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Appendix A

Air Quality Impact Assessment Report

INITIAL ASSESSMENT to be REFINED

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Air Quality Assessment Report

Solar Glass Manufacturing Facility in Selkirk, Manitoba

Canadian Premium Sand Inc.

60625356

August 2022

Delivering a better world

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List of Units

$\mu g/m^3$	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
$g/s/m^2$	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
m^2	Square metres
m^3	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 plant (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 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 tonnes per day (t/d) but intends to double that capacity to 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 green house 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
- **Railway Output:** Operation of locomotives outbound with final product and internal switch locomotive operation around loading area
- **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, sand storage, and loading area

- **Loading Area**: Operation of Kalmar forklifts from warehouse to loading area and then loading onto B-Train trucks and rail cars
- **Sand Storage Vent**: Unloading sand from the quarry project and local transport around the Production Building by front end loaders
- **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 70 m high 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. AERMOD was the model used to predict ambient air concentrations outside the Project footprint. Modelled concentrations were compared with the *Manitoba Ambient Air Quality Criteria* (MAAQC 2005).

A greenhouse gas (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** (**Appendix A**).

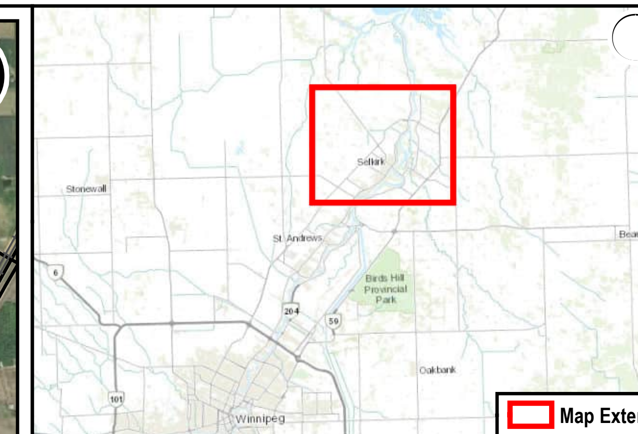
The molten glass is drawn through patterned rollers which flatten the glass into a long ribbon and imprint a permanent prismatic pattern to further improve light transmissivity. This process generates most emissions due to contact between molten, hot glass and equipment lubricants. The glass ribbon is 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

Map location: \\na.aecomnet.com\LFS\AMER\Winnipeg-CAWPG1\DCS\Projects\ENV\60663147_Float_Glass_Plant_Permit\900_CAD_GIS\920_929_GIS_Graphics\02_MXDs\Air Quality Assessment\CPS Solar\H001_60663147_CPSSolar_AQA_SiteLocation.mxd
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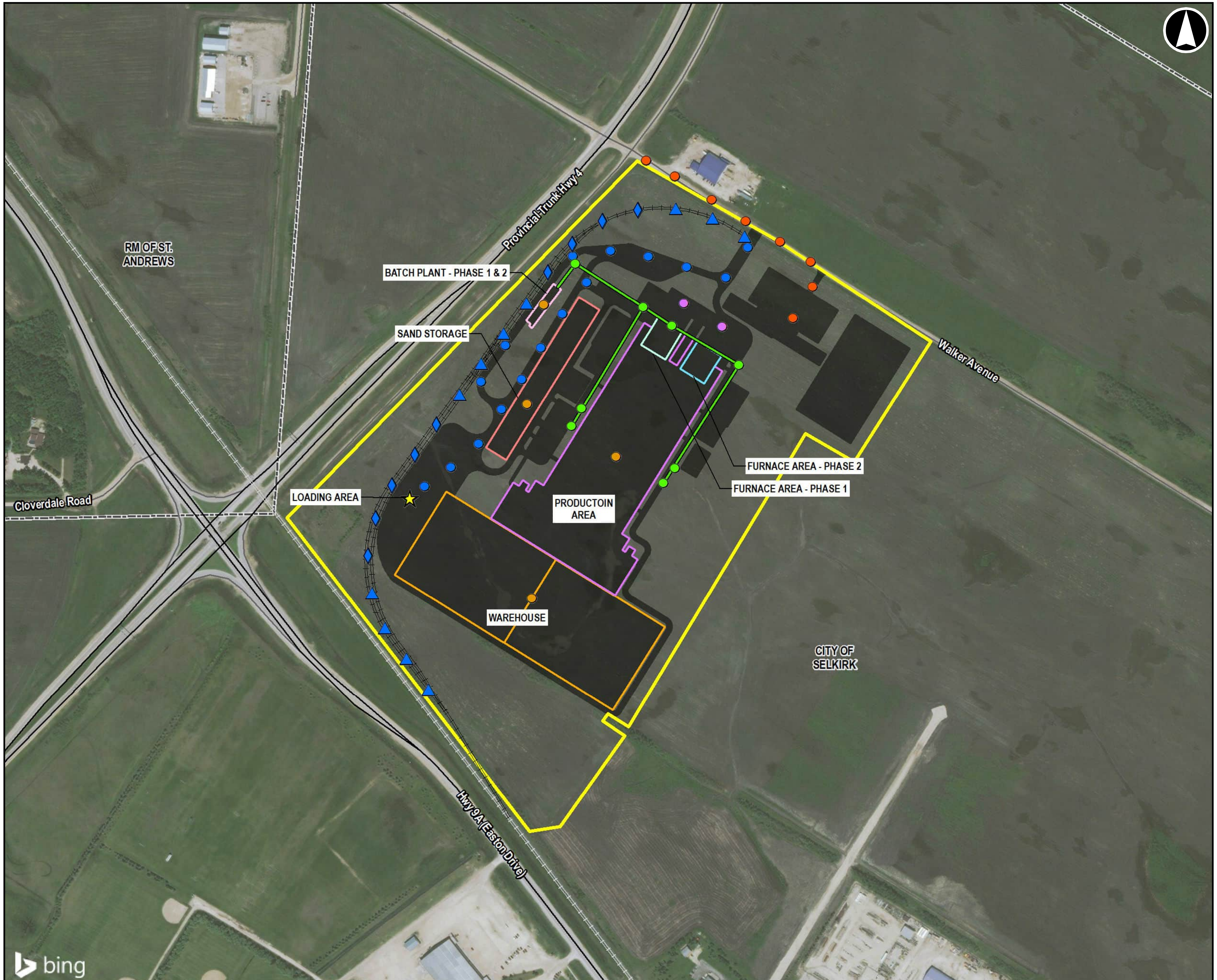

Map Extents

Legend

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

Building Outlines

- Sand Storage
- Warehouse
- Furnace Area - Phase 1
- Furnace Area - Phase 2
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- 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 AND EMISSION SOURCES

0 50 100 150 200
Metres

Datum: NAD 1983 UTM Zone 14N

Aug, 2022	PN#: 60663147	1:5,000 * when printed 11"x17"

Figure 2

AECOM

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 by rail or road. All buildings including sand storage and 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 the solar glass plant includes full operation of both **Phases 1 and 2**, which represent two times higher emissions in compared to **Phase 1**.

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
Sulphur Dioxide (SO_2)	1-hour 24-hour Annual	900 300 60

Compound[1]	Averaging Period	MAAQC (µg/m³)
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 less than the starting threshold of the anemometer (0.5 m/s).

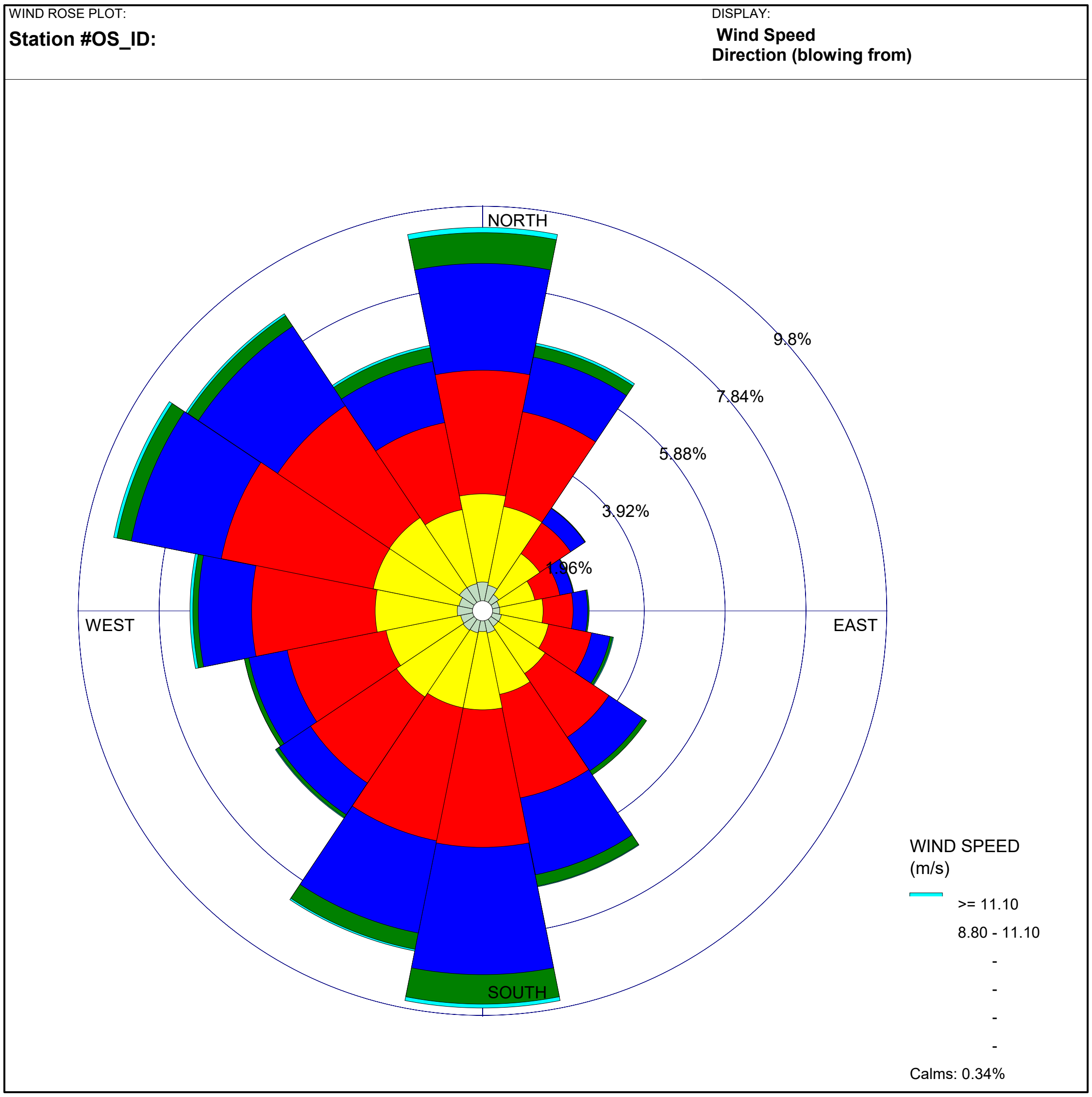


Figure 3: Windrose of Meteorological Data at CPS Solar Glass Plant Location (January 1, 2017-December 31, 2021)

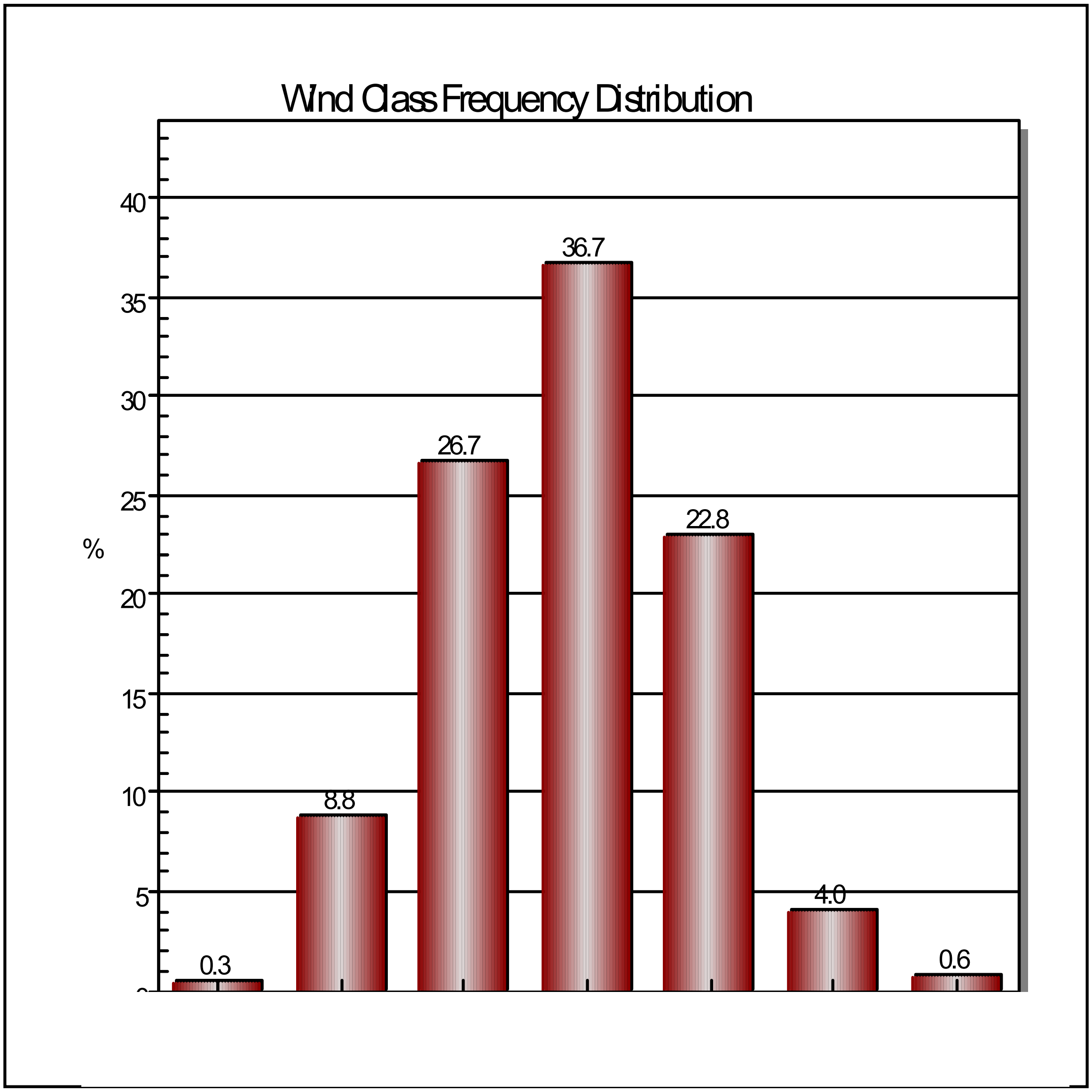


Figure 4: Wind Class Frequency Distribution of Meteorological Data (January 1, 2017, to December 31, 2021)

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).

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/m³)	Objective and/or Guideline (µg/m³)
$PM_{2.5}$	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).

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

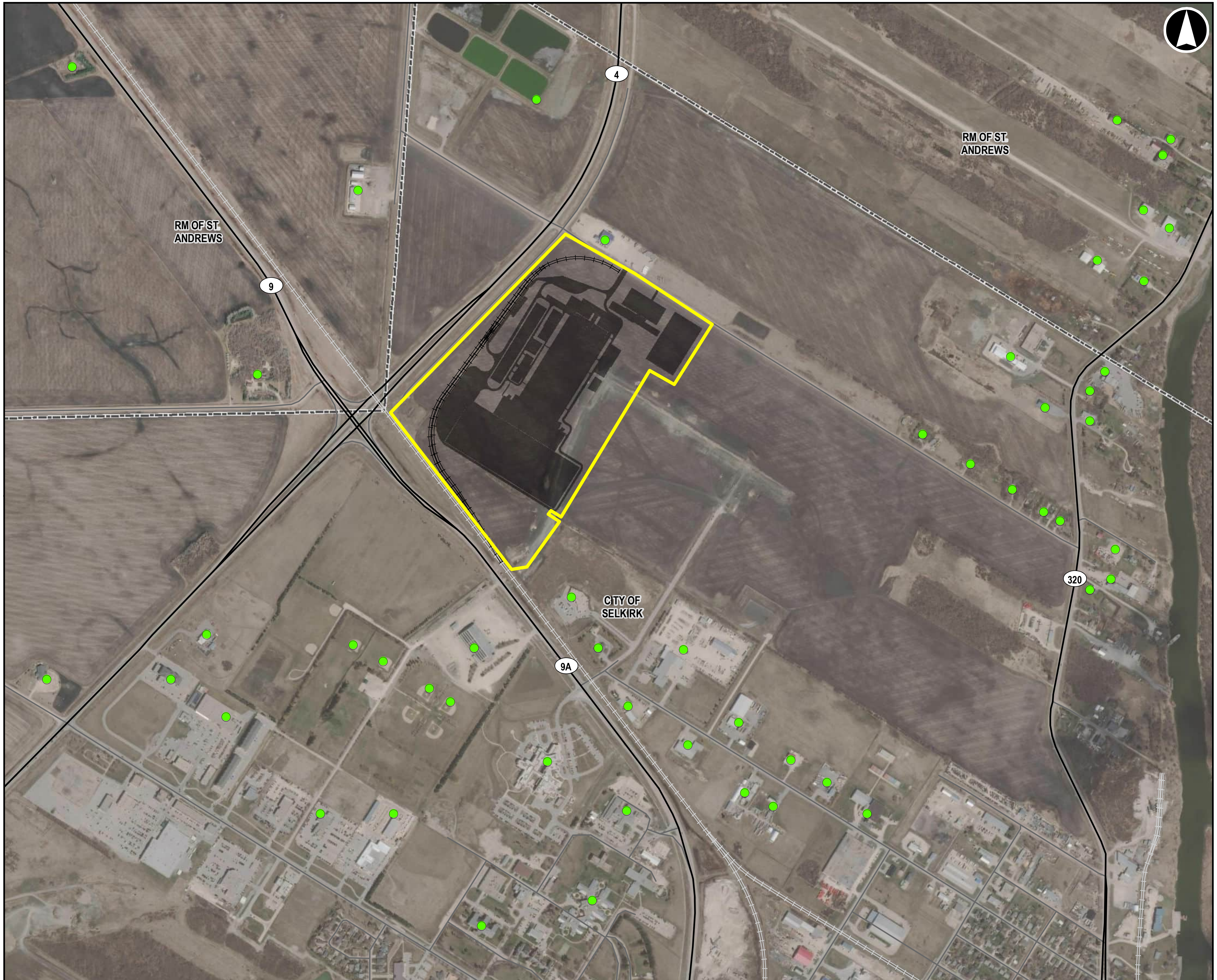
Sensitive receptors were also identified. **Table 4** lists their co-ordinates and distance from the furnace stacks and **Figure 6** shows the location of the receptors relative to the plant boundary

Figure 5: Land Use Within 3 km of the Solar Glass Plant Location

[Place Holder]

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
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 NOx, 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 NOx 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
90th Percentile 1 -hr	40.9	21.7	19.8	21.6	26.0
90th 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	21	42	36
Furnace Area 2	651,043	5,559,446	224	21	42	36
Batch Plant	650,835	5,559,523	224	30	61	13

5. Project Emissions

5.1 Sources and CAC Emissions

The air quality modelling assessment was based on 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 **Appendix 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**:**
  - **a.** a line locomotive arrives daily at 6:00 am, from the southwest along the northern project boundary, bringing soda ash, limestone flint, dolomite flint, and feldspar flint and within the same hour will leave along the western and southern plant boundaries.
  - **b.** a line locomotive arrives daily at 10:00 pm from the southwest along the southern project boundary to the loading area, receives finished product (solar glass panels) and then within the same hour leaves along northern plant boundary. Daily activity, rather than the anticipated frequency of 2-3 times weekly, is a conservative modelling approach.
- **Railway around Batch Plant:** From 7:00 am to 9:00 pm (15 hours), a switch locomotive will move rail cars which will be unloaded at rail offloading attached to batch plant.
- **Railway around Loading Area:** From 7:00 am to 9:00 pm (15 hours), another switch locomotive will move rail cars loaded with finished product between truck and rail loading areas. Both switch locomotives will idle during the 2:00 pm shift change, and emissions were modelled for 15 hours/day.
- **Access Road** from PTH 4 along paved Walker Avenue:
- Transport of high-quality sand from the quarry (see sand storage vent bullet for details of traffic volumes).
  - **a.** 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).
  - **b.** Four trips per day will deliver pallets or racks for transporting finished product. In addition, there will be other traffic (fuel delivery, company vehicles, visitors).
  - **c.** Half the final product will be transported offsite by B-Trains.
  - **d.** 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, sand storage, and loading areas. Liebherr L-556 front end loaders will travel between the batch plant and the sand storage area, and the other loaders will operate between the 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 7 trucks travelling (and/or idling) per hour for 24 hours per day (168 trips of trucks per day), rather than the 73 trips anticipated. Diesel combustion emissions are conservatively high. A part of diesel combustion emissions was assigned to sand storage, batch plant and warehouse building vent areas. Details are provided in **Appendix A**.

- **Batch Plant Vent**: A portion of emissions associated with rail and truck offloading of material occurs here. Emissions from material blending also occur here (unloading of material, loading onto the conveyor and loader include these emissions). A portion of the sand is transported by front end, Liebherr L-556, wheel loader to sand storage. One large GP45N forklift handles bags at this location.
- **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.
- **Sand Storage Vent**:
  - Quarry sand arrives at the plant on B-Trains for 9-10 months each year. During the transportation period, a daily maximum of 11 truck loads (40 t per load) will be delivered to the sand storage area and 21 truck loads (40 t per load) of sand from the quarry will be delivered to the batch plant building. Fugitive emissions of particulates were calculated and modelled for distances from PTH 4. Local traffic is included as background concentrations.
  - The maximum daily number of trips (32 trips per day) of B -Trains transporting wet sand from the quarry project was modelled to occur for the entire year, even though there will be two or three months without this transport and at least 5 months with 16 to 18 trips/day. Thus, fugitive particulate emissions are also conservatively high at this location.
  - Sand unused in daily operations (64 t/day) will be transported to sand storage by wheel loaders (Liebherr L-556). It was assumed the three loaders spend 1/16 of the time on travel between batch plant building and sand storage, 1/16 of the time idling at the batch plant building and the rest of the time (7/8) at the sand storage area, idling and/or forming the stockpile. In winter months, in the absence of the transport from the mine, sand is transported from sand storage to batch plant by loaders.
- **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 14 hours daily inside the warehouse (7:00 am to 1:00 pm and 3:00 pm to 9:00 pm). Emissions from two GP45N (4 t) forklifts used for maintenance and service were added to warehouse vent emissions.
- **Loading Area**: The Kalmar forklifts will travel from the warehouse to the loading area and load product containers onto B-Trains (20 trucks, 40 t each daily) and onto rail cars (10 railcars, 40 t each). Conservatively, it was assumed the forklifts operate 24 hours/day, 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**, **Table 8**, **Table 9** and **Table 10**. The following assumptions were used in modelling:

- All emission sources except the railway sources, commutes traffic, and Kalmar forklift inside the warehouse were based on 24-hour operations 365 days per year. For diesel combustion, the maximum possible number of trucks within one hour was determined and this maximum was used to calculate emissions and model them for every hour. As a result, instead of 32 trips daily, it was assumed there will be 72 B-Train 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. Combustion emissions assumed 24-hour operation for B-Train trucks transporting final product. There will be at most two trucks/hour and therefore 48 daily trips were modelled. However, in fact they will be operating 14 hours/day and there will be total of 20 trips within these 14 hours. Therefore, the maximum 1-hour predictions of SO_2, NO_2, and CO were realistic, but 24-hour and annual averages were conservative. The conveyor was also modelled as a continuous emission source, although it will work intermittently up to 16 hours daily.
- Emissions from material loading – unloading and mixing (batch house vent, sand storage 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 both the Air-fired and Oxygen-fired glass melting furnaces 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.

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

- All piles with 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 stockpiles will be within fully covered enclosures. 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 around the solar glass plant (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.

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	70	1.6	13.5	490
Furnace Stack 2	FUR2	651072	5559494	224	Vertical	70	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	4.99	12.47	1.67	1.08	1.41	2.49	0.50	0.0833	0.333
Furnace Stack 2	FUR2	4.99	12.47	1.67	1.08	1.41	2.49	0.50	0.0833	0.333
TOTAL Stack Emissions (g/s)		**10.0**	**24.9**	**3.33**	**2.2**	**2.8**	**5.0**	**1.0**	**0.17**	**0.67**
TOTAL Stack Emissions (kg/d)		**862**	**2,154**	**288**	**187**	**244**	**431**	**86.4**	**14.4**	**57.6**

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	No
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]
Sand Storage Vent	1	SandStorVent	650813	5559391	224	5.0	63.0	4.7	6.8E-04	0.023	0.010	0.0013	0.0026	0.0042	No
Batch Plant Vent	1	BatchVent	650835	5559523	224	15.0	19.8	14.0	2.0E-04	0.006	0.007	0.0015	0.0086	0.0178	No
TOTAL Vents and Loading Area Emissions (g/s)									**0.0034**	**0.381**	**0.244**	**0.041**	**0.078**	**0.134**	-
TOTAL Vents and Loading Area Emissions (kg/d)									**0.29**	**30.2**	**19.5**	**3.24**	**6.46**	**11.3**	-

Note: ASL – Above Sea Level
1. See Table 11

Table 10: 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	1.2E-06	0.0020	8.7E-04	1.7E-04	7.1E-04	0.0028	Yes
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	0.0020	8.7E-04	1.7E-04	7.1E-04	0.0028	Yes
From Gate to Intersection	5	Haul5 to Haul9	651106 650924	5559599 5559595	223 224	2.3	23.3	2.1	1.9E-05	0.0344	0.0131	9.8E-04	0.0034	0.0090	No
Point before Batch	1	Haul10	650874	5559588	224	2.3	23.3	2.1	8.1E-06	0.0147	0.0056	3.7E-04	0.0013	0.0029	No
From Batch toward Sand Storage Part 1	2	Haul11 to Haul12	650784 650752	5559469 5559421	224 224	2.3	23.3	2.1	3.6E-05	0.0087	0.0034	2.5E-04	7.4E-04	0.0017	No
From Batch toward Sand Storage Part 2	1	Haul13	650779	5559384	224	2.3	23.3	2.1	4.0E-05	0.0161	0.0062	5.3E-04	0.0018	0.0050	No
From Sand Storage to Intersection	4	Haul14 to Haul17	650806 650892	5559424 5559553	224 224	2.3	23.3	2.1	1.1E-05	0.0197	0.0075	6.1E-04	0.0022	0.0061	No
From Sand Storage 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	No
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
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
Railway: Batch Plant to Loading Area	4	Train9 to Train12	650782 650693	5559485 5559364	224 224	2.5	23.3	2.3	0.0023	0.0433	0.0271	1.3E-04	0.0012	0.0012	Yes
Railway around Loading Area	5	Train13 to Train17	650782 650693	5559485 5559364	224 224	2.5	23.3	2.3	7.2E-04	0.0980	0.0664	2.3E-04	0.0022	0.0022	Yes
Railway from Loading Area to out of Plant	3	Train18 to Train20	650782 650693	5559485 5559364	224 224	2.5	23.3	2.3	0.0023	0.0433	0.0271	1.3E-04	0.0012	0.0012	Yes
Conveyor Transfer Points	8	Conv1 to Conv8	650877 651005	5559578 5559495	224 224	5.5	1.4	1.4	0	0	0	5.8E-04	0.0038	0.0081	No
TOTAL Road Daily Maximum Emissions (kg/d)									**0.025**	**28.5**	**12.2**	**0.908**	**3.26**	**9.30**	**-**
TOTAL Railway Daily Maximum Emissions (kg/d)									**0.72**	**59.2**	**39.8**	**0.145**	**1.34**	**1.34**	**-**
TOTAL Conveyor Daily Maximum Emissions (kg/d)									**0**	**0**	**0**	**0.400**	**2.64**	**5.58**	**-**

Note: 1. ASL – Above Sea Level

The following conservative assumptions were applied in the modelling assessment. To operate plant and provide all materials for operation there will be needed:

- 32 trips /24 hours =1.33 B -Trains/h transporting wet sand from the quarry project (instead of 2 trucks/h used in diesel emission calculations)
- 20 trips /24 hours = 0.83 B-Trains/h with final product (instead 1 truck/h modelled)
- 1 trip /24 hours = 0.04 flat deck trucks/h delivering big bags with batch material additives for batch plant
- 4 trips /24 hours = 0.17 flat deck trucks/h delivering racks and/or pallets
- 7 trips /24 hours = 0.67 oil tankers/h. One truck/h to account for this delivery and all other traffic at and around the solar glass plant (e.g., lower-emitting company cars and trucks).

Table 11 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 14 hours, the switch locomotives and line locomotives. **Table 12** 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 **Appendix A**.

5.3 GHG Emissions

The A 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 mobile fleet considering estimated annual diesel/gasoline consumption: loaders, trucks, forklifts
- Emissions from line locomotives and switch locomotives
- 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 13 summarizes estimated annual GHG emissions from 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 **Appendix 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 11: Hourly Emission Factors (Unitless)

Hour	Access Road from PTH 4 to Gate (H1 to H4)					Access Road (H21 to H24)	Warehouse Vent				Railroad Train 1 3; 9 12 ; 18 20	Railroad Train 4 to 8; Train 13 to 17			
	SO_2	NOx	CO	$PM_{2.5}$	PM_{10} = TSP	All Compounds	SO_2	NOx	CO	$PM_{2.5}$=PM_{10}=TSP	All Compounds	SO_2	NOx	CO	$PM_{2.5}$=PM_{10}=TSP
0 to 1	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
2	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
3	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
4	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
5	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
6	8.22	1.23	14.0	2.11	2.22	1.00	0.755	0.229	0.436	0.122	1.00	3.18	0.442	0.408	0.552
7	3.88	1.09	6.20	1.44	1.49	0.398	1	1	1	1	0	1	1	1	1
8	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
9	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
10	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
11	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
12	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
13	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
14	8.66	1.25	14.8	2.18	2.30	1.06	0.755	0.229	0.436	0.122	0	1	1	1	1
15	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
16	3.88	1.09	6.20	1.44	1.49	0.398	1	1	1	1	0	1	1	1	1
17	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
18	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
19	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
20	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
21	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
22	8.22	1.23	14.0	2.11	2.22	1.00	0.755	0.229	0.436	0.122	1.00	3.18	0.442	0.408	0.552
23	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0
24	1	1	1	1	1	0	0.755	0.229	0.436	0.122	0	0	0	0	0

Table 12: Total Solar Glass Plant Maximum Daily Emissions

Sources	Emission Rate (kg/d)								
	SO_2	NOx	CO	$PM_{2.5}$	PM_{10}	TSP	NH_3	HF	HCl
Furnace Stacks	862	2,154	288	187	244	431	86.4	14.4	57.6
Vents and Loading Area	0.29	30.2	19.5	3.24	6.46	11.3	0	0	0
Paved Roads	0.02	28.5	12.0	0.89	3.15	8.85	0	0	0
Railway	0.72	59.2	39.8	0.14	1.34	1.34	0	0	0
Conveyor	0	0	0	0.40	2.64	5.58	0	0	0
TOTAL Plant Emission	**863**	**2,272**	**359**	**192**	**258**	**458**	**86**	**14**	**58**

Table 13: Total GHG Emissions from Operations

Emission Sources	Annual Usage Rate Value	Unit	Total Annual CO2eq Emissions (t/y)
Direct Emission			
Natural Gas Combustion-Dryer	142,743,706	m^3	274,508
Process – Batch Material Melting, Forming, Cooling	182,827	t	81,108
Transport by Trucks: Final Product, Batch Additives, Commute, etc.	Variable-depending on engine size and annual utilization		151
Two Line Locomotives to Transport Final Product, and Supplies + Two Switch Locomotives	Variable-depending on engine size and annual utilization		52,396
Equipment Exhaust	Variable-depending on engine size and annual utilization		4,132
		Total Direct	412,295
Indirect			
Electricity Usage	394,540,900	kW-hr	473
		Total Indirect	473
		Total Plant	***412,768***
		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 Project emissions are shown in **Table 14**, **Table 15**, **Table 16** and **Table 17**. **Appendix 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 conclusions from modelling assessment are:

- All predictions outside the Plant perimeter are below the MAAQC.
- Maximum concentrations of 1-hour average NO_2 (62% of MAAQC) were predicted at the southern plant boundary (**Figure B1**) and maximum concentrations of 24-hour average NO_2 (53% of MAAQC) were predicted at the western plant boundary (**Figure B2**). The maximum annual average was 43% of MAAQC.
- Maximum predicted 24-hour average particulate concentrations occur at the western plant boundary ($PM_{2.5}$ maximum is 87% of MAAQO; **Figure B3**) and at the western fenceline (PM_{10} 92% of MAAQC; **Figure B4**, and TSP 59% of MAAQC; **Figure B5**).
- The TSP maximum annual average (24% of MASAQC) was predicted around 30 m northeast of the fenceline (at the H.D. Repair and Welding Inc. site).
- The CO maximum 1-hour average (4% of MAAQC) was predicted at the southern plant boundary (**Figure B6**), and the CO 8-hour average maximum (3% of MAAQC) was predicted at the southwest border close to west-southwest corner of the fence line.
- The SO_2 maximum 1-hour average (8% 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 150 m south of the southeastern corner of the plant boundary (**Figure B8**) and the maximum annual average (6% of MAAQO) was predicted at southeastern part of fence line.
- Maximum predicted concentrations of NH_3, HF and HCl were between 1.2% (NH_3 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 168 per day rather than the expected 73 per day. 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 or no 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 14: 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	19.4	26	30
PM_{10}	24-hour	9.0	36.8	46	50
TSP	24-hour	18	52.7	71	120
	Annual mean	11	5.7	17	70

Table 15: 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	1,116	1,289	35,000
	8-hour	115	393	508	15,000
NO_s - TCM	1-hour	24	1,746	1,770	400
	24-hour	17	435	452	200
	Annual Mean	11	36	47	100
NO_2 - OLM	1-hour	24	224	248	400
	24-hour	17	89	106	200
	Annual Mean	11	32	43	100
SO_2	1-hour	4.5	40.2	45	900
	24-hour	4.1	9.4	14	300
	Annual mean	2.0	0.96	3.0	60
NH_3	1-hour	13.2	4.0	17.2	1,400
HF	24-hour	-	0.16	0.16	0.85
	7-days	-	0.090	0.090	0.55
	30-days	-	0.049	0.049	0.35
	70-days	-	0.039	0.039	0.20
HCl	1-hour	-	2.67	2.67	100

Table 16: 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	4.4	11	H.D. Repair & Welding Inc. 30 m NE	30
PM_{10}	24-hour	9.0	20.9	30	H.D. Repair & Welding Inc. 30 m NE	50
TSP	24-hour	18	45.6	64	H.D. Repair & Welding Inc. 30 m NE	120
	Annual mean	11	5.7	17	H.D. Repair & Welding Inc. 30 m NE	70

Table 17: 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	671	844	H.D. Repair & Welding Inc. 30 m NE	35,000
	8-hour	115	268	383	H.D. Repair & Welding Inc. 30 m NE	15,000
NO_2 - TCM	1-hour	24	1,114	1,138	H.D. Repair & Welding Inc. 30 m NE	400
	24-hour	17	240	257	H.D. Repair & Welding Inc. 30 m NE	200
	Annual Mean	11	24.1	35	H.D. Repair & Welding Inc. 30 m NE	100
NO_2-OLM	1-hour	24	160	184	H.D. Repair & Welding Inc. 30 m NE	400
	24-hour	17	70	87	H.D. Repair & Welding Inc. 30 m NE	200
	Annual Mean	11	24	35	H.D. Repair & Welding Inc. 30 m NE	100
SO_2	1-hour	4.5	38.4	43	H.D. Repair & Welding Inc. 30 m NE	900
	24-hour	4.1	8.5	13	Easton Place Pharmacy 120 m SSE	300
	Annual mean	2.0	0.81	2.8	Easton Place Pharmacy 120 m SSE	60
NH_3	1-hour	13.2	3.8	17.0	H.D. Repair & Welding Inc. 30 m NE	1,400
HF	24-hour	-	0.14	0.14	Easton Place Pharmacy 120 m SSE	0.85
	7-days	-	0.080	0.080	Easton Place Pharmacy 120 m SSE	0.55
	30-days	-	0.040	0.040	Easton Place Pharmacy 120 m SSE	0.35
	70-days	-	0.032	0.032	Easton Place Pharmacy 120 m SSE	0.20
HCl	1-hour	-	2.54	2.54	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
- Emission rates from furnace stacks (the main source of emissions) were maximums guaranteed by the manufacturer. Actual emissions may be lower
- 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 412,768 tonnes of CO_2e annually (using maximum emissions from furnace stack operations) which is 1.8 % of the reported emissions in 2019 which were 22.6 Mt CO_2e from Manitoba (Climate Change Connection, 2020), and 0.056% of the reported 738 Mt CO_2e from Canada in 2019 (Environment Canada, 2020).

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Appendix 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 tonnes per day but intends to double that capacity to 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.

Under normal circumstances, sand deliveries will occur from approximately mid-May until approximately mid-March for seven days a week between 7:00 am and 7:00 pm. If operationally feasible, deliveries will be reduced on weekends during 'Cottage Season' (from May long weekend to September long weekend) as sand trucks will be travelling to and from Seymourville on the east side of Lake Winnipeg. However, to maintain glass manufacturing operations, CPS may need to transport sand during nighttime. This case (increased sand transport in spring and fall) was chosen as the worst-case scenario and was modelled for 24-h 365-day operations.

Besides wet sand, the solar glass plant will receive other batch material by rail including dolomite, feldspar, and limestone flint, and some glass additives (e.g., soda ash and colours). Some additives will be delivered by flat-deck truck in big bags (e.g., sodium sulphide, carbon). Solar glass (final product) will be transported in containers offsite by rail, (50%) and B-Train trucks (50%)..

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 rail and B-Trains will occur over 14 hours a day (two shifts). 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	24	24
Loading Area (Forklift Kalmar dcf500-12)	14	24
Delivery of Pallets or Racks for Transport of Glass by Flat Deck Trucks	4	24
Conveyor Between Batch Plant and Production Area	16	24
Unloading of Material from Railcars at Batch Plant	14	24
Unloading of Material from B-Train (Flat Deck) Trucks	24	24
Transport of Wet Sand by Kalmar Loader from Batch Plant to Sand Storage	14	24
Line Locomotive – Train with Supplies (6:00 am)	1	1
Line Locomotive – Train with Solar Glass Product (10:00 pm)	1 hr 2-3 times/week	1
Two Switch Locomotives around Loading Area and Batch Plant	14	15
One Flat Deck Trucks with Sodium Sulphate or Coal or Other Supplies	1	16
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, Four Vents,	24	24

Most fugitive dust emissions were based on anticipated working hours but spread over 24 hours (for example, for the conveyor or loading area). Since particulates are predicted over 24-hour averages (and annual average for TSP), this approach is more conservative since the dispersion conditions are worse at night.

Gaseous emissions were calculated using the maximum number of trucks on site in one hour. Modelled predictions of CO, SO_2, and NO_2 are reported as maximum 1-hour averages. Since this assumption is also used to calculate particulate emissions from diesel combustion, the 24-hour particulate predictions from fugitive and exhaust sources are also conservative. Fugitive emissions are not expected from loading area, vents, stacks, line, and switch locomotives, but they were included in **Table A2**.

Emissions from locomotives and some vehicles were modelled using time-dependent factors in AERMOD. For switch locomotives, it was assumed that during shift change at 2:00 pm, two switch locomotives idle. The Kalmar forklift at loading area was assumed to work for 14 hours and idle for the remaining 10 hours.

A2.3 Batch Material Production

The maximum daily solar glass production is 1,200 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.

Table A3: Batch Material Production Numbers[1]

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	283,240	775.8
Soda Ash	86,067	235.8
Dolomite Flint	75,957	208.1
Limestone Flint	20,659	56.6
Feldspar Flint	10,111	27.7
Sodium Sulphide	4,344	11.9
Carbon	145	0.395
Total Batch Loaded on Conveyor Unloaded at Plant	**480,448**	**1,316.3**
Cullet	43,800	120
Total Material Used in Furnace	**524,248**	**1,436.3**
Total Produced Solar Glass Panels (13% to 18% loss)	**438,000**	**1,200**
Total Produced Solar Glass Panels Loaded on Railcars	**219,000**	**600**
Total Produced Solar Glass Panels Loaded on Trucks	**219,000**	**600**
Batch Material Transported to Sand Glass Plant		
Wet Sand Flint - Transported from Quarry Project	283,240	1,280
Wet Sand Flint Maximum Daily Delivered to Sand Storage	-	440
Wet Sand Flint Maximum Daily Delivered to Batch Plant	-	840
Wet Sand Flint Transported Daily from Batch Plant to Sand Storage	-	64
Soda Ash - Delivered by Train (3 railcars)	86,067	240
Dolomite Flint – Delivered by Train (3 railcars)	75,966	240
Limestone Flint – Delivered by Train (1 railcar)	20,659	80
Feldspar Flint – Delivered by Train (1 railcar)	10,111	80
Sodium Sulphide / Carbon etc. – Delivered by Flat Deck Truck	4,344 / 144	20
Total Batch Material Delivered to Plant Daily, by Train	-	**640**
Total Material Delivered to Plant Daily, by Trucks	-	**1,300**
Total Material Unloaded at Batch Plant	-	**1,480**
Total Material Unloaded at Sand Storage	-	**504**

Note: 1. Maximum hourly production source: CPS Truck logistic assumption_220207_summary.xlsx numbers prepared by cm.project.ing.

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:

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

Maximum emissions for unloading of wet sand (840 t/d), loading of products onto conveyor (1,316.3 t/d) and transporting wet sand by loaders (64 t/d) are:

$$TSP\ (kg/d) = 0.00177\ kg/t * 2{,}860\ t/d = 5.05$$

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. Then maximum fugitive emission from batch plant was:

$$TSP(kg/d) = 5.05\ kg/d * (1 - 0.7) = 1.52\ kg/d$$

Table A4 presents the maximum 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 Hour Maximum (kg/d)	PM_{10} 24 Hour Maximum (kg/d)	$PM_{2.5}$ 24 Hour Maximum (kg/d)
Batch Plant Loading & Unloading	1.52	0.717	0.109
Sand Storage Unloading	0.27	0.126	0.019
Eight Conveyor Transfer Points between Batch Plant and Production Building	5.58	2.641	0.400
Unloading from Conveyor, Loading to Furnace	1.40	0.660	0.100
Six Transfer Points inside Processing Plant Building	4.19	1.980	0.300
TOTAL DAILY Emissions from Loading / Unloading	**13.0**	**6.12**	**0.93**

A3.2 Vehicle Parameters (for Wheel Entrainment Emissions)

Table A5 summarizes parameters of vehicles travelling on the access roads and internal roads. Emissions depend on total vehicle kilometres travelled (VKT).

Table A5: Parameters of Vehicles Transporting Material on Roads (during 24-hour day)

Vehicle	Total Modelled VKT (per Day)	Trips/Day/ Vehicle	No. of Vehicles Needed	Vehicle Load (t)	Average Vehicle Weight (t)
Access Roads					
B-Train Trucks with Wet Sand from Quarry Project (Loaded & Empty)	13.18	4	8	40	43.5
Flat Deck Truck – Pallets or Racks	8.24	1	4	20	26.0
Flat Deck Truck – Raw Material	1.65	1	1	20	26.0
B-Train Trucks with Solar Glass	8.24	1	20	40	43.5
Blue Collar Commute	167.68	3	407	0.08	2
White Collar Commute	43.67	2	106	0.08	2
Inside Roads					
B-Train Trucks from Gate to Batch Plant – Loaded with Wet Sand	6.49	2.5	5	40	63.5
B-Train Trucks from Batch Plant to Gate – Empty	12.98	2.5	5	0	23.5
B-Train with Wet Sand from Gate to Sand Storage and Back Empty	11.33	1.5	3	40	43.5
Flat Deck Truck – Raw Material to Batch Plant Loaded	0.31	1	1	20	26.0
Flat Deck Truck –from Batch Plant Empty	0.62	1	1	20	26.0
B-Train Trucks Transport of Solar Glass from Gate to Loading Area (Empty & Loaded)	26.78	20	20	40	43.5
Flat Deck Trucks to Deliver Racks and Pallets (Loaded & Empty)	5.36	4	4	20	26.0
Liebher Loader from Batch Plant to Sand Storage	3.14	7	3	3.2	16.8
Kalmar Forklift from Warehouse to Loading Area	6.00	20	2	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 16 daily B-Train deliveries of wet sand at least five months of the year - 32 trips were modelled over 4 months and for two months there were no trips.
- Shipping of 600 t of final product was modelled with 20 B-Train trips per day (40 t load), although only 15 are needed. The remaining 600 t of final product is shipped by rail.

Overestimated emissions may include infrequent trips of 20 company cars and 4 light trucks (emission factors in **Table A6**). Assuming 26 trips a day, 2.73 km per trip (the longest distance at internal and access road), for company cars and light trucks results in a VKT as 71 km/d, which was omitted. Calculate particulate fugitive emissions for 26 trips (6 trips by light trucks and 20 trips by cars average a day) were 0.001% of total fugitive dust emissions from roads.

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**)

The VKT for the B-Trains transporting wet sand on the access road is 13.18 km/d (0.206 km*32 trips one way *2 return). The emission factor for the access road is (silt loading 0.2 g/m^2 and 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 = 13.18 km/d (**Table A5**):

38.7 (g/VKT) * 13.18 km/d / (1000 g/kg) = 0.51 kg/d

Table A6 summarizes emission factors and **Table A7** summarizes emissions from solar glass plant access and internal roads.

Table A6: 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	1.50
Emission Factor for Flat Deck Empty, Loaded	g/VKT	22.9	4.39	1.06
Emission Factor for Commuting Cars or Light Trucks	g/VKT	1.63	0.313	0.076
Internal Roads				
Emission Factor for B-Trains Empty, Loaded	g/VKT	105.1	20.18	4.88
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 Liebherr Loader Empty, Loaded	g/VKT	39.8	7.64	1.85
Emission Factor for Kalmar Forklift Empty, Loaded	g/VKT	196.5	37.71	9.12

Table A7: 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	0.510	0.098	0.024
Emissions – Flat Deck with Material to Batch Plant	kg/d	0.0094	0.0018	0.0004
Emissions – Flat Deck with Pallets Racks to Loading Area	kg/d	0.0094	0.0018	0.0004
Emissions – B Train with Solar Glass Finished Product	kg/d	0.319	0.061	0.015
Emissions – Commuters (Cars, Light Trucks)	kg/d	0.344	0.066	0.016
TOTAL Emissions from Access Road	**kg/d**	**1.22**	**0.234**	**0.057**
Internal Roads				
Emission - B-Trains Empty, Loaded Wet Sand to Sand Storage	kg/d	1.19	0.229	0.055
Emission - B-Trains Loaded Wet Sand to Batch Plant	kg/d	1.00	0.193	0.047
Emission - B-Trains Empty from Batch Plant	kg/d	0.73	0.140	0.034
Emission - B-Trains Empty, Loaded Solar Glass to Loading Area	kg/d	2.82	0.540	0.131
Emission - Flat Decks Empty, Loaded with Racks, Pallets	kg/d	0.33	0.064	0.015
Emission - Flat Deck Loaded with Material to Batch Plant	kg/d	0.03	0.0051	0.001
Emission - Flat Deck Empty from Batch Plant	kg/d	0.02	0.0045	0.001
Emission - Liebher Loader Empty, Loaded	kg/d	0.12	0.024	0.006
Emission - Kalmar Forklift Empty, Loaded*	kg/d	1.18	0.226	0.055
TOTAL Emissions from Internal Roads	**kg/d**	**7.43**	**1.425**	**0.345**

*Note: * Loading area emissions*

A3.4 Wind Generated Emissions from Stockpiles

The particulates emitted due to wind erosion were not modelled because material stockpiles will be covered and will not represent an emission source large enough to consider in the modeling.

The sand stockpile will be in an enclosed sand storage shed with air filtration. 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), Wind generated emissions were considered as negligible in comparison to loading, unloading, and paved road fugitive dust emissions.

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 A8 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 A8: 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)
2270002060	Sand Storage - Liebherr L-556 Wheel Loader	3	4	188	17
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 A9** 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 MOVES model) 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 A9: Load Factors (LF) and Brake Specific Fuel Consumption (BSFC) of Diesel-Powered Equipment

Equipment	LF	BSFC (lb/hp h)
Sand Storage - Liebherr L-556 Wheel Loader	0.59	0.371
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 A10 lists relative deterioration factors for nonroad diesel engines, dependant on Tiers (Table A6, page A16, US EPA 2010).

Table A10: 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 SO_2 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 A11** summarizes deterioration-adjusted emission factors used to calculate combustion emissions from diesel equipment.

Table A11: 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)
Liebherr L-556 Wheel Loaders	0.134	0.0049	0.282	0.127	0.014	0.013
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 A12 summarizes diesel combustion emissions calculated for equipment used in the modelling. The maximum hourly emissions (g/s) presented in **Table A12** 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 A9**
- $EF_{adjusted}$ – Adjusted Emission Factor (g/hp-h) from **Table A11**
- PR – Engine Power Rating (hp) (**Table A8**)
- EN – Number of Engines (**Table A8**)

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 A12** 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 A11**
- PR – Engine Power Rating (hp) (**Table A8**)
- EN – Number of Engines (**Table A8**)

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

Emission (g/s) = 0.00493 g/hp-h * 350 hp / (3600 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).

Wheel Loaders Liebherr L-556 should work less than 14 hours a day but were modelled for 24 hours a day. Liebherr loaders are usually inside the sand storage area (7/8 of the time); the rest of the time they are inside the batch plant or travelling between sand storage and the batch plant.

Table A12: 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)
Liebherr L-556 Wheel Loaders	0.01311	0.00082	0.0277	0.0124	0.00133	0.00129
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	0.01794	0.00086	0.2704	0.1526	0.02790	0.02707
TOTAL						
Hourly Maximum TOTAL (g/s)	**0.0568**	**0.0034**	**0.353**	**0.228**	**0.0319**	**0.0309**
Daily Maximum TOTAL (kg/d)	**4.91**	**0.295**	**30.47**	**19.66**	**2.75**	**2.67**

A4.2 Paved Road Diesel Combustion Emissions

Combustion emissions from trucks are based on the US EPA MOVES model which considers vehicle type as well as driving conditions. Table A**13** 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 A14 summarizes diesel combustion factors and Table A**15** 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 to not idle.

Table A13: Trucks and Cars Maximum Parameters During 1-Hour of Solar Glass Plant Operation

Transport / Parameter	Distance One Way (m)	Trips / Day	Max. Trips / Hour	Min. Idling Time (Minutes) per Vehicle per Hour
Access Road				
11 - B-Train Trucks with Wet Sand to Sand Storage	206	11	1	0
21 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant	206	22	2	0
20 - B-Train Trucks with Solar Glass Product and 4 – Flat Deck Trucks with Pallets and Racks	206	24	2	0
Commuters at 6:00 am and 10:00 pm	412	266	133	0

Transport / Parameter	Distance One Way (m)	Trips / Day	Max. Trips / Hour	Min. Idling Time (Minutes) per Vehicle per Hour
Commuters at 2:00 pm	412	141	141	0
Commuters at 7:00 am and 4:00 pm	412	106	53	0
Internal Roads				
11 - B-Train Trucks with Wet Sand to Sand Storage Loaded & Empty	515	11	1	10
21 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant - Loaded	309	22	2	10
21 - B-Train Trucks & One Flat Deck Truck from Batch Plant - Empty	618	22	2	10
20 - B-Train Trucks with Solar Glass Product and 4 – Flat Deck Trucks with Pallets and Racks – Loaded & Empty	670	24	2	10

Table A14: 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 & Flat Deck Trucks (g/VKT)	0.6693	0.0083	14.2201	6.075	1.5356	0.3552	2,480.66
Idling Long-Haul Trucks: B-Train & Flat Deck Trucks (g/VKT))	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

Table A15: 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 11 - B-Train Trucks with Wet Sand to Sand Storage Loaded / Empty (g/s)	7.66E-05	9.51E-07	1.63E-03	6.95E-04	1.76E-04	4.06E-05	0.284
Travel 21 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Loaded / Empty (g/s)	1.53E-04	1.90E-06	3.25E-03	1.39E-03	3.51E-04	8.13E-05	0.568
Travel 20 - B-Train Trucks with Solar Glass Product and 4 – Flat Deck Trucks with Pallets and Racks Empty / Loaded (g/s)	1.53E-04	1.90E-06	3.25E-03	1.39E-03	3.51E-04	8.13E-05	0.568
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
Inside Roads							
Travel 11 - B-Train Trucks with Wet Sand to Sand Storage Loaded / Empty (g/s)	1.92E-04	2.38E-06	4.07E-03	1.74E-03	4.39E-04	1.02E-04	0.710
Travel 21 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Loaded (g/s)	1.15E-04	1.43E-06	2.44E-03	1.04E-03	2.64E-04	6.10E-05	0.426
Travel 21 - B-Train Trucks with Wet Sand & One Flat Deck Truck with Material to Batch Plant Empty (g/s)	2.30E-04	2.85E-06	4.88E-03	2.09E-03	5.27E-04	1.22E-04	0.852
Travel 20 - B-Train Trucks with Solar Glass Product and 4 – Flat Deck Trucks with Pallets and Racks Empty / Loaded (g/s)	4.98E-04	6.18E-06	1.06E-02	4.52E-03	1.14E-03	2.64E-04	1.845
TOTAL Maximum 1-Hour Emission (g/s)	**6.40E-03**	**9.05E-05**	**3.41E-02**	**1.09E-01**	**5.53E-03**	**1.12E-03**	**16.4**
TOTAL Daily Maximum Emissions (kg/d)	**0.188**	**0.0025**	**2.65**	**2.37**	**0.311**	**0.0698**	**600**

A4.3 Rail Emissions

Combustion emissions from two switch locomotives (EMD GP39-2) working 15 hours a day and one line locomotive (GE AC6000CW) working two hours a day are based on US CFR 1 (2022). One line locomotive arrives at the plant in early morning, leaves railcars with batch material at the batch plant, and departs within one hour. A second locomotive arrives at the loading area in the evening, connects to railcars with final product, and leaves within one hour. The second locomotive operates 2 or 3 times a week, but it was modelled as a daily emission source. Switch locomotives move railcars around the batch plant (during unloading) and around the loading area (during loading of final product). It was assumed switching locomotives idle 90% of the time and travel 10% of the time each hour. Switch locomotives work 14 hours a day, but they were modelled for 15 hours if they will idle for one hour. **Table A16** summarizes locomotive parameters used to calculate emissions.

Table A16: 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
Switch Locomotive – Loading Area	2,300	5	20	0.25	1,015
Line Locomotives	6,000	5	20	1.00	12,918

Table A17 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^{o}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 MOVES model for heavy diesel trucks travelling 50 km/h.

Table A17: 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 A18 summarizes locomotive emissions. One-hour average emissions assumed 90% idling and 10% travelling. Daily emissions assumed that 2 switch locomotives work 15 hours per day and incoming and outgoing line locomotives travel one hour.

Table A18: 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	0.087	0.0036	0.049	0.332	0.0108	0.0012
Line Locomotive 1-hour Average	0.108	0.0458	0.867	0.542	0.0238	0.0026
Daily Total Emissions (kg/d)	**10.2**	**0.72**	**59.2**	**39.8**	**1.34**	**0.145**

A4.4 Furnace Emissions

Furnace stack parameters are summarized in **Table A19** and emissions in **Table A20**. 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 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
- TSP 0.3 kg/t of glass
- PM_{10} 0.17 kg/t of glass
- $PM_{2.5}$ 0.13 kg/t of glass

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 1,436.3 t of batch material melted in two furnaces. It is conservative approach, since the limits are normally used for tonnes of glass produced (1,200 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 * 1436.3 t/d = 2,154.45 kg/d *1,000 g/kg / (24 h*3600 s/h) = 24.94 g/s / (2 stacks) = 12.47 g/s/stack

Table A19: 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)	70	70
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 A20: 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	4.99	4.99	9.97	**862**
NO_X	12.47	12.47	24.94	**2,155**
CO	1.67	1.67	3.33	**288**
$PM_{2.5}$	1.08	1.08	2.16	**187**
PM_{10}	1.41	1.41	2.83	**244**
TSP	2.49	2.49	4.99	**431**
NH_3	0.50	0.50	1.00	**86.4**
HF	0.083	0.083	0.167	**14.4**
HCl	0.33	0.33	0.67	**57.6**

Note 1: There may be rounding discrepancies

A5. Summary of Total Emissions

Table A21 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 A21: 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	862	2,155	288	431	244	187
Maximum Daily TOTAL for Stacks	**862**	**2,155**	**288**	**431**	**244**	**187**
Vents and Loading Area (Volume Sources)						
Batch Plant Vent Diesel Combustion	0.017	0.53	0.63	0.025	0.025	0.0246
Batch Plant Vent Fugitive Emissions	0	0	0	1.516	0.717	0.1086
Sand Storage Vent Diesel Combustion	0.058	1.97	0.88	0.095	0.095	0.092
Sand Storage Vent Fugitive Emissions	0	0	0	0.267	0.126	0.019
Warehouse Vent	0.076	5.741	4.992	0.486	0.486	0.471
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	5.583	2.641	0.400
Loading Area Diesel Combustion	0.062	19.558	11.038	2.018	2.018	1.958
Loading Area Fugitive Emissions	0	0	0	1.179	0.226	0.055
Maximum Daily TOTAL for Vents and Loading Area	**0.29**	**30.2**	**19.5**	**11.3**	**6.45**	**3.24**
Road Emissions (Line Sources)						
Access Road Diesel Combustion	0.0014	0.76	1.56	0.11	0.11	0.0224
Access Road Fugitive Emissions	0	0	0	1.22	0.23	0.0567
Inside Roads (Including Loader Transport)	0.0234	27.75	10.61	1.72	1.72	0.406
Inside Roads Fugitive Emissions	0	0	0	6.25	1.20	0.290
Maximum Daily TOTAL for Road Emissions	**0.025**	**28.5**	**12.2**	**9.30**	**3.26**	**0.908**
Railway Emissions (Line Sources)						
Two Switch Locomotives 15 hours / day	0.553	56.04	37.83	1.25	1.252	0.136
Two Line-Locomotives 1 hour each / day	0.165	3.12	1.95	0.09	0.086	0.009
Total Daily Railway Emissions	**0.72**	**59.2**	**39.8**	**1.34**	**1.34**	**0.145**
Conveyor Emissions (Volume Sources)						
Eight Transfer Points from Batch Plant to Production Areas	0	0	0	5.58	2.64	0.400
Total Daily Conveyor Emissions	**0**	**0**	**0**	**5.58**	**2.64**	**0.400**
TOTAL Glass Plant Emissions	**863**	**2,273**	**360**	**459**	**258**	**192**

A6. GHG Annual Emissions

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

Table A22 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 A23** presents the global warming for GHG from diesel combustion equipment, assuming 100 years horizon, from IPCC (2018).

Table A22: 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 A23: 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 A22** and fuel consumption from **Table A8**, GHG emissions were calculated and summarized in **Table A24.** Following is an example calculation for Liebherr L-5566 Wheel Loaders:

Liebherr L-5566 Wheel Loaders:

CO_2 (t/y) = 2,681 g/L * 3 loaders * 24 h/d * 17 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 1,198
CH_4 (t/y) = 0.073 g/L * 3 loaders * 24 h/d * 17 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 0.033
N_2O (t/y) = 0.23 g/L *3 loaders * 24 h/d * 17 L/h * 365 d /1,000 g/kg / 1,000 kg/t = 0.103
GHG (t/y of CO_{2eq}) = 1,198 t/y + 25*0.033 t/y +298*0.103 t/y = 1,229

Table A24: 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)
Liebherr L-556 Wheel Loaders	446,760	1,198	0.033	0.103	1,229
Big-Bag Handling GP45N (4 t)	70,080	188	0.005	0.016	193
Finished Good Transport DP70N1	280,320	752	0.020	0.064	771
Cullet Handling GP55N (5 t)	140,160	376	0.010	0.032	386
Service GP45N (4 t) Forklifts	140,160	376	0.010	0.032	386
Loading of Pallets GP45N	210,240	564	0.015	0.048	578
Kalmar dcf500-12 Loading	219,000	587	0.016	0.004	589
Total	**1,506,720**	**4,040**	**0.110**	**0.301**	**4,132**

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 A25.** The total number of trips per year was obtained by division of annual solar glass plant sand demand (776 t/day*365 days) over 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 distancer for travel at access road and inside roads.......2.730 km
- Maximum allowance for idling on facility inside roads ....2.318 km

In the case of idling, it was assumed that trucks can be idling at facility inside facility roads. For idling emission calculation speed 0.1 km/h was assumed.

Example of GHG emission calculation for paved road travel:

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

Table A25: 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	2.32	-	7,081	42.01	0.69
B-Train with Wet Sand from Quarry Project Travel	2.73	10	7,081	2,480.66	47.95
Transport of Pallets to Facility - Idling	1.34	-	1,460	42.01	0.08
Transport of Pallets to Facility - Travel	1.75	10	1,460	2,480.66	6.34
Transport of Finished Product by Trucks - Idling	1.34	-	5,475	42.01	0.31
Transport of Finished Product by Trucks - Travel	1.75	10	5,475	2480.66	23.78
Transport of Additives (Flat Decks, Big Bags) - Idling	0.88	-	229	42.01	0.01
Transport of Additives (Flat Decks, Big Bags) Travel	1.29	10	229	2480.66	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	1.34	-	52	42.01	0.00
Miscellaneous (Oil Tanker, Oxygen, Urea, Hydrated Lime Coating) - Travel	1.75	10	52	2,480.66	0.23
Company Cars (20 Cars – Average 20 trips/day)	2.73	10	7,300	613.71	12.23
Company Trucks (3 Trucks - Average 6 trips/day)	2.73	10	2,190	772.59	4.62
Snow-Plow (Average 54 Days with Snow * 4 hours/day)	2.73	10	224	837.27	0.51
TOTAL Annual GHG Emissions from Paved Roads					**151**

A6.3 Rail Diesel Combustion Emissions of GHG

Rail GHG emission factors taken from EC (2020) are summarized in Table A**26**. Using these emission factors, Global Warming Potentials from **Table A23**, and fuel consumption from Table A**16**, rail GHG emissions were calculated and presented in **Table A27**. Following is an example calculation for one line locomotive hauling final product (2 – 3 trips per week - average 2.5 trips/week* 1 h a trip = 2.5 h/week):

$$GHG_{eq} \text{ (t/y)} = (2{,}680 \text{ g/l}*1+0.149 \text{ g/l}*25+1.029*298)*12{,}918 \text{ l/h}*365/7 \text{ weeks}*2.5 \text{ h/week} / 1000 \text{ g/kg} / 1000 \text{ kg/t}$$
$$GHG_{eq} \text{ (t/y)} = 5{,}036.5$$

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 two switch locomotives operating 15 hours each day.

Table A26: 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 A27: Locomotive Emission Factors (Tier 0)

Locomotive	GHG (CO_{2eq}) (t/y)
Two Switch Locomotives (15-hour per day; 365 days)	33,257.4
Line Locomotive – Train Delivering Material (1-hour per day; 365 days)	14,102.1
Line Locomotive – Train with Final Product (2 – 3 hours / week)	5,036.5
Total Railway GHG_{eq} emissions near the solar glass plant	**52,396**

A6.4 Furnace GHG Emissions

Furnaces will operate on natural gas, regardless of, if they are Air-Fired or Oxygen-Fired. According to CPS estimates, two furnaces require 58.1 MWh/h to operate during the melting process. While furnaces idle, to maintain temperature to prevent glass from hardening, there is a need for 23.24 MWh/h. We assumed 15 hours of normal operations and 9 hours of idling daily. According to Natural Gas Generator Efficiency & Approximate Consumption Chart (generatorsource.com), 12,780 ft^3/h of natural gas (362 $m^3/h/MW$) is needed. Using these assumptions, the natural gas annual requirement is:

Natural Gas consumption (m^3/y) = 362 $m^3/h/MW$ * (58.1 MW * 15 h + 23.24 MW * 9 h) *365 d = 142,743,706

Table A28 summarizes generic emission factors for natural gas combustion (Table A-1; US EPA 2016):

Table A28: 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 * 142,743,706 m^3/y / (1,000 g/kg) / (1,000 kg/t) = 274,228

Using emission factors from **Table A28** and Global Warming Potentials from **Table A23**, furnace stacks emissions from natural gas combustion were estimated and summarized in **Table A29:**

Table A29: 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	274,228
CH_4	0.00103	0.0364	5.19
N_2O	0.003	0.0035	0.50
GHG (CO_{2eq})			**274,508**

Sample of Calculation:

$$GHG (CO_2eq) = 274{,}228*1 + 5.19*25 + .50*298 = 274{,}508 \text{ t/y}$$

These calculations were also compared to IFC (2007) regulations, where there is a limit of 0.6 kg of CO_2 emitted for 1 kg of glass manufactured. With 1,200 t/d of produced glass, annual CO_2 emissions can be calculated as 262,800 t/y which is very close to calculated with more refined method 274,228 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 some 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 A30** 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 A30: 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	20,659	9,090
Dolomite Flint (+Carbon)	0.447	76,101	36,300
Soda Ash	0.415	86,067	35,718
Total GHG Emissions		**182,827**	**81,108**

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 A31 summarizes electricity consumption and indirect annual GHG emissions from plant operations.

Table A31: 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 A32 summarizes GHG emissions associated with operation of the solar glass plant.

Table A32: Annual GHG Emissions from Solar Glass Plant

Emission Sources	Annual Usage Rate Value	Unit	Total Annual CO2eq Emissions (t/y)
Direct Emission			
Natural Gas Combustion Furnaces	142,743,706	m^3	274,508
Melting of Glass	182,827	t	81,108
Transport by Trucks: Final Product, Additives, Commute, etc.	Variable-depending on engine size and annual utilization		151
Two Line Locomotives to Transport Final Product, and Supplies + Two Switch Locomotives	Variable-depending on engine size and annual utilization		52,396
Equipment Exhaust	Variable-depending on engine size and annual utilization		4,132
		Total Direct	412,295
Indirect			
Electricity Usage	432,612,600	kW-h	473
		Total Indirect	473
		Total	***412,768***
		Manitoba, Total for 2019	***22,600,000***
		Canada Total for 2019	***738,000,000***

Overall, the Project is estimated to generate 412,768 tonnes of CO_2e annually (using maximum emissions from furnace stack operations) which is 1.8 % of the reported emissions in 2019 which were 22.6 Mt CO_2e from Manitoba (Climate Change Connection, 2020), and 0.056% 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.

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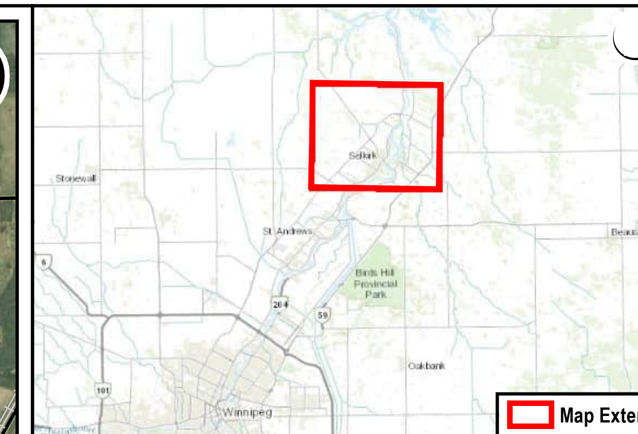
Appendix B

Isopleths



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 = 400 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 1-HOUR AVERAGE CONCENTRATION OF NO_2

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

Aug, 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

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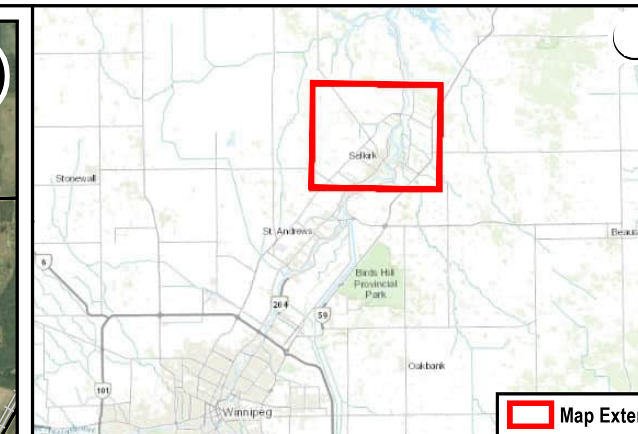

Legend

- 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

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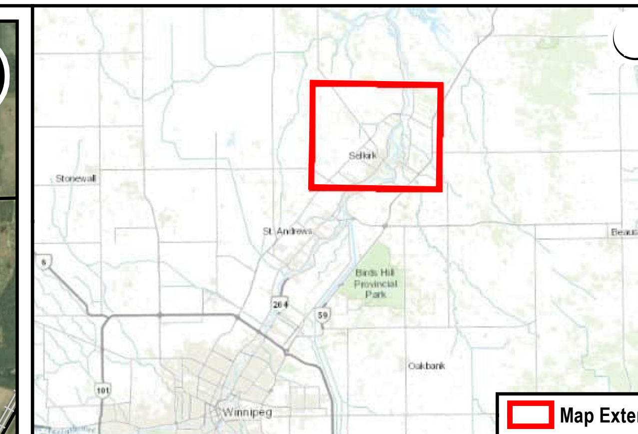
Figure B2

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/m³)
- Maximum Concentration at Sensitive Receptor (μg/m³)

MAAQC = 30 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 $PM_{2.5}$

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

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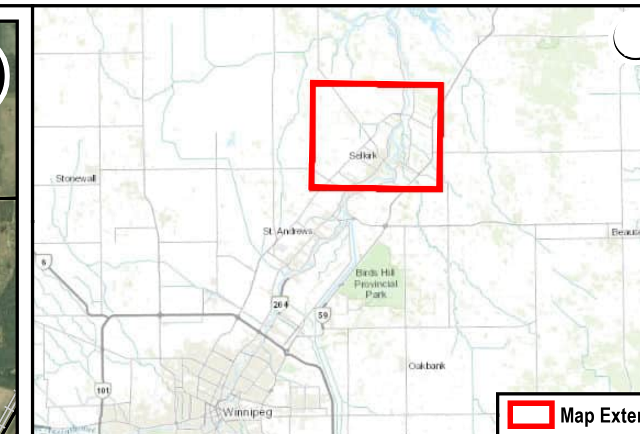
Figure B3

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

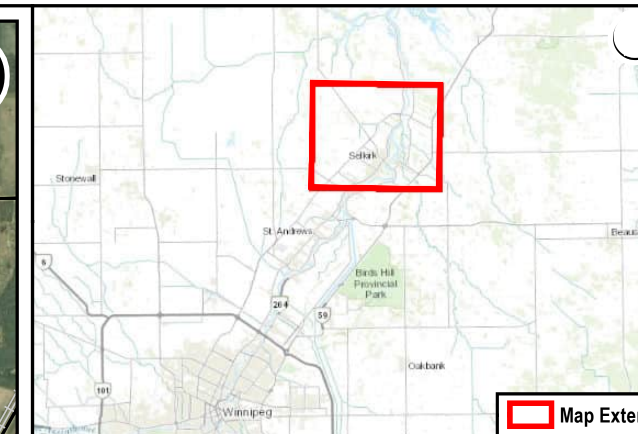
Datum: NAD 1983 UTM Zone 14N

Aug, 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 (µg/m³)
- Maximum Concentration at Sensitive Receptor (µg/m³)

MAAQC = 120 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 TSP

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

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AECOM

Figure B5

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

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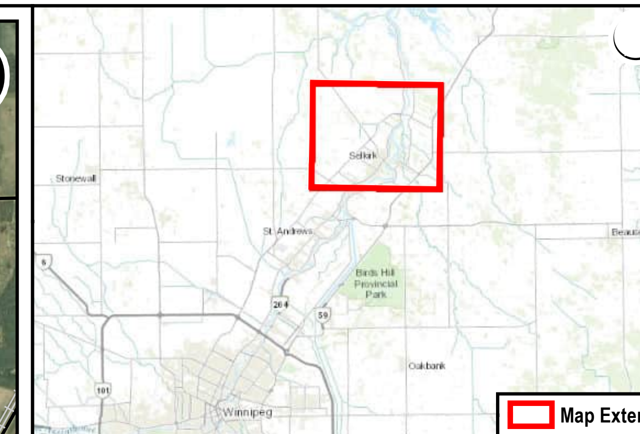


Legend

- 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 = 35,000 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

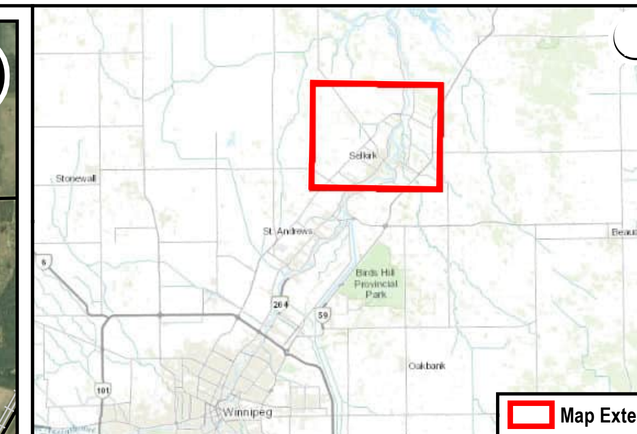
PREDICTIONS OF MAXIMUM 1-HOUR AVERAGE CONCENTRATION OF CO

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

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

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/m³)
- Maximum Concentration at Sensitive Receptor (μg/m³)

MAAQC = 900 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

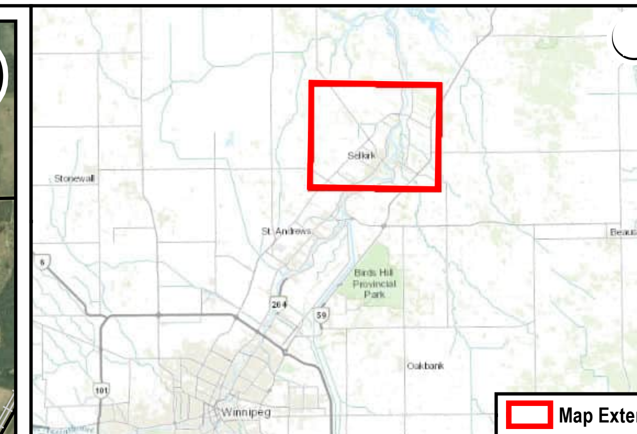
PREDICTIONS OF MAXIMUM 1-HOUR AVERAGE CONCENTRATION OF SO_2

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

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

Figure B7

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



Map Extents

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 = 300 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 SO_2

0 0.5 1 1.5 2
Kilometres

Datum: NAD 1983 UTM Zone 14N

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

Figure B8

AECOM

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

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