:

- Wet sand delivered to sand storage and back ....1.442 km
- Wet sand to batch plant and back ....1.288 km
- Maximum total distance for travel at access road and inside roads..........2.730 km
- Maximum allowance for idling on facility inside roads ....2.318 km

It was assumed that trucks may idle at roads inside the facility. For idling emissions, a calculation speed of 0.1 km/h was used.

Example of GHG emission calculation for paved road travel:

- GHG_{eq} (t/y) = 2.73 km * 7,081 trips/year*2,480.66 g/VKT/(1,000 g/kg)/(1,000 kg/t) = 47.95

Table A26: Annual GHG Emissions from Paved Road Traffic (Access Road and Inside Roads)

Transport	Total Distance (km)	Travel Speed (km/hour)	Number of Trips per Year	GHG_{eq} Emission Factor (g/VKT)	GHG (CO_{2eq}) (t/y)
B-Train with Wet Sand from Quarry Project Idling	-	-	9,395	42.01	0.066
B-Train with Wet Sand from Quarry Project Travel	1.34	10	9,395	2,480.66	31.21
Transport of Pallets to Facility - Idling	-	-	1,460	14.88	0.004
Transport of Pallets to Facility - Travel	1.75	10	1,460	837.27	2.14
Transport of Finished Product by Trucks - Idling	-	-	17,520	14.88	0.043
Transport of Finished Product by Trucks - Travel	1.75	10	17,520	837.27	25.69
Transport of Additives (Flat Decks, Big Bags) - Idling	0.88	-	229	14.88	0.001
Transport of Additives (Flat Decks, Big Bags) Travel	1.29	10	229	837.27	0.73
Commuting by Cars	0.41	10	93,623	613.71	23.67
Commuting by Passenger Trucks	0.41	10	93,623	772.59	29.80
Miscellaneous (Oil Tanker, Oxygen, Urea, Hydrated Lime Coating) - Idling	-	-	52	42.01	0.0004
Miscellaneous (Oil Tanker, Oxygen, Urea, Hydrated Lime Coating) - Travel	1.75	10	52	2,480.66	0.226
Company Cars Idling	-	-	7,300	11.00	0.013
Company Cars (20 Cars – Average 20 trips/day)	2.73	10	7,300	613.71	9.23
Company Trucks Idling	-	-	2,190	13.73	0.005
Company Trucks (3 Trucks - Average 6 trips/day)	2.73	10	2,190	772.59	3.49
Snow-Plow (Average 54 Days with Snow * 4 hours/day)	2.73	10	224	837.27	0.563
TOTAL Annual GHG Emissions from Paved Roads					**127**

A6.3 Rail Diesel Combustion Emissions of GHG

Rail GHG emission factors taken from EC (2020) are summarized in **Table A27**. Using these emission factors, Global Warming Potentials from **Table A24**, and fuel consumption from **Table A17**, rail GHG emissions were calculated and presented in **Table A28**. Following is an example calculation for line locomotive hauling batch mixture components (2 – 3 trips/week - average 2.5 trips/week* 1 h a trip = 2.5 h/week):

- GHG_{eq} (t/y) = (2,680.5 g/l*1+0.149 g/l*25+1.029*298)*12,918 l/h*365/7 weeks*2.5 h/week / 1000 g/kg / 1000 kg/t GHG_{eq} (t/y) = 5,036.5

The calculation basis is one line locomotive (operating 1 h/day in the vicinity of the plant) delivering material daily to the batch plant, and one switch locomotive operating 16 hours on the same days line locomotive operates.

Table A27: Emission Factors Used for Rail GHG Emission Calculations

Compound	Emission Factors EC (2020) (g/L)
CO_2	2,680.5
CH_4	0.149
N_2O	1.029

Table A28: Locomotive Emission Factors (Tier 0)

Locomotive	GHG (CO_{2eq}) (t/y)
One Switch Locomotive (16-hour per day; 2 to 3 times a week; 365 days)	6,334.8
Line Locomotive – Train Delivering Material (2 to 3-hours per week; 365 days)	5,036.5
Total Railway GHG_{eq} emissions near the solar glass plant	**11,371**

A6.4 Furnace GHG Emissions

Furnaces will operate on natural gas. According to CPS estimates, approximately 8,400 m^3/h of gas is required to melt the raw materials in a 1,200 t/d facility with the furnace operating 24 h per day, 7 days a week (365 days per year).

Natural Gas consumption (m^3/y) = 8,400 m^3/h * 24 h/d *365 d = 73,584,000

Table A29 summarizes generic emission factors for natural gas combustion (Table A-1; US EPA 2016):

Table A29: Furnace GHG Generic Emission Factors (US EPA 2016) Used for Emission Calculations

Compound	Emission Factors US EPA (2016) (g CO_2/scf)
CO_2	54.44
CH_4	0.00103
N_2O	0.00010

Sample calculation:

- CO_2 emission Factor (g/m^3) = 54.44 g/(scf) / (0.02832 m^3/scf) = 1,921.12
- CO_2 emission (t/y) = 1,921.12 g/m^3 * 73,584,000 m^3/y / (1,000 g/kg) / (1,000 kg/t) = 141.364

Using emission factors from **Table A29** and Global Warming Potentials from **Table A24**, furnace stacks emissions from natural gas combustion were estimated and summarized in **Table A30:**

Table A30: Furnace GHG Emissions from Natural Gas Combustion

Compound	Emission Factors (g CO_2/scf)	Emission Factors (g/m^3)	Emissions (t/y)
CO_2	54.44	1,921.1	141,364
CH_4	0.00103	0.0364	2.68
N_2O	0.003	0.0035	0.26
GHG (CO_{2eq})			**141,506**

Sample calculation:

- GHG (CO_2eq) = 141,364*1 + 2.68*25 + 0.26*298 = 141,506 t/y

A6.5 Glass Production GHG Emissions

The major glass raw materials which emit CO_2 during the melting process are limestone - $CaCO_3$, dolomite - Ca,Mg$(CO_3)_2$, and soda ash – Na_2CO_3. The minor sources are from other minor additives (e.g., powdered anthracite coal or other organic materials added to create reducing conditions in the molten glass and which combine with available oxygen in the glass melt to produce CO_2). The emission factors for carbonates used in glass manufacturing were taken from Table 4 in US EPA (2009). Emissions were calculated following IPPC (2006) guidance. **Table A31** summarizes emission factors and emissions. Batch material from **Table A3** was used in calculations. The small amount of carbon was accounted by adding 144 t/y to dolomite flint (75,957 t/y).

Table A31: GHG Emission Factors and Process Emissions

Batch Material	Emission Factors US EPA (2016) (t of CO_2 / t of Carbonate)	Amount of Material (t/y)	CO_2 (= GHG_{eq}) Emissions (t/y)
Limestone Flint	0.440	18,834	8,287
Dolomite Flint (+Carbon)	0.447	69,377	31,012
Soda Ash	0.415	78,463	32,562
Total GHG Emissions		**166,674**	**71,861**

A6.6 Indirect GHG Emissions

Indirect emissions from annual electrical consumption were calculated using electricity demand presented in the previous section. Assuming a daily average demand of 1,081 MW, annual electricity demand will be 394,4409 GW/y. The most recent NIR (2022) emission factor for Manitoba (Table A13-8) of 1.2 t of CO_{2eq}/GW-h (based on 2019 and 2020) was used to calculate indirect emissions. The Manitoba Hydro (2021) emission factor is 1.14 t CO_{2eq}/GW-h which was not used.

Table A32 summarizes electricity consumption and indirect annual GHG emissions from plant operations.

Table A32: Indirect Annual GHG Emissions from Electricity Usage

	Annual Consumption (MW-h/y)	Miscellaneous (e.g., Gates, Lights, Scales) (MW-h/y)	Electricity Consumption (GW/y)	GHG (CO_{2eq}) (t/y)
Plant Working (Phase 1 & 2)	394,441	100	394.541	473.4
TOTAL			**394.541**	**473**

A6.7 Summary of Annual GHG Emissions

Table A33 summarizes GHG emissions associated with operation of the solar glass plant.

Table A33: Annual GHG Emissions from Solar Glass Plant

Emission Sources	Annual Usage Rate Value	Unit	Total Annual CO_{2eq} Emissions (t/y)
Direct Emission			
Natural Gas Combustion Furnaces	73,584,000	m^3	141,506
Process – Batch Material Melting, Forming, Cooling	166,674	t	71,861
Transport by Trucks: Final Product, Batch Additives, Supplies, Company Cars & Trucks, Commute, etc.	Variable-depending on engine size and annual utilization		127
One Line Locomotive to Transport Batch Mix Additives + One Switch Locomotive	Variable-depending on engine size and annual utilization		11,371
Non-Road Equipment (Forklifts) Exhaust	Variable-depending on engine size and annual utilization		2,942
		Total Direct	**227,807**
Indirect			
Electricity Usage	432,612,600	kW-h	473
		Total Indirect	473
		Total	***228,280***
		Manitoba, Total for 2019	***22,600,000***
		Canada Total for 2019	***738,000,000***

Overall, the Project is estimated to generate 228,280 tonnes of CO_2e annually (using maximum emissions from furnace stack operations) which is 1.0 % of the reported emissions in 2019 which were 22.6 Mt CO_2e from Manitoba (Climate Change Connection, 2020), and 0.031% of the reported 738 Mt CO_2e from Canada in 2019 (Environment Canada, 2020). Project emissions were compared to provincial and federal 2019 total emissions, since 2020 and 2021 data are affected by the COVID pandemic economic downturn and are lower than previous years.

A7. Appendix References

Climate Change Connection, 2022:
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Attachment B

Isopleths

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration ($\mu g/m^3$)
- Maximum Concentration at Sensitive Receptor ($\mu g/m^3$)

MAAQC = 400 $\mu g/m^3$

- Concentration Contour ($\mu g/m^3$)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 1-HOUR AVERAGE CONCENTRATION OF NO_2

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 * when printed 11 x17

Figure B1

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration (µg/m³)
- Maximum Concentration at Sensitive Receptor (µg/m³)

MAAQC = 200 µg/m³

- Concentration Contour (µg/m³)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 24-HOUR AVERAGE CONCENTRATION OF NO_2

0 0.5 1 1.5 2
Kilometres
Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 *when printed 11 x17

Figure B2

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration (µg/m^3)
- Maximum Concentration at Sensitive Receptor (µg/m^3)

MAAQC = 30 µg/m^3

- Concentration Contour (µg/m^3)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 24-HOUR AVERAGE CONCENTRATION OF $PM_{2.5}$

0 0.5 1 1.5 2
Kilometres
Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 *when printed 11 x17

Figure B3

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration (µg/m^3)
- Maximum Concentration at Sensitive Receptor (µg/m^3)

MAAQC = 50 µg/m^3

- Concentration Contour (µg/m^3)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 24-HOUR AVERAGE CONCENTRATION OF PM_{10}

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 * when printed 11 x17

Figure B4

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration ($\mu g/m^3$)
- Maximum Concentration at Sensitive Receptor ($\mu g/m^3$)

MAAQC = 120 $\mu g/m^3$

- Concentration Contour ($\mu g/m^3$)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 24-HOUR AVERAGE CONCENTRATION OF TSP

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 * when printed 11 x17

Figure B5

AECOM

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration ($\mu g/m^3$)
- Maximum Concentration at Sensitive Receptor ($\mu g/m^3$)

MAAQC = 35,000 $\mu g/m^3$

- Concentration Contour ($\mu g/m^3$)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 1-HOUR AVERAGE CONCENTRATION OF CO

0 0.5 1 1.5 2
Kilometres
Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 *when printed 11 x17	AECOM

Figure B6

Data Sources: Canvec, MLI
Imagery: Esri World Imagery Basemap
Key Map: Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration (µg/m^3)
- Maximum Concentration at Sensitive Receptor (µg/m^3)

MAAQC = 900 µg/m^3

- Concentration Contour (µg/m^3)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 1-HOUR AVERAGE CONCENTRATION OF SO_2

0 0.5 1 1.5 2
Kilometres
Datum: NAD 1983 UTM Zone 14N

Oct, 2022	PN#: 60663147	1:45,000 * when printed 11 x17	AECOM

Figure B7

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Legend

- Project Site Area
- Modelling Domain (10 km x 10 km)
- Sensitive Receptor
- Maximum Modelled Concentration ($\mu g/m^3$)
- Maximum Concentration at Sensitive Receptor ($\mu g/m^3$)

MAAQC = 300 $\mu g/m^3$

- Concentration Contour ($\mu g/m^3$)

General Features

- Highway
- Road
- Existing Railway
- Municipal Boundary

AIR QUALITY ASSESSMENT
CANADIAN PREMIUM SANDS INC.
SOLAR GLASS MANUFACTURING FACILITY

PREDICTIONS OF MAXIMUM 24-HOUR AVERAGE CONCENTRATION OF SO_2

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

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Figure B8			

Data Sources Canvec MLI
Imagery Esri World Imagery Basemap
Key Map Esri World Topographic Map

Piotr Staniaszek, Ph.D.
Senior Air Quality Specialist
Global Air Quality Modelling Specialty Lead
M: 403-463-9682
E: Piotr.Staniaszek@aecom.com

AECOM Canada Ltd.
48 Quarry Park Blvd. SE., Suite 300
Calgary, AB T2C 5P2
Canada

T: 403.254.3301
F: 403.351.1678
www.aecom.com