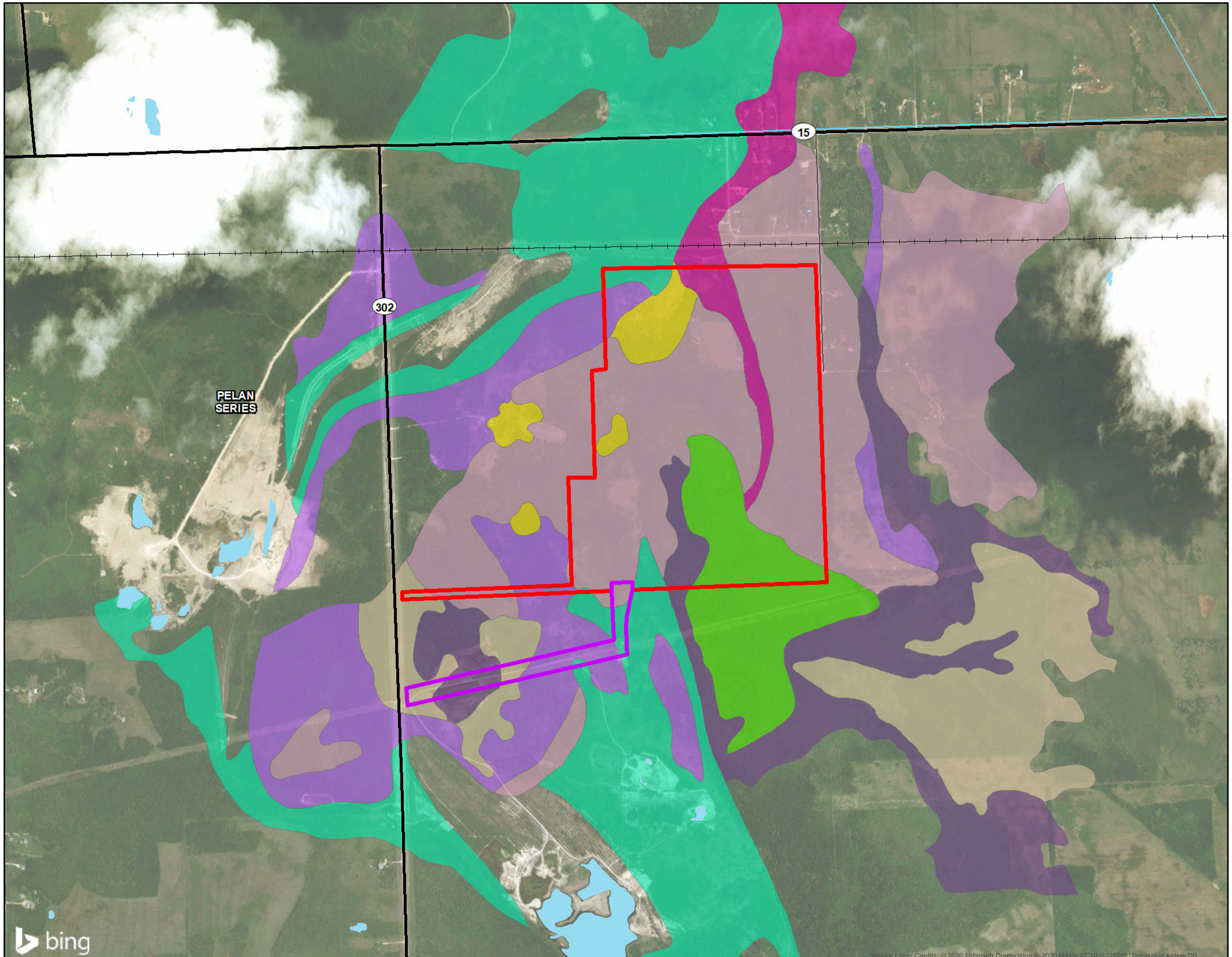
Appendix A

Soil Characteristics in the Project Site Area



Legend

- Project Site
- Project Site – Temporary Use

Soil Name *

- Beaverdam Lake
- Berry Island
- Gunton
- Kergwenan
- Leary
- Pelan
- Rat River
- Sprague

General Features

- Highway
- Road
- Railway
- Watercourses including Ditches and Drains
- Waterbody

* Note: Refer to Appendix A, Table A-1 for a description of the Soil Names

N
W E
S

1:15,000
NAD 1983 UTM Zone 14N

150 75 0 150 300 m

Basemap: Manitoba Land Initiative; CanSIS Detailed Soil Survey (Agriculture and Argi-food Canada); Canvec

AECOM

Appendix A

Vivian Sand Facility Project

Soils

CanWhite Sands Corp.

Last saved by: STEPHANIE.CLARK (2020-06-18) Last Plotted: Thu Jun 18, 2020 Project Management Initials: Designer: Checked: Approved: ANSI B 279.4mm x 431.8mm

Filename: L:\ENVIRONMENT\GIS\STEPHANIE CLARKE\WINNIPEG\VIVIAN_60625656\02_MXDS\VIVIAN SAND FACILITY PROJECT\H00A_60625356_FACILITY_SOILS.MXD

Table A-1: Description of Soil Types for the Soil Names occurring in the Project Site Area

Soil Name	Soil Drainage	Surface Texture	Textural Group of the Soil Profile
Beaverdam Lake	Imperfect	Loamy Sand	Very Coarse over Medium to Mod. Fine
Berry Island	Poor	Loamy Sand	Very Coarse over Medium to Mod. Fine
Gunton	Well	Loamy Sand	Very Coarse over Medium to Mod. Fine
Kergwenan	Imperfect	Loamy Sand	Very Coarse
Leary	Rapid	Loamy Sand	Very Coarse
Pelan	Imperfect	Loamy Fine Sand	Coarse over Medium to Mod. Fine
Rat River	Very poor	Mesic forest peat	Organic over Coarse
Sprague	Poor	Loamy fine sand	Coarse over Medium to Mod. Fine

For more detailed information on each Soil Name within the Project Site Area, refer to: Government of Canada and Government of Manitoba. 2011. Soils of the Municipality of Springfield. Report No. D88. 120 pp.

Appendix B

Air Quality Report

CanWhite Sands Corporation

Air Quality Assessment Report

Silica Sand Processing Facility, Vivian, Manitoba – Operations Phase

Prepared by:

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

T: 403 254 3301
F: 403 270 0399
www.aecom.com

Prepared for:

CanWhite Sands Corp.
Suite 2650, 645 – 7th Ave. SW
Calgary, Alberta T2P 4G8

Date: July 2, 2020

Project #: 60625356

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

Authors

Report Prepared By:

Pooya Shariaty, PhD, M.Eng.
Air Quality EIT

Report Reviewed By:

Piotr Staniaszek, PhD
Air Quality Scientist, Technical Lead

Randy Rudolph
Senior Air Quality Scientist

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

Table of Contents

page

List of Figures

List of Tables

List of Units

µg/m³............ Microgram per cubic metres
g/s .... Grams per second
g/s/m²........... Grams per second per square metres
K................... Kelvin
km .... Kilometres
kw-hr............ Kilowatt hour
m .... Metres
m/s .... Metres per second
m²................. Square metres
m³................. Cubic metres
mm............... Millimetres
ppb............... Parts per billion
t/hr................ Tonnes per hour
t/y .... Tonnes per year

Attachments

1. Introduction

1.1 Overview

CanWhite Sands Corp. (CanWhite) is applying for an Environment Act Licence from Manitoba Conservation and Climate (MBCC), to construct and operate a silica sand processing facility (the Project) located in the Rural Municipality (RM) of Springfield, near Vivian, Manitoba. AECOM was engaged to provide environmental assessment and permit application services to support the regulatory review and approval process required to proceed with the Project. A component of the Project environmental assessment information requirements was to perform an air quality assessment to determine the impact of potential emissions from the Project on the off-site air quality. This assessment focusses on the operations phase of the Project.

This air quality assessment is divided into air dispersion modelling assessment and green house gas (GHG) emissions assessment.

Key components of the Project (defined as the Processing Facility) are:

- A sand wash and dry facility that will include a ‘Wet Plant’, a ‘Dry Plant’ and the following associated components:
    - Two outdoor stockpiles of wet sand ready to be processed;
    - One overs/fines sand reject pile (outdoor) associated with the Wet Plant
    - One overs/fines sand reject pile (outdoor) associated with the Dry Plant;
    - Four dry sand product fully enclosed storage silos;
    - Ancillary structures, including permanent office, staff kitchen, washrooms, operator control centre, maintenance building and storage buildings; and
- A rail loop track (approximately 3.5 km length) connecting with a Rail Load Out for direct sand product loading to enclosed railcars, and for railcar storage.

The outside boundary of the site of the Processing Facility is defined in this report as the ‘Fenceline’ (see Figure 1). The Fenceline does not represent a physical fence but is simply the outside boundary of CanWhite’s property.

In addition, the Project will include a 5 m wide single-lane gravel access road approximately 1 km in length to the Processing Facility, with 1 m wide shoulders on either side for passing.

Dispersion modeling is performed using computer software that simulates the dispersion of emissions and the downwind ambient concentration of air pollutants emitted from stationary sources. The estimate of the resulting environmental concentrations depends on the source air emissions, meteorological data, topography and other information. The model can be used to predict future pollutant concentrations.

The air dispersion model utilized (AERMOD) for this study considered emissions from material transfer points, stacks/vents, material storage areas (stockpiles, silos), unpaved permanent access road, and equipment/vehicle exhausts (explained in detail below in Section 5). Modelled concentrations outside the Fenceline were compared with the *Manitoba Ambient Air Quality Criteria* (MAAQC 2005).

The MAAQC provides maximum time-based pollutant concentration limits for the protection and preservation of ambient air quality. These limits are specified to achieve a standard ambient air quality to protect the environment and human health. The limits are used to set standard thresholds above which emission controls and mitigation might be required.

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

- Dryer emissions based on estimated annual natural gas usage;
- Emissions from the mobile fleet considering estimated annual diesel/gasoline consumption: loaders, skid steer, grader, dozer, rail car mover, and light duty truck fleet; and
- Indirect emissions from electricity use in operations based on estimated consumption and the GHG intensity of the grid.

2. Project Description

2.1 Facility Location

The Project is located 1.3 km southwest of Vivian, Manitoba and approximately 35 km east of the City of Winnipeg (**Figure 1**). The proposed Processing Facility is surrounded by primarily trembling aspen forest, with agriculture and aggregate quarries dominating the adjacent local area land use. The nearest aggregate pits occur 1 km to the west, 750 m to the south and 2 km to the north.

The approximate latitude and longitude co-ordinates of the Facility are: 49°; 52' N and 96°; 28' W (UTM Zone 14U 682221 E; 5527462 N).

2.2 Process Description

Figure 2 illustrates the sequence of activities at the Processing Facility. CanWhite is proposing to process silica sand for bulk transportation to markets by railway.

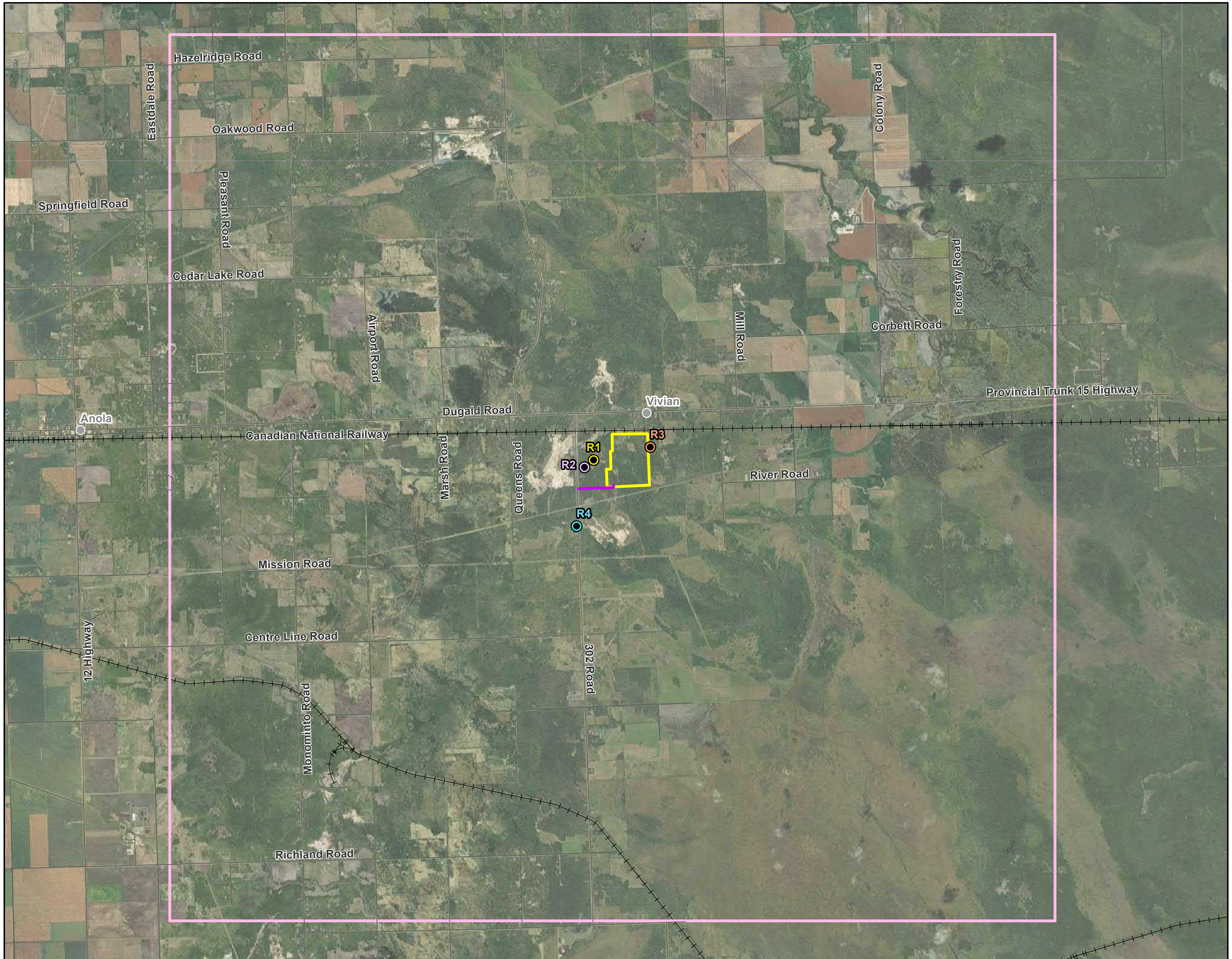
Wet sand that has been dewatered to remove water and particles smaller than 105 microns, and the remaining coarse particles stockpiled on-site, will be transferred to a hopper using a loader. From the hopper, the sand will be transferred to the dryer (within the enclosed Dry Plant) via conveyor belts. After drying, the sand will be screened to separate the target sizes. The final sand products will be stored in the silos and then transferred to railcars for transportation to markets by railway. Sand consisting of 'overs' and 'fines' that are either too large or too small, respectively, for the target sand buyer markets will be sold to alternate markets.

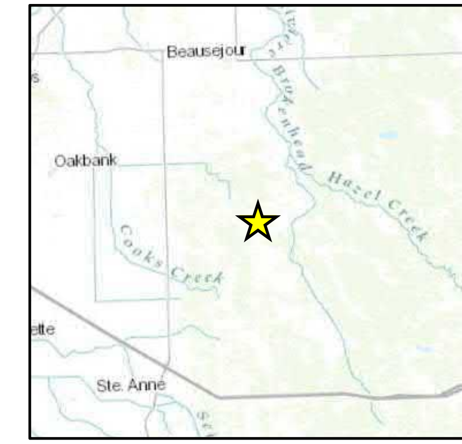
The Wet Plant is anticipated to be in operation 24 hours per day for eight months, 211 days per year, and the Dry Plant will be running continuously throughout the year for 298 days, considering downtimes for maintenance as required (around 7,000 hours per year). The emission sources associated with the Wet Plant were assessed based on eight months of operation (April to November), while the remaining emission sources associated with the dry process (including a loader) , conservatively, were assessed for 365 days in a year. The emissions from materials transfer points, equipment/vehicles exhausts, material storage area, and drying processes were considered as the main sources impacting the air quality.

AECOM

Figure: 1

FACILITY LOCATION





Key Map

Legend

- Road
- Railway

Model Features

- Modelling Domain (20x20 km)
- Fenceline
- Permanent Access

Sensitive Receptors

- R1 (Nearest Residence)
- R2 (Nearest Residence)
- R3 (Nearest Residence)
- R4 (Nearest Residence)

N / W / E / S

1:90,000
NAD 1983 UTM Zone 14N

1 0.5 0 1 2 3 km

Ortho-Imagery: ESRI World Imagery; ESRI Topographic Basemap, Canvec

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-23

ANSI B 279.4mm x 431.8mm
Approved:
Checked:
Designer:
Project Management Initials:
Last Plotted: Tue Jun 23, 2020
Last saved by: PAIGE.CROSSMAN (2020-06-23)
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\H001_60625356_AIRDISPERSION_FACILITYLOCATION.MXD

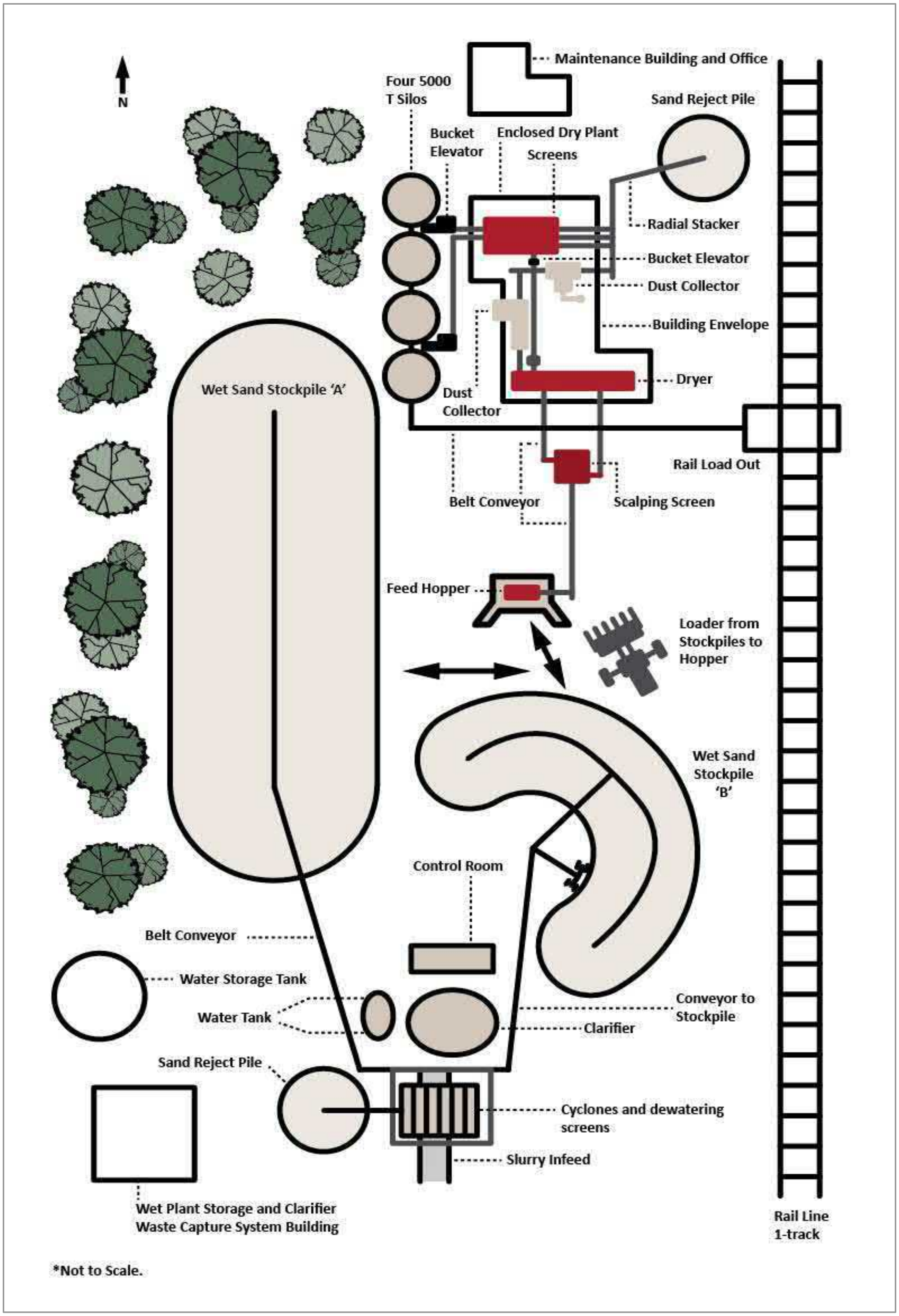


Figure 2: Process Sketch

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 2013) and the United States (US EPA 2013). 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 Modelling Guideline	AEP (2013)	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)	Manitoba provides a listing of Ambient Air Quality Criteria and Guidelines for various air pollutants.
US EPA AERMOD Implementation Guide	US EPA (2013)	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

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 Concentrations* provided by Manitoba Ambient Air Quality Criteria *(*MAAQC 2005) were used in this assessment.

The target parameters for the study include:

<u>Particulate Emissions</u>

- Particulate Matter with a diameter of 2.5 micrometres and less ($PM_{2.5}$)
- Particulate Matter with a diameter of 10 micrometres and less (PM_{10})
- Total Suspended Particulate (TSP)

<u>Gaseous Emissions</u>

- Carbon Monoxide (CO)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)

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

Table 2: Ambient Air Quality Criteria

Compound1	Averaging Period	MAAQC (µg/m³)
Particulate Matter with a diameter of 2.5 micrometres and less (PM2.5)	24-hour	30
Particulate Matter with a diameter of 10 micrometres and less (PM10)	24-hour	50
Total Suspended Particulate (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
Sulfur Dioxide (SO_2)	1-hour 24-hour Annual	900 300 60

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

4. Dispersion Modelling Methodology

4.1 The Choice of Air Dispersion Model

Air dispersion models are important tools that can be used to assess the likelihood of airborne contaminants from the facility impacting a particular location such as the nearest residences. The use of these tools comes with a certain amount of uncertainty. 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.

AERMOD is an approved regulatory dispersion model used in Manitoba as outlined in the *Draft Guidelines for Air Quality Dispersion Modelling in Manitoba (MCWS, 2006)*. AERMOD (Model Version 18081) was chosen for this assessment because it is useful for modelling concentrations in the near-field (within 1 km of the emission sources). AERMOD was also selected for this application 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; and
- Terrain influences.

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

In addition, AERMET 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 2013)* and the US EPA *AERMOD Implementation Guide (US EPA* 2013) were used as guidance.

4.2 Dispersion Model Boundaries

The modelled ground-level concentrations from the Project and comparison with MAAQC were investigated within two defined boundaries.

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 Fenceline. A study area of 20 km by 20 km surrounding the Processing Facility was used for this analysis; the appropriateness of this boundary selection was confirmed by the model outputs which showed that maximum concentrations were found within less than 0.5 km of the Fenceline. Model receptor points are described in **Section 4.4.2**.

4.2.2 Temporal Boundary

Temporal boundaries for this assessment were developed in consideration of continuous operations and emissions from the 24-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

Air quality is dependent on the rate of pollutant emissions into the atmosphere and the ability of the atmosphere to disperse the pollutant emissions. 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. AERMET (Model Version 18081) was employed to process meteorological data and terrain data inputs for AERMOD. AERMET requires surface hourly data and upper air data as an input. The surface hourly and upper air data were collected from Winnipeg James Armstrong International Airport and the International Falls Station, Minnesota over a five-year period (2013-2017), respectively.

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 1.4% of the time. Calm is defined as less than the starting threshold of the anemometer (0.5 m/s).

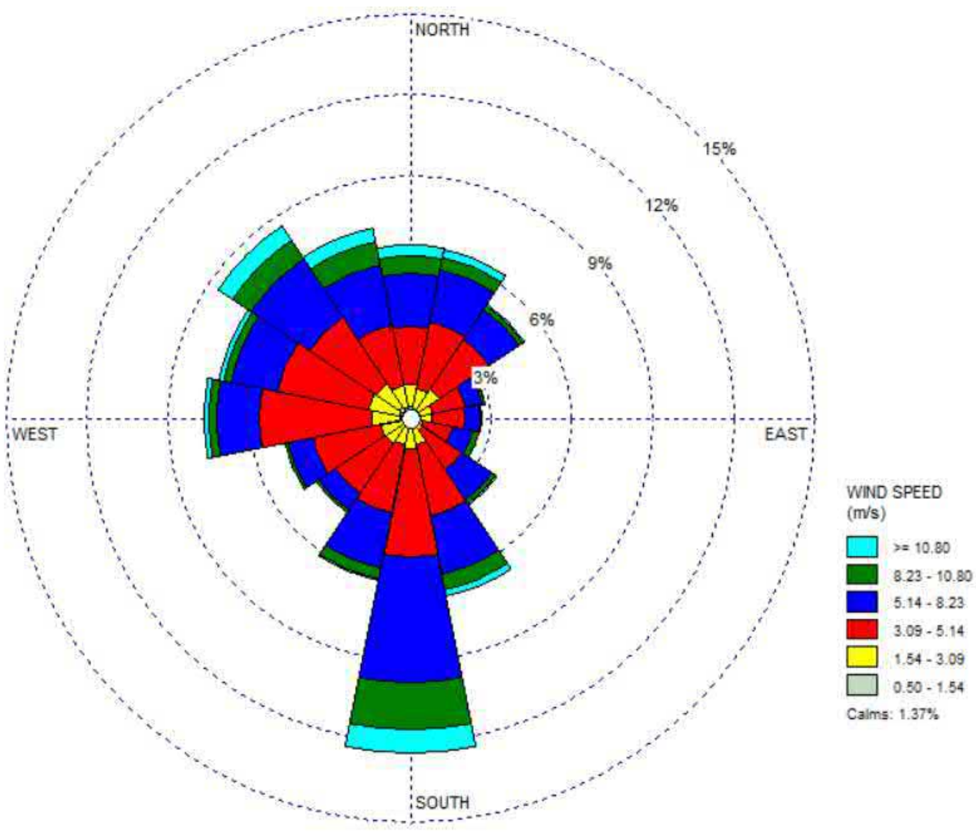


Figure 3: Windrose of Meteorological Data (Jan 1, 2015-Dec 31, 2019)

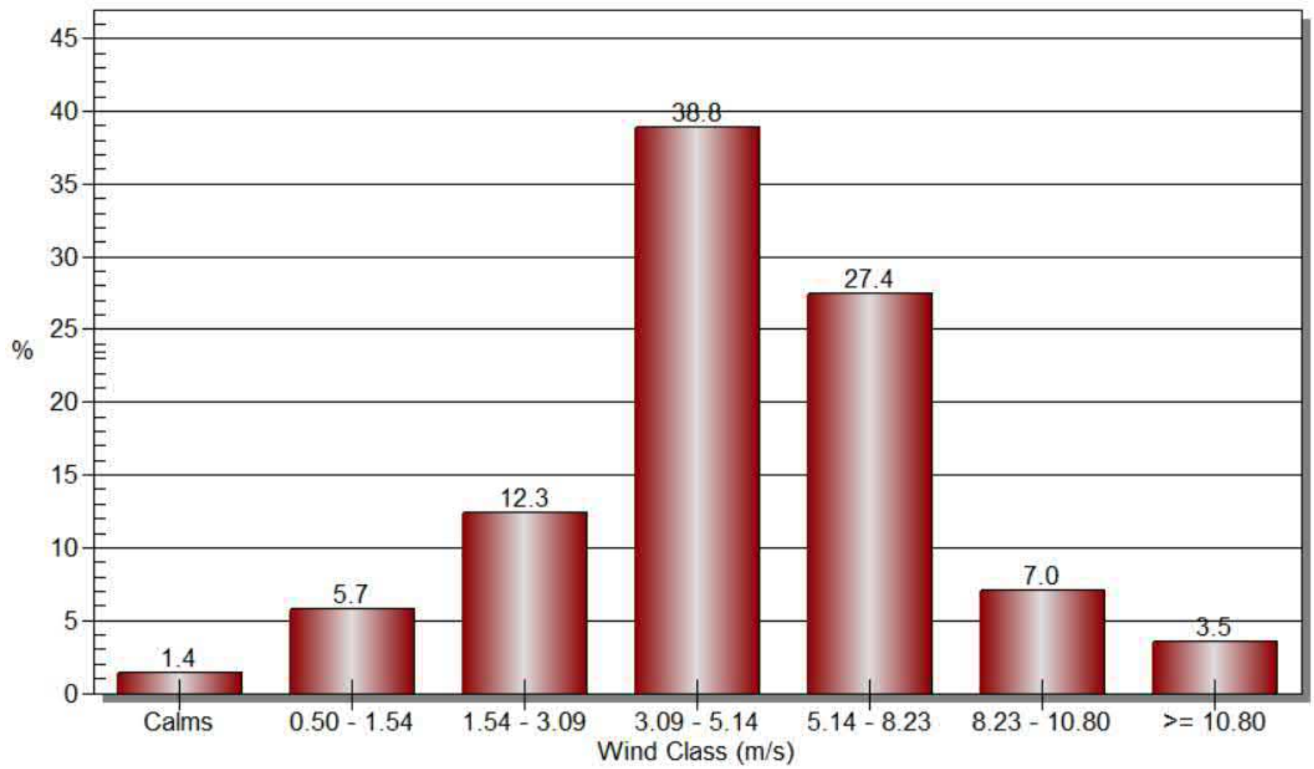


Figure 4: Wind Class Frequency Distribution of Meteorological Data (January 1, 2015 to December 31, 2019)

AERMOD does not have the ability to model calm winds. As such, these events were not assessed as part of the dispersion modelling analysis. AERMOD over-predicts emission concentrations in light winds.

AERMET produces surface scalar parameters and vertical profiles of meteorological data that were used as an input for AERMOD. In order 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.

The AERMOD Implementation Guide (AIG) (US EPA 2013) recommends that the surface characteristics be determined based on digitized land cover data. US EPA has developed a tool called AERSURFACE (US EPA 2013) that can be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. 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;
2. "Summer": when vegetation is lush and healthy;

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; and
4. “Winter”: for snow-covered surfaces and subfreezing temperatures.

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 potential impacts of the Project. The background concentrations of the modelled parameters were obtained from the Winnipeg Ellen Street and Thompson Air Quality Stations. These stations were selected because they are the closest locations that compile the background air quality measurements needed for the study. The background conditions at the applicable averaging periods for the most recent year (2019) are summarized in the following **Table 3**.

Table 3: Ambient Background Air Quality Concentrations(1)

Pollutant	Data Source Location	Averaging Period	Ambient Background Air Quality ($\mu g/m^3$)	Objective and/or Guideline ($\mu g/m^3$)
$PM_{2.5}$	Ellen St. Station, Winnipeg	24-hour	9	30
PM_{10}	Ellen St. Station, Winnipeg	24-hour	14	50
TSP (2)	Ellen St. Station, Winnipeg	24-hour Annual mean	14 6.7	120 70
CO	Ellen St. Station, Winnipeg	1-hour 8-hour	103 85	35,000 15,000
NO_2	Ellen St. Station, Winnipeg	1-hour 24-hour Annual Mean	28 25 13	400 200 100
SO_2 3	Thompson	1-hour 24-hour Annual mean	8 8 0.9	900 300 60

Notes: 1. The 90th percentile for all averaging periods were applied to the background concentrations.
2. No data was available for TSP background concentration. PM10 background concentration was used instead.
3. Thompson Station data was used for SO_2 since the data from Ellen St Station was not valid.

4.5 Land use and Terrain Characteristics

According to the AERMOD user guide (US EPA 2013), the model should be based on the dominant land use category within 3 km of the Facility, where approximately one half of the land is deciduous forest. The surface roughness, albedo and Bowen ratios for land use and seasons are default values outlined in the Alberta Modelling Guideline (AEP 2013).

4.6 Receptors

The receptor grid was designed to ensure that the model captures the maximum modelled concentrations associated with the facility emissions. A Cartesian receptor grid was developed 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 Alberta Air Quality Model Guideline (AEP 2013):

- 50 m receptor spacing within 0.5 km from the sources of interest;
- 250 m receptor spacing within 2 km from the sources of interest;
- 500 m spacing within 5 km from the sources of interest; and
- 1,000 m spacing beyond 5 km.

Additionally, the following four sensitive receptors were identified and included in this model. **Table 4** illustrates the co-ordinates and distance from the Fenceline.

Table 4: Sensitive Receptor Details

Discrete Receptor	Receptor ID	Approximate Distance from the Fenceline (m)	UTM Co-ordinate	
			(mE)	(mN)
Nearest Resident 1	R1	354	681,439	5,527,848
Nearest Resident 2	R2	493	681,235	5,527,680
Nearest Resident 3	R3	54	682,722	5,528,139
Nearest Resident 4	R4	1,115	681,054	5,526,353

4.7 Nitrogen Dioxide Modelling

Maximum predicted NO_X concentrations were conservatively assumed as 100% which is referred by Alberta Modelling Guidelines modelling (AEP 2013) as Total Conversion Method (TCM). If TCM exceeds the MAAQC for NO_2 then the other methods can be used. 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:

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

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 St Station, Winnipeg, Manitoba provided in **Table 5**. NO_2 concentrations are also reported using the total conversion method (all NO_x is converted to NO_2).

Table 5: Summary of Ozone Concentration Data Obtained from Ellen St Station

Hour of the Day	Ozone Concentration (ppb)											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
0.00	12.9	15.2	18.5	20.0	13.7	10.9	8.1	6.4	7.3	6.8	9.5	12.7
1.00	13.1	15.1	17.4	19.9	13.6	10.9	8.3	6.6	7.3	6.5	9.9	13.3
2.00	13.4	14.0	17.3	19.9	12.7	11.0	7.5	6.6	7.1	6.1	9.8	14.0
3.00	13.3	14.6	17.5	20.2	12.4	11.5	7.4	6.4	7.0	5.7	9.9	14.0
4.00	12.9	14.2	17.1	19.0	12.9	11.3	7.3	6.7	6.9	5.4	9.3	13.6
5.00	12.7	12.8	16.5	17.5	11.8	9.8	6.2	5.7	5.8	4.8	8.6	13.0
6.00	11.7	12.0	15.2	16.0	10.2	8.8	5.6	5.6	5.1	4.4	7.4	12.7
7.00	10.7	10.9	13.9	15.9	11.1	9.6	6.3	6.3	5.8	4.4	6.8	11.0
8.00	10.2	10.7	13.7	18.1	13.6	11.0	7.7	6.7	6.5	5.7	7.8	11.0
9.00	11.6	11.9	16.6	20.2	15.2	12.7	9.3	7.7	8.0	6.7	8.9	12.4
10.00	13.6	14.7	18.9	22.0	16.6	13.8	10.8	9.3	9.4	7.4	9.4	13.9
11.00	14.8	16.9	20.5	23.3	17.1	15.6	11.8	10.0	10.4	8.2	9.9	14.5
12.00	15.1	18.1	21.8	23.8	17.6	16.3	12.6	10.4	11.2	8.8	10.2	15.6
13.00	15.7	18.0	22.1	24.0	18.1	17.2	13.1	10.8	11.1	9.2	10.9	15.3
14.00	15.3	17.6	23.3	23.8	18.3	16.9	12.8	10.6	10.7	9.2	10.9	15.3
15.00	14.1	16.4	22.2	23.5	17.0	16.6	12.7	9.9	10.0	8.2	10.2	14.5
16.00	12.9	15.3	21.9	23.9	17.1	16.6	12.6	9.5	9.8	8.2	10.1	13.3
17.00	11.8	14.1	20.3	23.7	16.9	16.7	12.4	9.5	9.4	7.6	9.7	11.5
18.00	12.0	14.5	18.8	22.6	16.1	16.4	12.1	9.1	8.7	7.1	9.7	11.5
19.00	12.2	14.9	18.3	21.3	15.5	15.4	11.2	8.5	7.7	6.0	9.6	12.0
20.00	12.2	15.6	18.9	20.0	14.1	13.9	9.7	7.4	7.3	5.9	9.2	12.6
21.00	12.6	15.7	18.6	20.2	13.7	13.0	8.4	6.6	6.8	6.0	9.1	12.4
22.00	13.2	15.3	18.7	20.6	13.4	12.0	7.5	6.3	7.0	7.1	9.1	12.1
23.00	12.6	15.4	18.6	20.9	13.4	11.4	7.3	6.4	7.1	7.3	9.1	12.7

5. Project Emissions

The details of emission calculations (including samples of calculations) are provided in **Attachment A**. This section summarizes emission scenarios, source parameters and emissions used for modelling. These air emissions were used in the AERMOD dispersion model to assess maximum predicted TSP, PM_{10} (which includes silica), $PM_{2.5}$, NO_2, CO, and SO_2 ground-level concentrations.

The following emission sources were identified at the Project:

- Dryer Baghouse Stack (NO_X and particulates)
- Sand Screen Baghouse Stack (particulates);
- Silo Bin Dust Collection Vents (particulates)
- Load-out Spouts Dust Collection Vents (particulates)
- Load-out Bin Dust Collection Vents (particulates)
- Wind Driven Emission from 40/140 Stockpile A (particulates)
- Wind Driven Emission from 40/140 Stockpile B (particulates)
- Wind Driven Emission from Oversize / Fines Stockpile (particulates)
- Loader Up-loading Material Areas (particulates)
- Material Transfer Points at the stockpiles and between Conveyor Belts (particulates) (40/140 Stockpile A – Tripper-Drop and 40/140 Stockpile B – Stacker-Drop)
- Equipment Plant Operations (particulates, NO_X, CO, and SO_2)
- Rail Car Mover Exhaust (particulates, NO_X, CO, and SO_2)
- Access Road (particulates, NO_X, CO, and SO_2)

The source model input parameters are summarized in **Table 6** to **Table 8**. **Figure 5** displays the emission source locations used in the model. The following assumptions were considered for the modelling assessment:

- All emission sources, except for material transfer points (tripper and stacker dropping sand on the two sand stockpiles), were modelled based on 24 hours 365 days operations;
- These material transfer points (tripper and stacker drops on 40/140 Stockpiles A and B) were modelled for April to November only (based on the time period during which sand will be stockpiled);
- All emission sources, including vehicles on the access road, were assumed to be operating at the same time;
- For exhaust emissions on the permanent access road, it was very conservatively assumed that at every hour of every day there will be on the road:
  - 50 light duty trucks (for transport of employees in and out of the Project, or visitors or supplies),
  - two heavy duty rigs, and
  - one medium duty truck, either for fuel supply or for waste disposal.

More detailed descriptions of all assumptions used for emission estimates are provided in **Attachment A**.

Table 6: Modelled Point Source Parameters

Point Source Name	Source ID	UTM X (km)	UTM Y (km)	Stack Orientation	Stack Height (m)	Eq Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)	Emission Rate (g/s)			
									$PM_{2.5}$	PM_{10}	TSP	NOx
Plant 1 Dryer Baghouse (DC-110)	DRYER	681,884	5,527,507	Vertical	22.86	1.575	16.96	372.15	0.021	0.136	0.288	0.869
Plant 1 Nuisance Baghouse (DC-120)	SCREEN	681,895	5,527,510	Vertical	22.86	1.016	16.71	333.15	0.00418	0.028	0.058	
Silo 610 Bin Vent Dust Collection (BV-310)	SILO1	681,878	5,527,529	Horizontal	35.0	0.180	16.74	333.15	0.00383	0.029	0.053	
Silo 620 Bin Vent Dust Collection (BV-620)	SILO2	681,877	5,527,514	Horizontal	35.0	0.180	16.74	333.15	0.00383	0.029	0.053	
Silo 630 Bin Vent Dust Collection (BV-630)	SILO3	681,877	5,527,499	Horizontal	35.0	0.180	16.74	333.15	0.00468	0.035	0.065	
Silo 640 Bin Vent Dust Collection (BV-640)	SILO4	681,877	5,527,484	Horizontal	35.0	0.180	16.74	333.15	0.00468	0.035	0.065	
Loadout Spout (SP-420)	SPOUT1	681,872	5,527,529	Horizontal	11.4	0.180	8.73	333.15	0.000010	0.000070	0.000140	
Loadout Spout (SP-430)	SPOUT2	681,872	5,527,514	Horizontal	11.4	0.180	8.73	333.15	0.000010	0.000070	0.000140	
Loadout Spout (SP-440)	SPOUT3	681,872	5,527,499	Horizontal	11.4	0.180	8.73	333.15	0.000010	0.000070	0.000140	
Loadout Spout (SP-450)	SPOUT4	681,872	5,527,484	Horizontal	11.4	0.180	8.73	333.15	0.000010	0.000070	0.000140	
Loadout Bin Vent Dust Collection (BV-410)	BINV1	681,940	5,527,488	Horizontal	24.6	0.180	16.74	333.15	0.000104	0.000687	0.001453	
Loadout Bin Vent Dust Collection (BV-420)	BINV2	681,937	5,527,489	Horizontal	19.0	0.180	16.74	333.15	0.000104	0.000687	0.001453	
Loadout Bin Vent Dust Collection (BV-430)	BINV3	681,943	5,527,490	Horizontal	19.0	0.180	16.74	333.15	0.000104	0.000687	0.001453	
Loadout Bin Vent Dust Collection (BV-440)	BINV4	681,937	5,527,486	Horizontal	19.0	0.180	16.74	333.15	0.000104	0.000687	0.001453	
Loadout Bin Vent Dust Collection (BV-450)	BINV5	681,943	5,527,487	Horizontal	19.0	0.180	16.74	333.15	0.000104	0.000687	0.001453	

Table 7: Modelled Volume Source Parameters

Volume Source Name	Source ID	Effective Height (m)	Initial Sigma Y (m)	Initial Sigma Z (m)	Emission Rate (g/s)					
					$PM_{2.5}$	PM_{10}	TSP	NOx	CO	SO_2
40/140 Stockpile A - Tripper-Drop	STPA	4.5	1.4	2.1	0.00012	0.0008	0.0017			
40/140 Stockpile B - Stacker-Drop	STPB	4.5	1.4	2.1	0.00009	0.0006	0.0013			
Overs/Fines Stockpile-Drop	STPFINE	4.5	1.4	2.1	0.00268	0.0177	0.0375			
Up-loading Material Area 1	LOAD1	1.5	1.4	0.70	0.00065	0.00430	0.0091			
Up-loading Material Area 2	LOAD2	1.5	1.4	0.70	0.00015	0.00098	0.0021			
Road (LINE VOLUME *7)	RD	3.4	5.7	3.2	0.0220	0.0304	0.0843	0.531	0.125	0.0074
Railcar mover (LINE VOLUME *25)	RAIL	3.4	6.1	3.2	0.0206	0.0212	0.0212	0.302	0.065	0.0198
Access Road (LINE VOLUME * 35)	ARD	1.7	11.6	1.6	0.0269	0.0538	0.1933	0.275	0.155	0.0009
Hopper Discharge Conveyor-Drop	CDRP1	0.3	0.47	0.14	0.00090	0.0046	0.0125			
Hopper Discharge Conveyor-Drop	CDRP2	0.3	0.47	0.14	0.00090	0.0046	0.0125			
Hopper Discharge Conveyor-Drop	CDRP3	0.3	0.47	0.14	0.00090	0.0046	0.0125			

Table 8: Modelled Wind Speed Dependent Source Parameters

Area Source Name	Source ID	Release Height (m)	Area (m^2)	Emission Rate ($g/s/m^2$)		
				$PM_{2.5}$	PM_{10}	TSP
40/140 Stockpile A - Wind Driven Emission	STPAW	14.3	3500	0.0000112	0.0000739	0.000156
40/140 Stockpile B - Wind Driven Emission	STPBW	7.47	1500	0.0000112	0.0000739	0.000156
Overs/Fines Stockpile-Wind Driven Emission	STPFW	4.27	200	0.0000112	0.0000739	0.000156

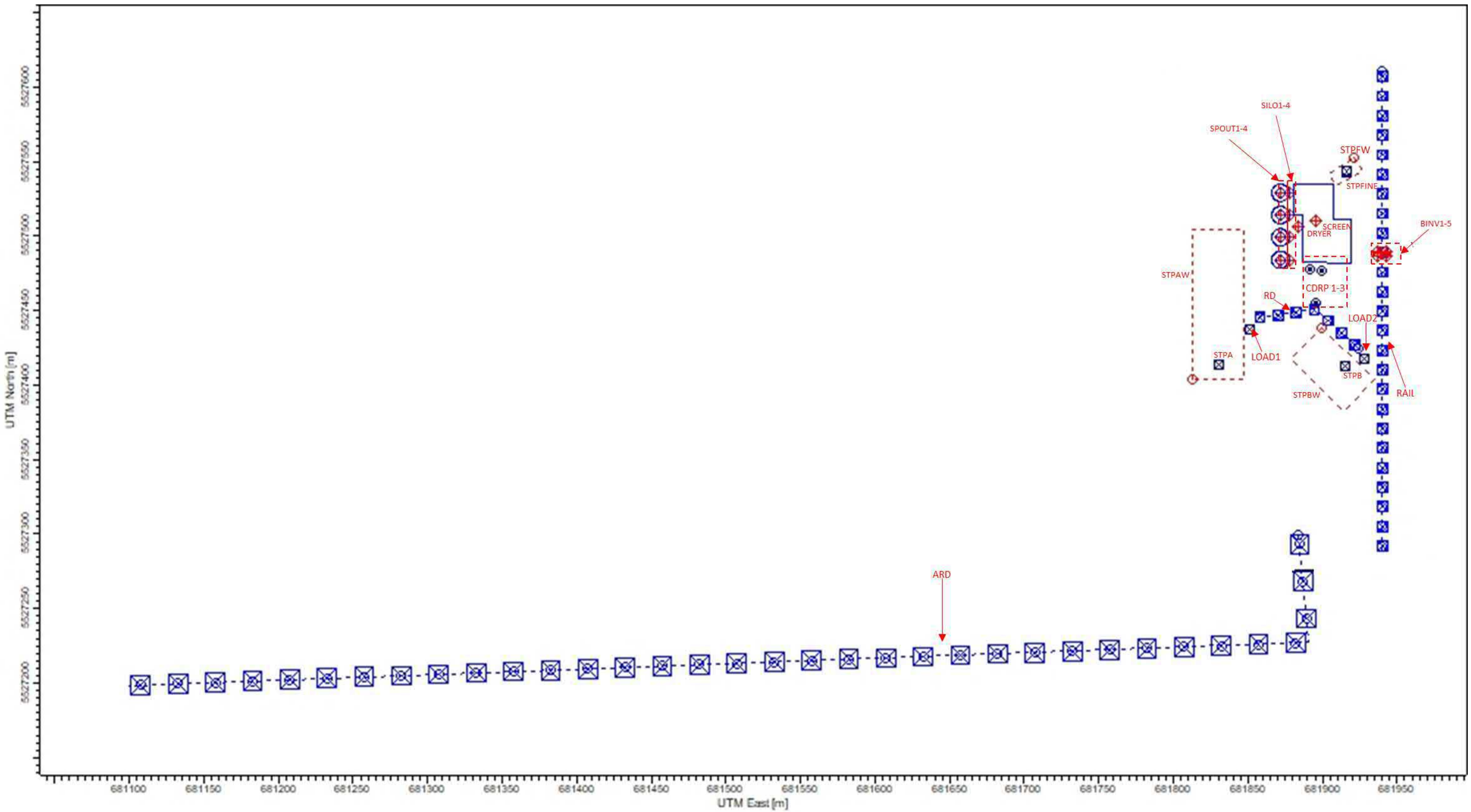


Figure 5: Source Locations

6. GHG Emissions

A GHG emission inventory was developed considering both direct and indirect emissions associated with Project operations. The total annual GHG emission calculation was completed using the information provided by CanWhite as well as recommended emission factors from Canada's Greenhouse Gas Quantification Requirements (EC 2019), Manitoba Hydro (2019), and US EPA (1996). **Table 9** summarizes estimated annual GHG emissions from Project sources.

Based on provided information, propane will be used to fuel the dryer for first two years of operation and replaced by natural gas afterward.

Table 9: GHG Emissions from Operations

Emission Sources	Annual Usage Rate Value	Unit	Total Annual CO2eq Emissions (t/y)
Direct Emission			
Propane Combustion-Dryer (Year 1-2)	4,949,422	m^3	27,791
Natural Gas Combustion-Dryer (after Year 2)	12,090,044	m^3	24,837
Equipment Exhaust	Variable-depending on engine size and annual utilization		1,053
Vehicles on the Access Road	Variable-depending on engine size and annual utilization		35
		Total Direct (Year 1-2)	28,879
		Total Direct (after Year 2)	25,925
Indirect			
Electricity Usage (annual total)	19,998,337	kWh	8,399
		Total Indirect	8,399
		Total (Year 1-2)	***37,278***
		Total (after Year 2)	***34,324***

7. Dispersion Modelling Results

7.1 Introduction

AERMOD was executed with emission rates for the emissions sources specified in **Table 6** to **Table 8**. As described above in Section 4.4, background concentrations were taken from data at the Winnipeg Ellen Street and Thompson air quality monitoring stations.

The following conservative assumptions were incorporated into the model:

- All emission sources, except for material transfer points (tripper and stacker dropping sand on the two sand stockpiles), were modelled based on 24 hours 365 days operations;
- These material transfer points (tripper and stacker drops on 40/140 Stockpiles A and B) were modelled for April to November only (based on the time period during which sand will be stockpiled);
- All emission sources, including vehicles on the access road, were assumed to be operating at the same time;
- Dust reduction due to rainfall was not considered in summer; and
- Dust reduction from snow covered or partially frozen sand stockpiles was not considered in winter.

Based on the Project description, the following assumptions concerning possible mitigation of dust were incorporated into the model:

- Hopper discharge conveyor
    - Three source segments were modelled on the basis that they will be partially covered (70% emission reduction).
    - Since the material will be both coarse and wet (15% moisture content), an additional 50% reduction (total reduction 85%) was applied to unmitigated emission factors.
- Processing Facility yard – haul road for loaders from wet sand stockpiles to hopper
    - The sand dropped to the road surface will be coarse and will contain a small percentage of water. Based on these facts, particulate emissions were reduced by 50%.
- Wind speed generated emissions
    - We assumed an active area for stockpiles as conservatively large, but because the sand will be moist and coarse (fines removed), dust emissions were reduced by 75%.
- Loading materials onto loaders next to sand stockpiles A and B
    - Based on the moisture content and coarse nature of the material, a 50% reduction in dust emissions was applied.
- Material drops onto sand stockpiles (A and B) are uncovered, and no mitigation was applied.
- It was assumed that the access road will be watered on dry hot days before shift change (in the morning and in the evening) with an 80% emission reduction.
- It was assumed that particulate emissions for rigs and supply trucks on the access road are unmitigated (access road is not watered before they travel).

Mitigation 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.

7.2 Model Results

The results of two model scenarios are presented:

1. Emission from the Processing Facility only, including background concentrations
2. Emissions from the Processing Facility as well as Project related road dust and vehicle exhaust emissions on the access road. Background concentrations are also included.

7.2.1 Processing Facility

Error! Reference source not found. and Error! Reference source not found. below display the maximum predicted ground-level concentrations for emissions from the Processing Facility of all compounds, modeled for five years of meteorological data, compared to MAAQC guidelines. Associated figures are provided in **Attachment B**.

7.2.1.1 Particulate Emissions

For particulate emissions, off-site (beyond the Fenceline) exceedances of the MAAQC were predicted to occur only 0.3% of the time that the Facility is in operation (between one and five exceedances every five years), and only under the worst-case emissions scenario (described in detail in Section 7.2.3).

In addition, the extent of any exceedance will be limited to within 20 m to 70 m (up to approximately 2/3 length of a football field) from the Fenceline. The point of the potential exceedance is more than 450 m from the nearest residence (see **Attachment B**, **Figures B-1** to **B-3**).

The details of the predicted possible exceedances of the MAAQC for particulate matter (TSP, PM_{10}, and $PM_{2.5}$) are as follows:

- Possible MAAQC exceedances of the 24-hour $PM_{2.5}$ concentrations:
  - Occur near the western Fenceline and do not extend more than approximately 20 m beyond it (**Figure B-1**);
  - Only one exceedance (99.95% compliance) was predicted in five years of data;
  - This exceedance was predicted for late January; and
  - The model did not account for snow and frozen surfaces expected in the winter months, which would further reduce dust emissions beyond those modeled.
- Possible exceedances of MAAQCs of the 24-hour PM_{10} and TSP concentrations:
  - Occur approximately 50-70 m beyond the western Fenceline (**Figure B-2** and **Figure B-3**);
  - PM_{10} predictions met the MAAQCs 99.7% of the time (five exceedances in five years);
  - TSP predictions met the MAAQCs 99.8% of the time (three exceedances in five years);
  - These exceedances were predicted for late November or late January;
  - The model did not account for snow and frozen surfaces expected in the winter months, which would further reduce dust emissions beyond those modeled.

The maximum annual TSP prediction is 34% of the MAAQC (66% below the MAAQC limit). Even this is an over-estimation because the model assumes that the Project is operating continuously with no downtime for 365 days a year.

As outlined above, the modelled concentrations at sensitive receptors were well below the MAAQCs, demonstrating that no residences or public roads will be affected by particulate emissions from Project operations.

7.2.1.2 Gaseous Emissions

The model predicted no exceedances off-site for any gaseous compounds.

Table 10: Maximum Predicted Concentrations-Processing Facility

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration – Operations (µg/m³)	Maximum Predicted Concentration + Background (µg/m³)	MAAQC (µg/m³)	Location of Maximum Point of Impingement	
						UTM (mE)	UTM (mN)
$PM_{2.5}$	24-hour	9	22	32	30	681,713	5,527,346
PM_{10}	24-hour	14	55	69	50	681,713	5,527,346
TSP	24-hour	14	137	151	120	681,713	5,527,346
	Annual mean	6.7	5	12	70	681,713	5,527,346
CO	1-hour	103	486	589	35,000	681,713	5,527,446
	8-hour	85	179	265	15,000	681,713	5,527,496
NO_x	1-hour	28	2,076	2,104	-	681,713	5,527,446
	24-hour	25	348	373	-	681,713	5,527,346
	Annual Mean	13	16	29	-	681,713	5,527,346
NO_2-OLM	1-hour	28	223	251	400	681,713	5,527,446
	24-hour	25	63	88	200	681,713	5,527,346
	Annual Mean	13	16	29	100	681,713	5,527,346
SO_2	1-hour	8	64	72	900	681,913	5,527,146
	24-hour	8	10	18	300	681,913	5,527,146
	Annual mean	0.9	0.5	1	60	681,863	5,527,146

Table 11: Maximum Modelled Concentrations at Sensitive Receptors-Processing Facility

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration at Sensitive Receptors + Background (µg/m³)				MAAQC (µg/m³)
			R1	R2	R3	R4	
$PM_{2.5}$	24-hour	9	11	14	10	12	30
PM_{10}	24-hour	14	18	26	15	21	50
TSP	24-hour	14	23	42	17	29	120
	Annual mean	6.7	7	7	7	7	70
CO	1-hour	103	236	274	119	239	35,000
	8-hour	85	105	147	91	118	15,000
NO_2 - TCM	1-hour	28	634	818	118	641	400
	24-hour	25	53	116	36	80	200
	Annual Mean	13	14	15	13	14	100
NO_2-OLM	1-hour	28	114	126	66	128	400
	24-hour	25	52	59	36	66	200
	Annual Mean	13	14	15	13	14	100
SO_2	1-hour	8	23	26	10	26	900
	24-hour	8	8.8	10.2	8.3	9.5	300
	Annual mean	0.9	0.94	0.96	0.91	0.95	60

7.2.2 Processing Facility and Access Road

Table 12 and **Table 13** below display the maximum predicted ground-level concentrations of all compounds for emissions from the Processing Facility plus the permanent gravel access road modeled for five years of meteorological data compared to MAAQC guidelines. Associated figures are provided in **Attachment B.**

7.2.2.1 Particulate Emissions

The model predicted possible off-site exceedances of the MAAQC for particulate matter (TSP, PM_{10}, and $PM_{2.5}$) associated with the Project operations, specifically gravel road dust from vehicular traffic generated by employees, suppliers and visitor travelling to and from the Processing Facility. The addition of the access road to the model introduced additional concentrations of particulate matter (non-silica sand) beyond the southwestern Fenceline under the worst-case emission scenario. Minor $PM_{2.5}$ exceedances occurred to about 200 m beyond the Fenceline (**Figure B-6**) and minor PM_{10} and TSP exceedances occurred to about 300 m (**Figure B-7** and **Figure B-8**, respectively). However, the modelled concentrations of dust generated from the access road at sensitive receptors were well below the MAAQCs.

Although the model has predicted the off-site migration of particulate matter from gravel road dust, the generation and migration of airborne dust from gravel roads is not uncommon, particularly during dry, summer months when gravel dust can be easily dispersed by moving vehicles. Road dust will be controlled to the extent possible throughout the operation of the Processing Facility with the application of the mitigation measures outlined in Section 7.1 above.

7.2.2.2 Gaseous Emissions

The model predicted no exceedances off-site for any gaseous compounds.

Table 12: Maximum Predicted Concentrations - Processing Facility and Access Road

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration – Operations (µg/m³)	Maximum Predicted Concentration + Background (µg/m³)	MAAQC (µg/m³)	Location of Maximum Point of Impingement	
						UTM (mE)	UTM (mN)
$PM_{2.5}$	24-hour	9	26	36	30	681,863	5,527,146
PM_{10}	24-hour	14	57	71	50	681,863	5,527,146
TSP	24-hour	14	153	167	120	681,863	5,527,146
	Annual mean	6.7	9	16	70	681,763	5,527,146
CO	1-hour	103	755	858	35,000	681,113	5,527,196
	8-hour	85	262	348	15,000	681,113	5,527,196
NO_x	1-hour	28	2,092	2,120	-	681,713	5,527,446
	24-hour	25	365	390	-	681,813	5,527,146
	Annual Mean	13	21	33	-	681,813	5,527,146
NO_2-OLM	1-hour	28	224	252	400	681,713	5,527,396
	24-hour	25	70	95	200	681,713	5,527,146
	Annual Mean	13	21	33	100	681,813	5,527,146
SO_2	1-hour	8	64	72	900	681,913	5,527,146
	24-hour	8	10	18	300	681,913	5,527,146
	Annual mean	0.9	0.5	1.4	60	681,863	5,527,146

Table 13: Maximum Modelled Concentrations at Sensitive Receptors - Processing Facility and Access Road

Compounds	Averaging Period	Background Concentration (µg/m³)	Maximum Predicted Concentration at Sensitive Receptors + Background (µg/m³)				MAAQC (µg/m³)
			R1	R2	R3	R4	
$PM_{2.5}$	24-hour	9	11	15	10	15	30
PM_{10}	24-hour	14	18	26	16	24	50
TSP	24-hour	14	23	43	18	43	120
	Annual mean	6.7	7.5	7.6	6.9	7.8	70
CO	1-hour	103	240	278	126	297	35,000
	8-hour	85	110	148	93	140	15,000
NO_2 - TCM	1-hour	28	641	824	130	743	-
	24-hour	25	55	117	38	98	-
	Annual Mean	13	15	15	13	15	-
NO_2-OLM	1-hour	28	115	126	67	138	400
	24-hour	25	55	59	38	60	200
	Annual Mean	13	15	15	13	15	100
SO_2	1-hour	8	23	26	10	26	900
	24-hour	8	8.8	10.2	8.3	9.5	300
	Annual mean	0.9	0.94	0.96	0.91	0.95	60

7.2.3 Model Constraints and Limitations

The predicted particulate exceedances using the model occur during the “worst-case” emission scenario. This worst-case emissions scenario includes the following assumptions:

- The Processing Facility is operating on maximum plant load (200 t/hr) for 365 days a year;
- The train is loaded every day;
- Maximum potential hourly traffic travels the access road every day; and,
- Heavy-duty vehicles travel the access road every day.

In the model, the worst-case emissions scenario is applied to five years of meteorological data, which would also include extreme meteorological conditions. When these two events occur simultaneously it results in a worst-case scenario prediction (when the particulate exceedances associated with the Processing Facility have been predicted to occur). It is very unlikely that the worst-case emissions would occur simultaneously with extreme meteorological events, and in the unlikely event the this does occur CanWhite will temporarily modify operations to ensure plant load is reduced and rail loading activities and site traffic are closely regulated to mitigate the generation of dust on site.

The model also predicts emission concentrations over all seasons, but for winter months the effects of snow cover and frozen conditions are not applied to all model sources. Therefore, predicted concentrations that occur during fall/winter months (when sand stockpiles have the highest potential to be at their maximum height) can be over-estimated.

The model does not incorporate natural dust suppression that can occur from rain and snow. According to the Canadian Climate Normals (EC 2020) for Winnipeg, there are 125 days annually with precipitation 0.2 mm or above. Thus, natural dust suppression from precipitation will occur about 34% of the time and will contribute to further emission reduction.

8. Conclusions

8.1 Air Quality

8.1.1 Processing Facility

The dispersion modelling assessment of the Processing Facility indicated exceedances of the MAAQC were predicted to occur only 0.3% of the time that the Facility is in operation (between one and five exceedances every five years), and only under the worst-case emissions scenario. In addition, the extent of any exceedance will be limited to within 20 m to 70 m (up to approximately 2/3 length of a football field) from the Fenceline. The point of the potential exceedance is more than 450 m from the nearest residence.

8.1.2 Processing Facility and Access Road

The model predicted possible off-site exceedances of the MAAQC for particulate matter associated with gravel road dust (not silica sand) from vehicular traffic generated by employees, suppliers and visitor travelling to and from the Processing Facility. The addition of the access road to the model introduced additional concentrations of particulate matter (non-silica sand) beyond the southwestern Fenceline under the worst-case emission scenario (approximately 200 m beyond Fenceline for $PM_{2.5}$ and approximately 300 m beyond the Fenceline for PM_{10} and TSP). The modelled concentrations of dust generated from the access road at sensitive receptors were well below the MAAQCs.

Based on the results of the air quality assessment it is concluded that, with the mitigation measures proposed, the operation of the Processing Facility and access road will have a negligible to minor impact on the air quality of the region. This conclusion has been determined for the following reasons:

- The area within which exceedances of regulatory thresholds for particulates were predicted is very localized and most likely to occur during worst-case emissions scenario.
- The model used in the assessment is generally considered to be conservative;
- The effects of precipitation to reduce summer emissions were not considered;
- The effects of snow cover and frozen conditions was not considered for all sources in winter;
- No residences or public roads are affected by predicted exceedances; and
- Additional operational controls to mitigate dust emissions can be applied as required (dry conditions, extreme weather events, etc.).

8.2 GHG

The Project is estimated to generate 34,324 tonnes of CO_2e annually during dryer operations with natural gas, which is 0.00016 % of the 2018 Manitoba emissions of 21.8 Mt CO_2e (Climate Change Connection 2020) and 0.000005% of the 2018 national emissions of 729 Mt CO_2e (Environment Canada, 2020). Therefore, the impact of the Project on greenhouse gas contributions to the atmosphere is negligible.

9. Recommendations

AECOM recommends that a dust management plan be developed that minimizes the potential for exceedances of ambient criteria at the Fenceline. AECOM also recommends that an air monitoring program be designed and implemented during operation of the Processing Facility to collected additional air quality data, evaluate the effectiveness of dust control measures on site, and refine mitigations measures if required.

10. References

Alberta Environment and Parks (AEP), 2013:
Air Quality Model Guidelines (October 2013). Retrieved from: http://aep.alberta.ca/air/air-quality-modelling/documents/AirQualityModelGuideline-Oct1-2013.pdf

Climate Change Connection, 2020:
Manitoba GHG emission trend 1990-2018, retrieved from: https://climatechangeconnection.org/wp-content/uploads/2020/04/Manitoba_GHG_trend_data_1990-2018.pdf

Environment Canada (EC), 2019:
Canada's Greenhouse Gas Quantification Requirements (Dec 2019), retrieved from: http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/collection_2020/eccc/En81-28-2019-eng.pdf

Environment Canada (EC), 2020:
Canada's Climate Normals 1981-2010 (https://climate.weather.gc.ca/climate_normals/station_select_1981_2010_e.html?searchType=stnProv&lstProvince=MB), data accessed for Winnipeg International Airport in June 2020.

Environment Canada (EC), 2020:
Greenhouse gas emissions, Canada, 1990 to 2018, retrieved from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

Manitoba Ambient Air Quality Criteria (MAAQC), 2005:
Manitoba Objectives and Guidelines for Various Air Pollutants
https://www.gov.mb.ca/sd/envprograms/airquality/pdf/criteria_table_update_july_2005.pdf

Manitoba Conservation and Water Stewardship (MCWS), 2006:
Draft Guidelines for Air Quality Dispersion Modelling Manitoba (MCWS, November 2006)

Manitoba Hydro, 2019:
Greenhouse Gas Emission Factors (October 2019), retrieved from: https://www.hydro.mb.ca/environment/pdf/ghg-emission-factors.pdf

National Pollutant Inventory. Australian Government Department of the Environment and Heritage, 2006:
Emission Estimation Technique Manual for Gold Ore Processing Version 2.0 (December 2006). Retrieved from: http://www.npi.gov.au/resource/emission-estimation-technique-manual-gold-ore-processing-version-20

Natural Resources Canada (NRCan), 2020a:
Land Use Categories shape files supplied by the NRCan website: ftp://ftp.geogratis.gc.ca/pub/nrcan_rncan/vector/geobase_lcc_csc/shp_en/. Natural Resources Canada, Earth and Sciences Sector. Data accessed in May 2020

Natural Resources Canada (NRCan), 2020b:
Canadian Digital Elevation Data. Natural Resources Canada, Earth and Sciences Sector. The 1-Degree and 15-Minute DEMs available automatically in WebGIS have been retrieved by using the integrated feature in the Terrain Processor of the AERMOD-View. Data accessed in May 2020

Government of Ontario (Ontario), 2019:
Ontario's Ambient Air Quality Criteria. https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria-sorted-contaminant-name

United States Environmental Protection Agency (US EPA), 1995:
11.19.1 Sand and Gravel Processing (AP-42: Compilation of Air Emissions Factors, November 1995), retrieved from: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s19-1.pdf

US EPA, 1996:
Section 3.3 Gasoline and Diesel Engines (AP-42: Compilation of Air Emissions Factors, September 1996) prepared by Eastern Research Group. retrieved from: https://www3.epa.gov/ttnchie1/ap42/ch03/bgdocs/b03s03.pdf

US EPA, 2006:
13.2.4 Aggregate Handling and Storage Piles (AP-42: Compilation of Air Emissions Factors, November 2006), retrieved from: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0204.pdf

US EPA, 2013:
AERSURFACE User's Guide. (EPA-454/B-08-001, January 2008 (Revised January 2013). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

Attachment A

Emissions Estimates Details

Point Sources

Site Specific Information: All physical properties of the exhaust vents/stacks and load rates were provided by CanWhite

Assumptions:

- The removal efficiency of 99.5% and 98.1% were assumed for baghouse and scrubber, respectively (based on US EPA 1995; Section 11.19.1)

Emission Factors (EF): Following emission factors were obtained from US EPA (1995) Section 11.19.1 Table 11.19.1-1 and from US EPA (2006a) Section 11.12 Table 11.12-1, and used with the information provided by CanWhite to calculate the emission rates for the modelling

	Load Rate (t/d)	Emission Factors (kg/tonne)			
		PM2.5	PM10	TSP	NOx
Plant 1 Dryer Baghouse (DC-110)	4693	0.000380	0.00251	0.00530	0.016
Plant 1 Nuisance Baghouse (DC-120) (Sand Screening)	4564	0.000079	0.00052	0.00111	-
Silo 610 & 620 Bin Vent	1027	0.0003220	0.00240	0.00450	-
Silo 630 & 640 Bin Vent s	1255	0.0003220	0.00240	0.00450	-
Loadout Spouts	932	0.0000009	0.000007	0.000013	-
Loadout Bin Vents	745	0.0000120	0.000080	0.000168	-

Emission Rate (ER) Sample Calculation (TSP, Dryer Stack):

$$ER = 0.0053\,\frac{kg}{tonne} \times 4693\,\frac{tonnes}{day} \times 1000\,\frac{g}{kg} \times \frac{1}{3600 \times 24}\,\frac{day}{s} = 0.288\,\frac{g}{s}$$

Material Drop from Stacker and Tripper on Top of Stockpiles

Site Specific Information:

Moisture content, operating time, and material transfer rates specified by CanWhite

Assumptions:

- For stockpiles A and B, average wind speed value (5.07 m/s) was used in the calculations, and the emissions only modelled April-November
- For overs/fines stockpile, variable emission rates were used in the model based on different wind speed bins.

Emission Factors (EF):

The following equation from US EPA (2006b) was used for emission factor calculation:

$$EF = K \times (0.0016) \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \frac{kg}{t}$$

U is wind speed (12.5 m/s is max value from hourly surface met data used for AERMOD modelling);
M is moisture content (15%); K=Size factor (TSP=0.74, PM_{10}=0.35, $PM_{2.5}$= 0.053)

Following emission factors were calculated using US EPA (2006b) for different wind speed bins

Wind Speed Bins	A (<1.54 m/s)	B (1.54-3.09 m/s)	C (3.09-5.14 m/s)	D (5.14-8.23 m/s)	E (8.23-10.80 m/s)	F (>10.80 m/s)
Variable Wind Speed Factors	0.027	0.112	0.236	0.443	0.702	1.000

Emission Rate (ER) Sample Calculation (TSP, overs/fines stockpile):

$$ER = 0.74 \times (0.0016) \times \frac{\left(\frac{12.5}{2.2}\right)^{1.3}}{\left(\frac{15}{2}\right)^{1.4}} \frac{kg}{t} \times 1000 \frac{g}{kg} \times 200 \frac{t}{hr} \times \frac{1}{3600} \frac{hr}{s} = 0.0375 \frac{g}{s}$$

Loading/Unloading at the Stockpiles A and B

Site Specific Information: Moisture content, operating time, and material transfer rates specified by CanWhite

Assumptions:

- 50% emission reduction was assumed considering material moisture and coarse grain size
- Two areas were assumed in the model next to stockpiles A and B as the main loading/unloading locations
- Variable emission rates were used in the model based on wind speed bins.

Emission Factors (EF): The following equation from US EPA (2006b) was used for emission factor calculation:

$$EF = K \times (0.0016) \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \frac{kg}{t}$$

U is wind speed (12.5 m/s max value from hourly surface met data used by AERMOD); M is moisture content (15%); K=Size factor (TSP=0.74, PM_{10}=0.35, $PM_{2.5}$= 0.053)

Following emission factors were calculated for different wind speed bins

Wind Speed Bins	A (<1.54 m/s)	B (1.54-3.09 m/s)	C (3.09-5.14 m/s)	D (5.14-8.23 m/s)	E (8.23-10.80 m/s)	F (>10.80 m/s)
Variable Wind Speed Factors	0.027	0.112	0.236	0.443	0.702	1.000

Emission Rate (ER) Sample Calculation (TSP, stockpile A):

$$ER = 0.74 \times (0.0016) \times \frac{\left(\frac{12.5}{2.2}\right)^{1.3}}{\left(\frac{15}{2}\right)^{1.4}} \frac{kg}{t} \times 1000 \frac{g}{kg} \times 97.14 \frac{t}{hr} \times \frac{1}{3600} \frac{hr}{s} \times (1 - 0.5)(50\%\ emission\ reduction) = 0.009 \frac{g}{s}$$

Equipment Exhaust

Site Specific Information:

Moisture content, operating time, and material transfer rates specified by CanWhite

Assumptions:

- TSP emission rates were assumed the same as PM_{10}. Also, it was assumed that 97% of the PM_{10} is within $PM_{2.5}$ particle size range (US EPA 2008)
- For vehicles travelling with 30 km/hr speed on 920 m long access road it was assumed that every vehicle is for less than 2 minutes on the road.
- There are 20 to 25 employees driving to the Plant at every shift change, 20 to 25 travelling back home. We have assumed 50 trips/hour and model them for 24 hours and 365 days a year.
- There are 10 rigs leaving Facility every few days and weekly fuel and parts delivery (or water truck on dry hot day). It was assumed that at one day there are 2 rigs leaving facility and 1 supply truck (or water truck). They were modelled every day for 365 days. Following Source Classification Code were selected for the Plant equipment, and trucks on access road, in the model. Other parameters were collected based on the selected SCC from US EPA (2008) NONROAD model and information provided by CanWhite:

Equipment	SCC	Tier	BSFC (g/hp-h)	LF	Engine Net Power (hp)	Utilization (hr/year)
FEL - 980 H	2270002060	3	0.371	0.59	349	7000
Backhoe loader, clean up CAT 415F	2270002060	4	0.412	0.59	68	1000
FEL 924 H - Maintenance	2270002060	4	0.371	0.59	128	1000
Skid Steer - CAT 246D3	2270002072	4	0.412	0.21	74	1000
D6 - Dozer	2270002063	4	0.433	0.59	215	500
Grader - 14G	2270002048	4	0.371	0.59	238	500
Light Trucks (F-150) Passenger Cars	2270002051	3	0.371	0.59	385	-
Rigs, Supply Trucks	2270002051	3	0.371	0.59	505	-

Emission Factors (EF):

Raw emission factors were collected from US EPA (2008) based on equipment SSC – Source Classification Code.

	Emission Factors raw (g/hp-hr)			
SCC	PM10	NOx	CO	THC
2270002060	0.22	2.61	1.29	0.17
2270002060	0.0184	3	0.36	0.13
2270002060	0.0092	2.5	0.13	0.13
2270002072	0.0184	3	0.61	0.13
2270002063	0.0092	2.5	0.11	0.13
2270002048	0.0092	2.5	0.11	0.13
2270002051	0.22	2.61	1.29	0.17

For PM_{10} and SO_2, the following equation from US EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition (US EPA 2010) were also used refine the emission factors:

PM_{10}:

$$EF_{adj}\left(\frac{g}{hp-h}\right) = EF_{raw} \times DF - SPM_{adj}$$

Where:

- EF_{raw} – Emission Factor for PM_{10} (g/hp-h) from raw data in US EPA (2008) based on equipment SSC – Source Classification Code
- DF – Maximum Deterioration Factor (unitless) (is equal to 1.473 for PM_{10} for every technology type and age of the engine)
- SPM_{adj} – adjustment to PM emissions to account for variation in diesel fuel sulphur content (only used for Tier 3 equipment, Equation 5 at Page 22 of the US EPA 2010).

$$SPM_{adj} = \mathrm{BSFC} \times 7 \times 0.02247 \times 0.01 \times (0.33 - 0.0015)$$

BSFC – Brake Specific Fuel Consumption (lb/hp-h) obtained from US EPA (2008) based on equipment SSC-Source Classification Code

SO_2:

$$\mathrm{EF} = [\mathrm{BSFC} \times (1 - 0.02247) - \mathrm{THC}] \times 0.01 \times 2 \times 0.0015$$

- THC – Total Hydrocarbon emission factor obtained from US EPA (2008) based on equipment SSC-Source Classification Code

Additionally, following equation was used to calculate the emission rates based on the emission factors (there is no multiplication by LF for SO_2 emissions):

$$\text{Emission Rate}\left(\frac{g}{s}\right) = \mathrm{EF}_{adjusted} \times \mathrm{LF} \times \text{Efficiency} \times \mathrm{PR}$$

Where:

- $EF_{adjusted}$ – Adjusted Emission Factor (g/hp-h)
- LF – Load Factor
- Efficiency - Operating Efficiency
- PR – Engine Power Rating (hp)

Emission Rate (ER) Sample Calculation (FEL - 980 H):

$$ER(PM_{10}) = [0.22\frac{\mathrm{g}}{\mathrm{hp-hr}} \times 1.473 - 169\frac{\mathrm{g}}{\mathrm{hp-hr}} \times 7 \times 0.02247 \times 0.01 \times (0.33 - 0.0015)] \times 0.59 \times 349\ \mathrm{hp} \times \frac{1}{3600}\frac{hr}{s}$$

$$= 0.014\frac{g}{s}$$

$$ER(SO_2) = \left[169\,\frac{\mathrm{g}}{\mathrm{hp-hr}} \times (1 - \ 0.02247) - \ 0.17\,\frac{\mathrm{g}}{\mathrm{hp-hr}}\right] \times 0.01 \ \times 2 \ \times 0.0015 \times 349\ \mathrm{hp} \times \frac{1}{3600}\,\frac{hr}{s} = 0.000478\,\frac{g}{s}$$

On-Site Trucks and Rail Mover Exhaust Emissions

Site Specific Information:

Fuel consumption specified by CanWhite

Equipment	Fuel Consumption (L/hr)
F-150 Truck	10
F-350 Truck	15
Railcar mover	10

Assumptions:

- TSP emission rates were assumed the same as PM_{10}. Also, it was assumed that 97% of the PM_{10} is within $PM_{2.5}$ particle size range (US EPA 2008)
- The heating value of the diesel fuel was assumed as 0.0193 MMBtu/lb fuel. Also, the density of the fuel was assumed as 850.87 g/L.

Emission Factors (EF):

Since the only available information for on-site trucks and rail mover was fuel consumption, conservative emission factors from US EPA (1996) was used to calculate the emission rates.

	PM_{10}	NOx	CO	SO_2
Emission Factors (lb/MMBtu fuel input)	0.31	4.41	0.95	0.29

Emission Rate (ER) Sample Calculation (PM_{10}, Rail Mover):

$$ER = 0.31\frac{lb}{MMBtu\ fuel} \times 0.0193\frac{MMBtu\ fuel}{lb\ fuel} \times 453.6\frac{lb\ fuel}{g\ fuel} \times 850.87\frac{g\ fuel}{L\ fuel} \times 10\frac{L\ fuel}{hr} \times \frac{1}{453.6}\frac{g}{lb} \times \frac{1}{3600}\frac{hr}{s} = 0.014\frac{g}{s}$$

Dust Emission from Equipment Movement on site	
Assumptions:	• On-site ground surface silt content (the surface where the equipment travelling on) is assumed to be 4.8% based on US EPA (2006c) (Table 13.2.2-1). • Loaders were assumed to make 24 to 35 trips/hour with average distance 400 m/trip so they will be travelling 1.4 km during one hour between piles and hopper • Mean Loader Weight was assumed to be 33.2 tonnes • 50% emission reduction was assumed considering applying moist, coarse material handled
Emission Factors (EF):	Following scraper travelling equation obtained from NPI (2012) was used to calculate the emission factor for loaders movement on site: $$EF\frac{kg}{Vehicle\ km\ Traveled} = 0.0000096 \times Silt\ Content^{1.3} \times Equipment\ Weight^{2.4}$$
Emission Rate (ER) Sample Calculation (TSP):	$$ER = (0.0000096 \times 4.8^{1.3} \times 33.2^{2.4})\frac{kg}{Vehicle\ km\ Traveled} \times 1.4\frac{km}{hr} \times 1000\frac{g}{kg} \times \frac{1}{3600}\frac{hr}{s} \times (1 - 0.5)(50\%\ emission\ reduction) = 0.062\frac{g}{s}$$

Dust Emission from Equipment Movement on Permanent Access Road

Assumptions:

- Ground surface silt content of the Access Road is assumed to be 4.8% based on US EPA (2006c) (Table 13.2.2-1).
- Ground surface moisture content of the Access Road is assumed to be 7.4% based on US EPA (2006b) (Table 13.2.4-1).
- There are 20 to 25 employees driving to the Plant at every shift change, 20 to 25 travelling back home (assumed 100 trips/day). In addition, we have added 20 trips per day for visitors, maintenance staff, etc.
- There are 10 rigs leaving Facility every few days and weekly fuel and parts delivery. It was assumed that at one day there are 2 rigs leaving facility and 1 supply truck. They were modelled every day for 365 days.
- For Access Road average distance 920 m/trip light trucks will be travelling 110.4 km a day and supply truck (water truck) and two rigs will travel 2.8 km a day
- The average weight of light trucks will be 2 tonnes and average weight of rigs and supply truck will be 72 tonnes
- 80% dust emission reduction for light trucks was assumed considering watering at dry and hot conditions

Emission Factors (EF):

For light trucks at Access Road equation for trucks travelling on public roads can be used (this equation was developed for trucks between 1.4 and 2.7 tonnes) (US EPA 2006c).

$$EF\ (TSP)\frac{kg}{Vehicle\ km\ Traveled} = 6 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{1} \times \left(\frac{Speed}{48}\right)^{0.3} / \left(\frac{Mosture\ Content}{0.5}\right)^{0.3}$$

$$EF\ (PM_{10})\frac{kg}{Vehicle\ km\ Traveled} = 1.8 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{1} \times \left(\frac{Speed}{48}\right)^{0.5} / \left(\frac{Moisture\ Content}{0.5}\right)^{0.2}$$

$$EF\ (PM_{2.5})\frac{kg}{Vehicle\ km\ Traveled} = 0.18 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{1} \times \left(\frac{Speed}{48}\right)^{0.5} / \left(\frac{Moisture\ Content}{0.5}\right)^{0.2}$$

For heavy trucks (rigs and supply truck) at Access Road equation for trucks travelling on industrial roads can be used (this equation was developed for trucks between 1.8 and 260 tonnes) (US EPA 2006c):

$$EF\ (TSP)\frac{kg}{Vehicle\ km\ Traveled} = 4.9 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{0.7} \times \left(\frac{Equipment\ Weight}{2.7}\right)^{0.45}$$

$$EF\ (PM_{10})\frac{kg}{Vehicle\ km\ Traveled} = 1.5 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{0.9} \times \left(\frac{Equipment\ Weight}{2.7}\right)^{0.45}$$

$$EF\ (PM_{2.5})\frac{kg}{Vehicle\ km\ Traveled} = 0.15 \times 0.2819\left(\frac{miles}{lb}\right) \times \left(\frac{Silt\ Content}{12}\right)^{0.9} \times \left(\frac{Equipment\ Weight}{2.7}\right)^{0.45}$$

Emission Rate (ER) Sample Calculation (TSP for Light Trucks):	$ER\ (TSP) = \left(6 \times 0.2819 \times \left(\frac{4.8}{12}\right)^{1} \times \left(\frac{30}{48}\right)^{0.3} / \left(\frac{7.4}{0.5}\right)^{0.3}\right) \frac{kg}{Vehicle\ km\ Traveled\ Daily} \times 110.4 \frac{km}{day} \times 1000 \frac{g}{kg} \times \frac{1}{3600} \frac{hr}{s} \times \frac{1}{24} \times (1 - 0.8)(80\%\ emission\ reduction) = 0.067 \frac{g}{s}$
Emission Rate (ER) Sample Calculation (TSP for Heavy Trucks):	$ER\ (TSP) = \left(4.9 \times 0.2819 \times \left(\frac{4.8}{12}\right)^{0.7} \times \left(\frac{72}{2.7}\right)^{0.45}\right) \frac{kg}{Vehicle\ km\ Traveled\ Daily} \times 2.8 \frac{km}{day} \times 1000 \frac{g}{kg} \times \frac{1}{3600} \frac{hr}{s} \times \frac{1\ Day}{24\ hours} = 0.102 \frac{g}{s}$

Conveyors Transfer Points

Site Specific Information: Material transfer rates (200 tonnes/hr) is provided by CanWhite

Assumptions:

- 70% removal efficiency was assumed for partially closed transfer points
- 50% removal efficiency was assumed for the high moisture content of the wet sand travelled
- 7% of TSP was assumed to be within $PM_{2.5}$ range

Emission Factors (EF): Following emission factors were obtained from US EPA (2004) (Table 11.19.2-1) for conveyor transfer point

	Dry Material Emission Factor (kg/tonnes)	
	PM_{10}	TSP
Conveyor Transfer Point	0.00055	0.0015

Emission Rate (ER) Sample Calculation (TSP):

$$ER = 0.00251 \frac{kg}{tonnes} \times 200 \frac{tonnes}{hr} \times 1000 \frac{g}{kg} \times \frac{1}{3600} \frac{hr}{s} \times (1 - 0.5)(50\%\ emission\ reduction) \times (1 - 0.7)(70\%\ emission\ reduction) = 0.0125 \frac{g}{s}$$

Wind Driven Emission Rates from Sand Stockpile

Site Specific Information:

Stockpile dimensions and moisture content specified by CanWhite

Assumptions:

- The active area of stockpiles was assumed to be half of their footprints:

	Estimated Active surface area of the Pile (ha)
40/140 Stockpile A - Tripper	0.35
40/140 Stockpile B - Stacker	0.15
Overs/Fines Stockpile	0.02

- 75% emission reduction was assumed considering: the coarse size of material and moist conditions (sand applied at 15% moisture and slowly drying) in summer; potential for additional wet sand application in hot, dry weather; and snow-covered and partially frozen pile conditions in winter.
- The wind driven emission was calculated based on the variable wind speeds, considering no emission below 5.14 m/s

Emission Factors:

The following equation from US EPA (1998) was used for wind driven emission factors calculation:

$$EF = K * 1.8\ U\ \frac{kg}{(ha)(hr)}$$

U is wind speed (12.5 m/s max value from hourly surface met data); K=Size factor (TSP=1, PM_{10}=0.35/0.74, $PM_{2.5}$= 0.053/0.74)

Following emission factors were calculated using US EPA (1998) for wind speed bins:

Wind Speed Bins	A (<1.54 m/s)	B (1.54-3.09 m/s)	C (3.09-5.14 m/s)	D (5.14-8.23 m/s)	E (8.23-10.80 m/s)	F (>10.80 m/s)
Variable Wind Speed Factors	0	0	0	0.535	0.761	1.000

Emission Rate (ER) Sample Calculation (TSP, Stockpile A):

$$ER = 1 \times 1.8\ \times 12.5\ \frac{kg}{(ha)(hr)} \times 1000\,\frac{g}{kg} \times 0.35\ ha \times \frac{1}{3600}\,\frac{hr}{s} \times (1 - 0.75)(75\%\ emission\ reduction) = 0.547\,\frac{g}{s}$$

References:

National Pollution Inventory (NPI). 2012. *Emission Estimation Technique Manual for Mining* Version 3.1; January 201

US EPA. 1995. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.19.1: Sand and Gravel Processing, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 1996. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources*. Part 3.3 Gasoline and Diesel Industrial Engines, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 1998. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.9 Western Surface Coal Mining, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 2004. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.19.2: Crushed Stone Processing and Pulverized Mineral Processing, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 2006a. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 11.12: Concrete Batching, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 2006b. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 13.2.4: Aggregate Handling and Storage Piles, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA. 2006c. *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources.* Part 13.2.2: Unpaved Roads, Fifth Edition (AP 42). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

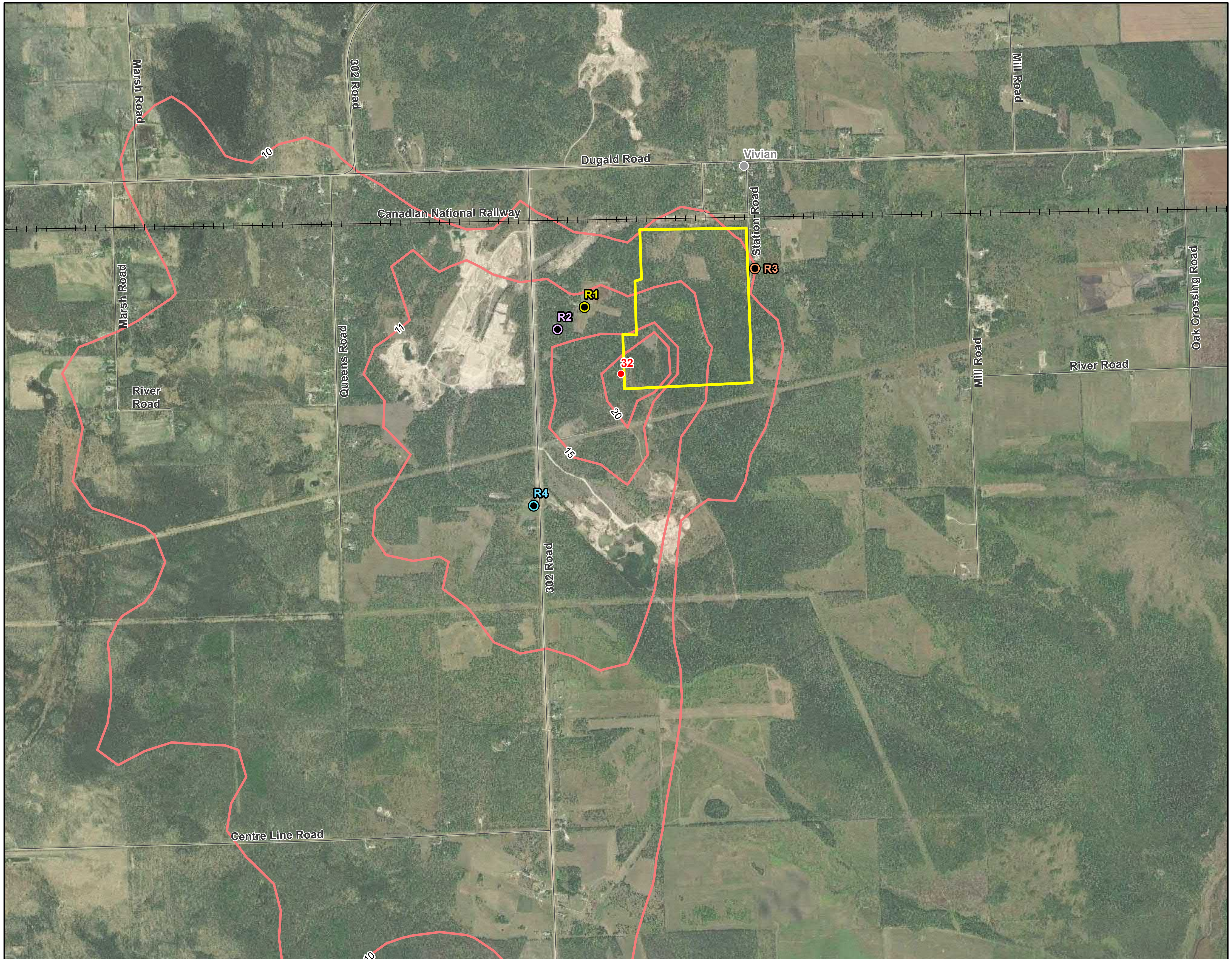
US EPA. 2008. *Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition.* Prepared by the Office of Transportation and Air Quality, Research Triangle Park, NC. Report No. NR-009c.

US EPA. 2010. *Exhaust and Emission Factors for Nonroad Engine Modelling – Compression-Ignition*. Assessment and Standards Division Office of Transportation and Air Quality. EPA-420-R-10-018; NR-009d, July 2010.

AECOM Imagine it. Delivered.

Attachment B

Isopleths



Legend

- Road
- Railway

Model Features

- Fenceline
- Maximum Modelled Concentration (g/m^3)

Sensitive Receptors

- R1 (Nearest Residence)
- R2 (Nearest Residence)
- R3 (Nearest Residence)
- R4 (Nearest Residence)

Manitoba Air Quality Criteria = 30 g/m^3

- Concentration Contour (g/m^3)

Maximum Modelled Concentration = 32 (g/m^3)
Background Concentration = 9 (g/m^3)

N
W E
S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

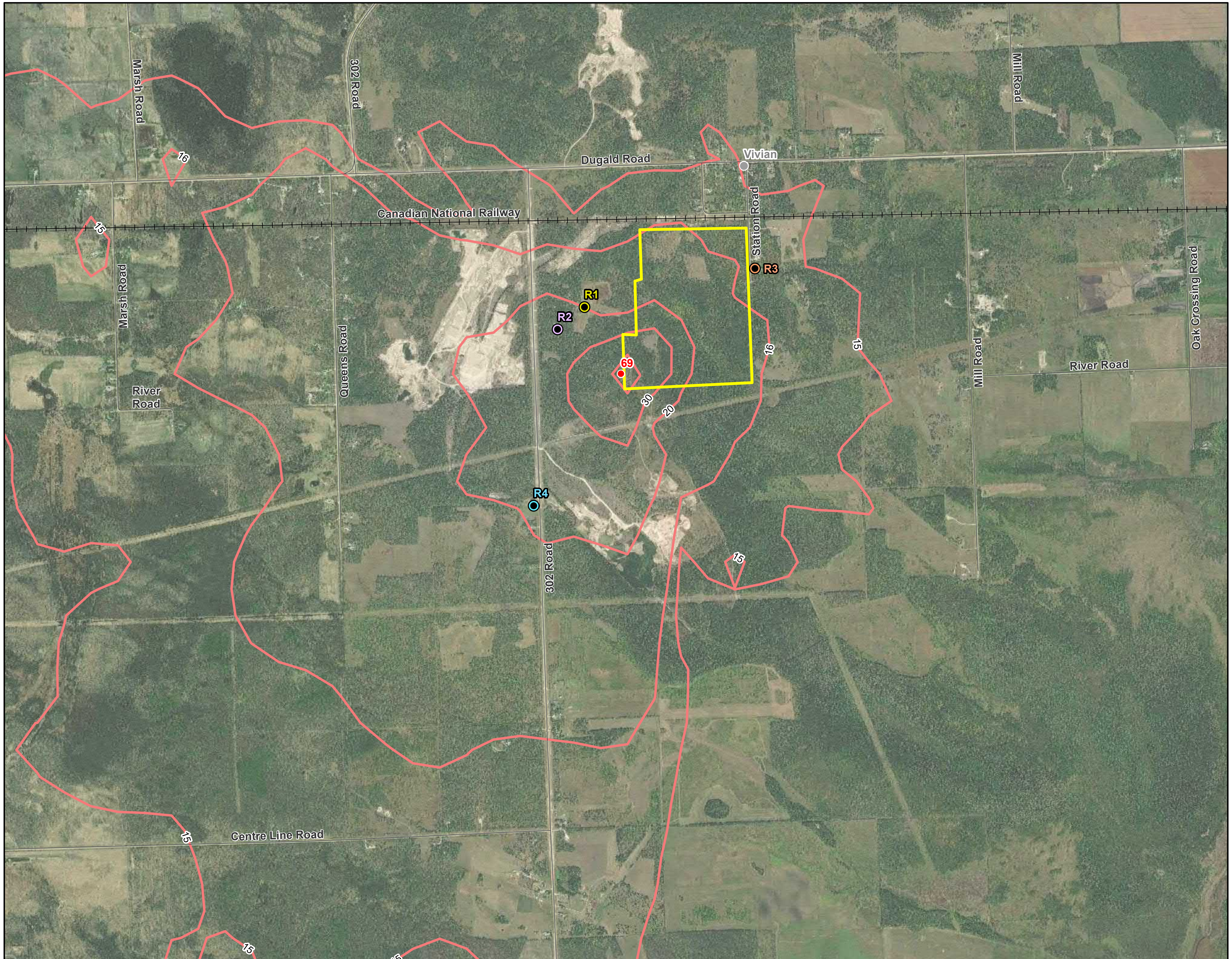
Ortho-Imagery: ESRI World Imagery, Canvec

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Figure: B-1

MAXIMUM 24-HOUR AVERAGE $PM_{2.5}$ CONCENTRATIONS (G/M^3) PROCESSING FACILITY

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-23



Legend

Road

Railway

Model Features

Fenceline

Maximum Modelled Concentration (g/m^3)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 50 g/m^3

Concentration Contour (g/m^3)

Maximum Modelled Concentration = 69 (g/m^3)
Background Concentration = 14 (g/m^3)

N W E S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Ortho-Imagery: ESRI World Imagery, Canvec

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

AECOM

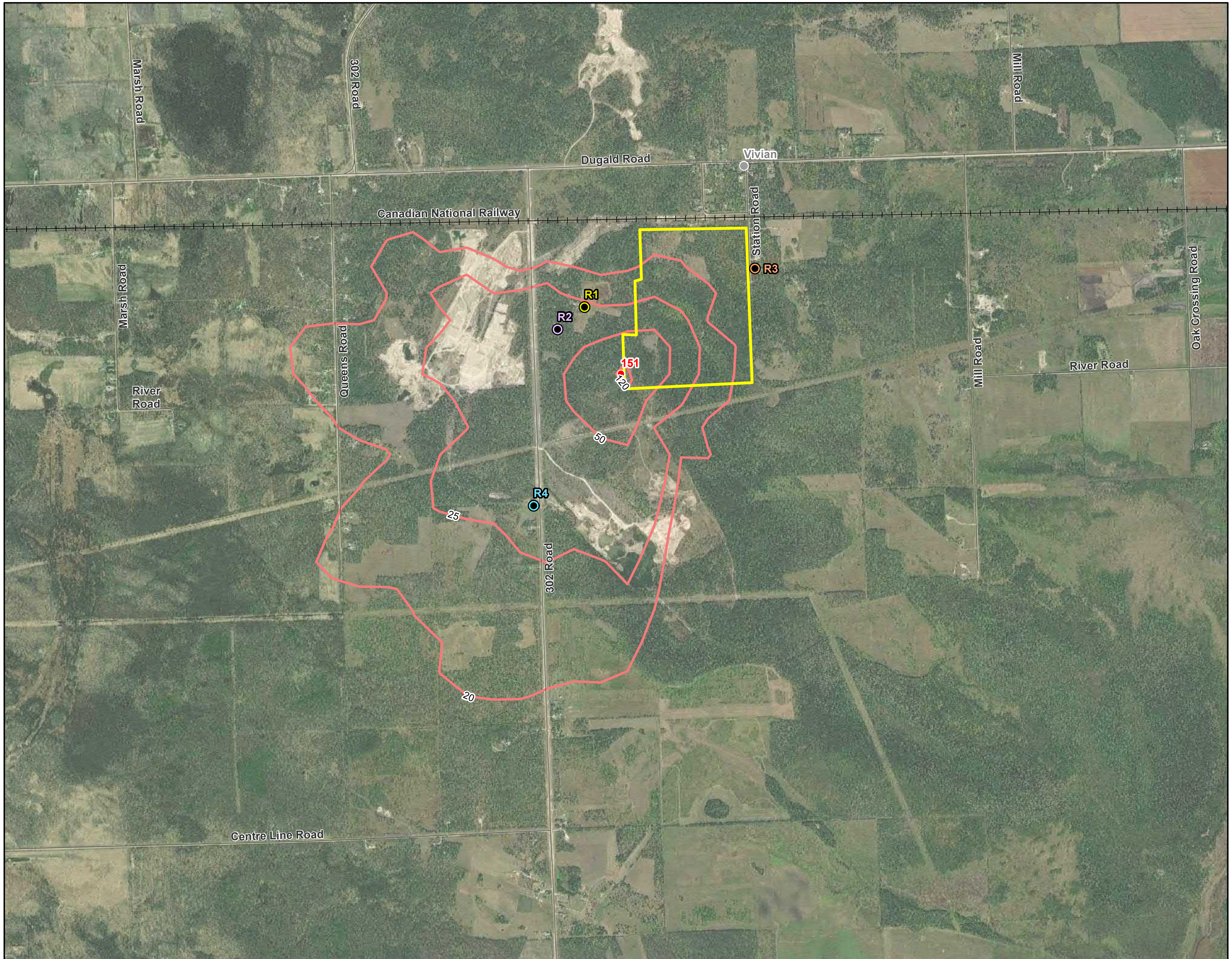
Figure: B-2

MAXIMUM 24-HOUR AVERAGE PM_{10} CONCENTRATIONS (G/M^3) PROCESSING FACILITY

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-23

ANSI B 279.4mm x 431.8mm Approved: Checked: Designer: Project Management Initials:

Last saved by: PAIGE.CROSSMAN (2020-06-23) Last Plotted: Wed Jun 10, 2020
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-7_60625356_ISOPLETH_PM10.MXD



Legend

Road

Railway

Model Features

Fenceline

Maximum Modelled Concentration (g/m³)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 120 g/m³

Concentration Contour (g/m³)

Maximum Modelled Concentration = 151 (g/m³)
Background Concentration = 14 (g/m³)

N W E S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

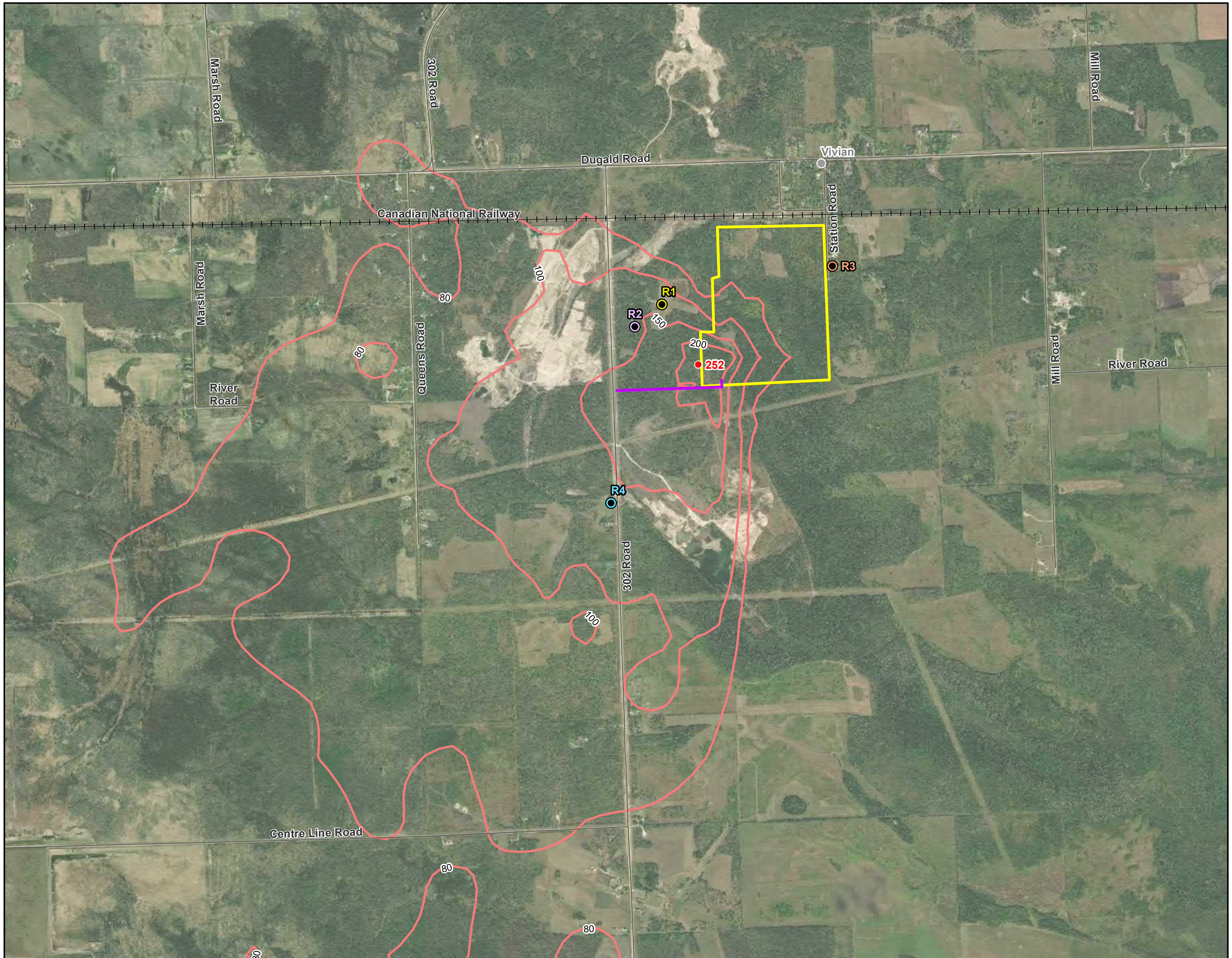
Ortho-Imagery: ESRI World Imagery, Canvec

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-23

MAXIMUM 24-HOUR AVERAGE TSP CONCENTRATIONS (G/M³) PROCESSING FACILITY

AECOM

Figure: B-3



Legend

Road

Railway

Model Features

Fenceline

Permanent Access Road

Maximum Modelled Concentration (μg/m³)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 400 μg/m³

Concentration Contour (μg/m³)

Maximum Modelled Concentration = 252 (μg/m³)
Background Concentration = 28 (μg/m³)

N
W E
S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Ortho-Imagery: ESRI World Imagery, Canvec

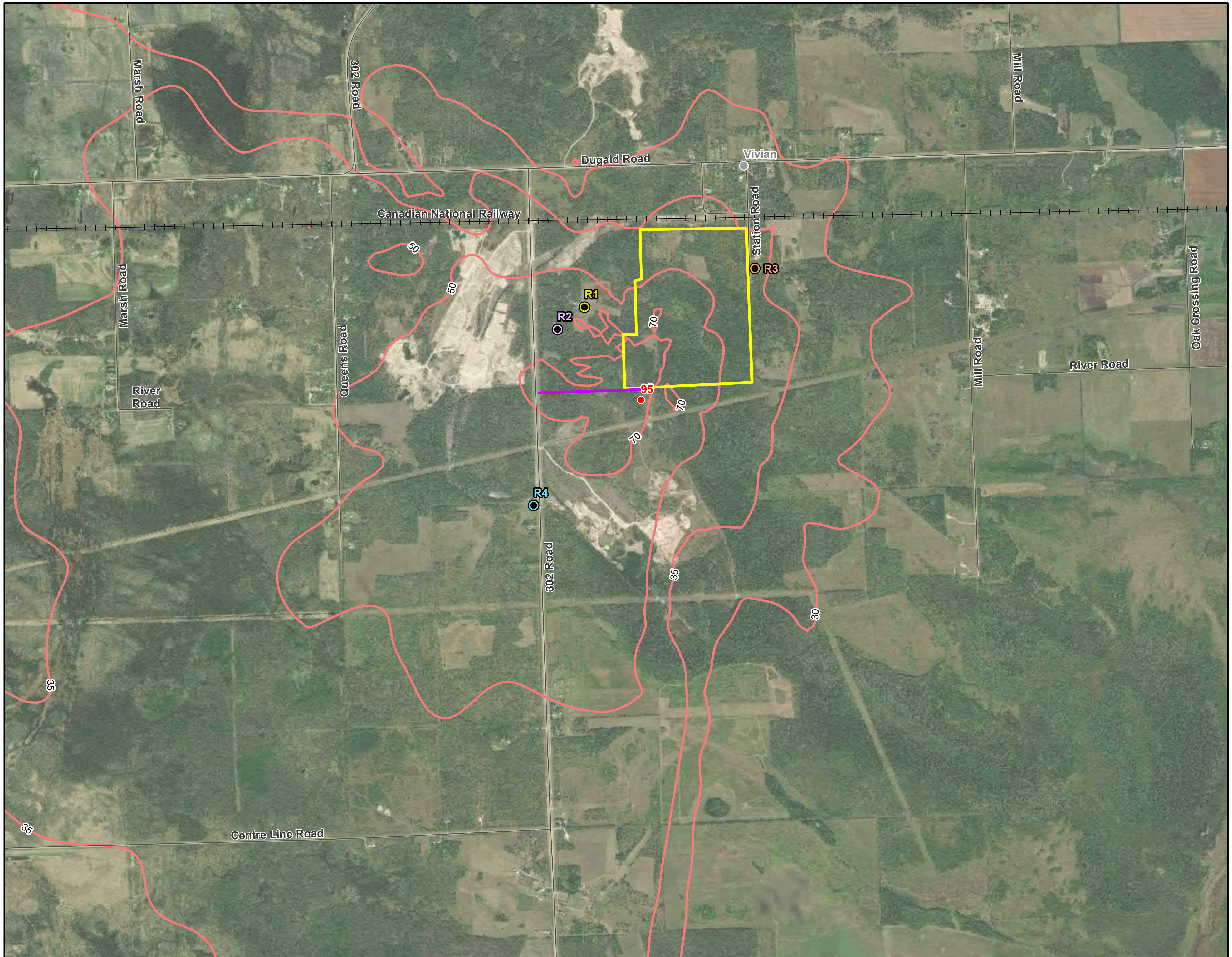
MAXIMUM 1-HOUR AVERAGE NO_2 CONCENTRATIONS - OLM (μg/m³)

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-25

AECOM

Figure: B-4

Last saved by: PAIGE.CROSSMAN (2020-06-25) Last Plotted: Thu Jun 25, 2020 Project Management Initials: Designer: Checked: Approved: ANSI B 279.4mm x 431.8mm
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-1_60625356_ISOPLETH_NO2_1HR.MXD



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Road
- Railway

Model Features

- Fenceline
- Permanent Access Road
- Maximum Modelled Concentration (µg/m^3)

Sensitive Receptors

- R1 (Nearest Residence)
- R2 (Nearest Residence)
- R3 (Nearest Residence)
- R4 (Nearest Residence)

Manitoba Air Quality Criteria = 200 µg/m^3

- Concentration Contour (µg/m^3)

Maximum Modelled Concentration = 95 (µg/m^3)
Background Concentration = 25 (µg/m^3)

N W E S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Ortho-Imagery: ESRI World Imagery, Canvec

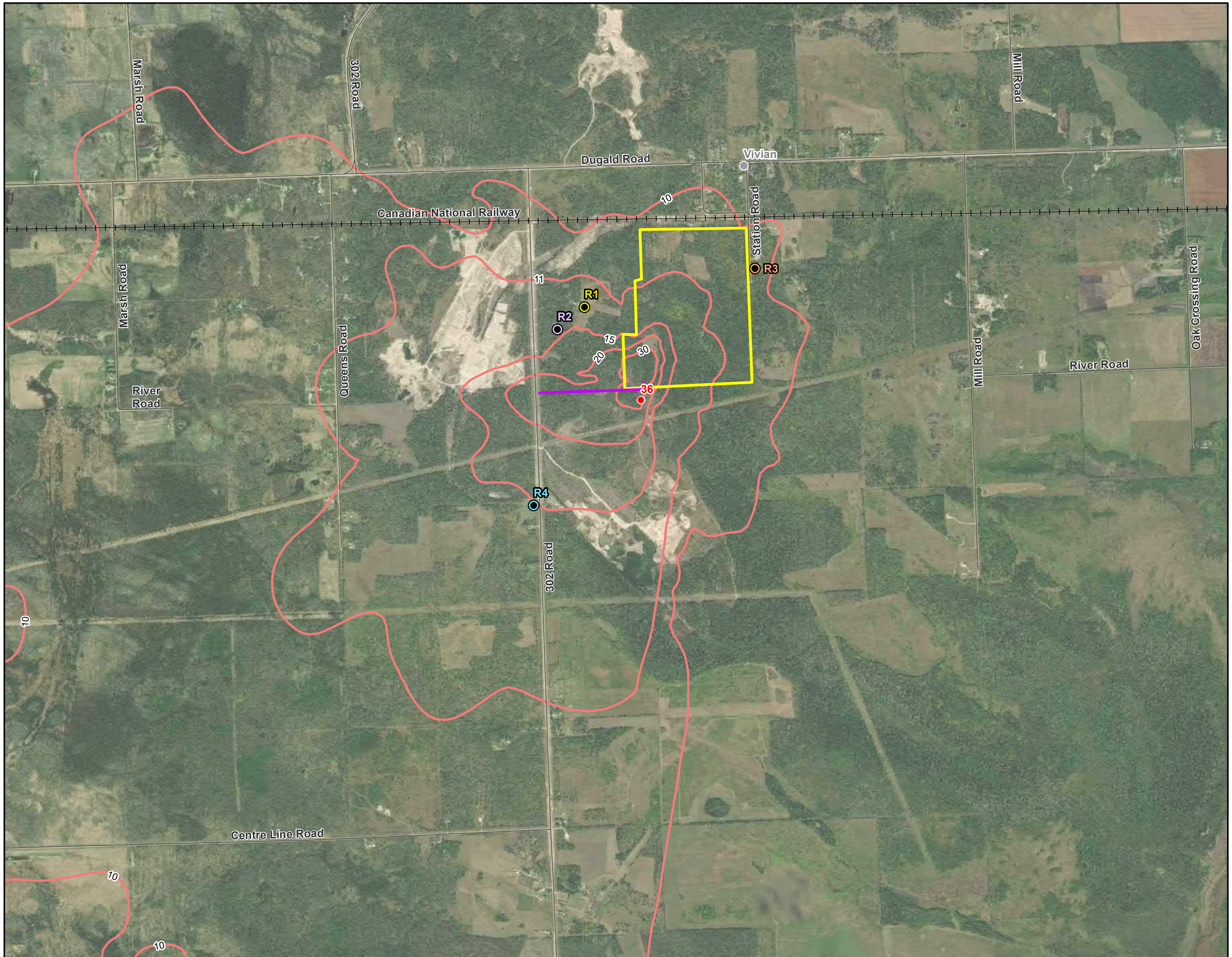
AECOM

Figure: B-5

MAXIMUM 24-HOUR AVERAGE NO_2 CONCENTRATIONS - OLM (µg/m^3)

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-25

Last saved by: PAIGE.CROSSMAN (2020-06-25) Last Plotted: Thu Jun 25, 2020 Project Management Initials: Designer: Checked: Approved: ANSI B 279.4mm x 431.8mm
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-2_60625356_ISOPLETH_NO2_24HR.MXD



Legend

Road

Railway

Model Features

Fenceline

Permanent Access Road

Maximum Modelled Concentration (µg/m^3)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 30 µg/m^3

Concentration Contour (µg/m^3)

Maximum Modelled Concentration = 36 (µg/m^3)
Background Concentration = 9 (µg/m^3)

N W E S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Ortho-Imagery: ESRI World Imagery, Canvec

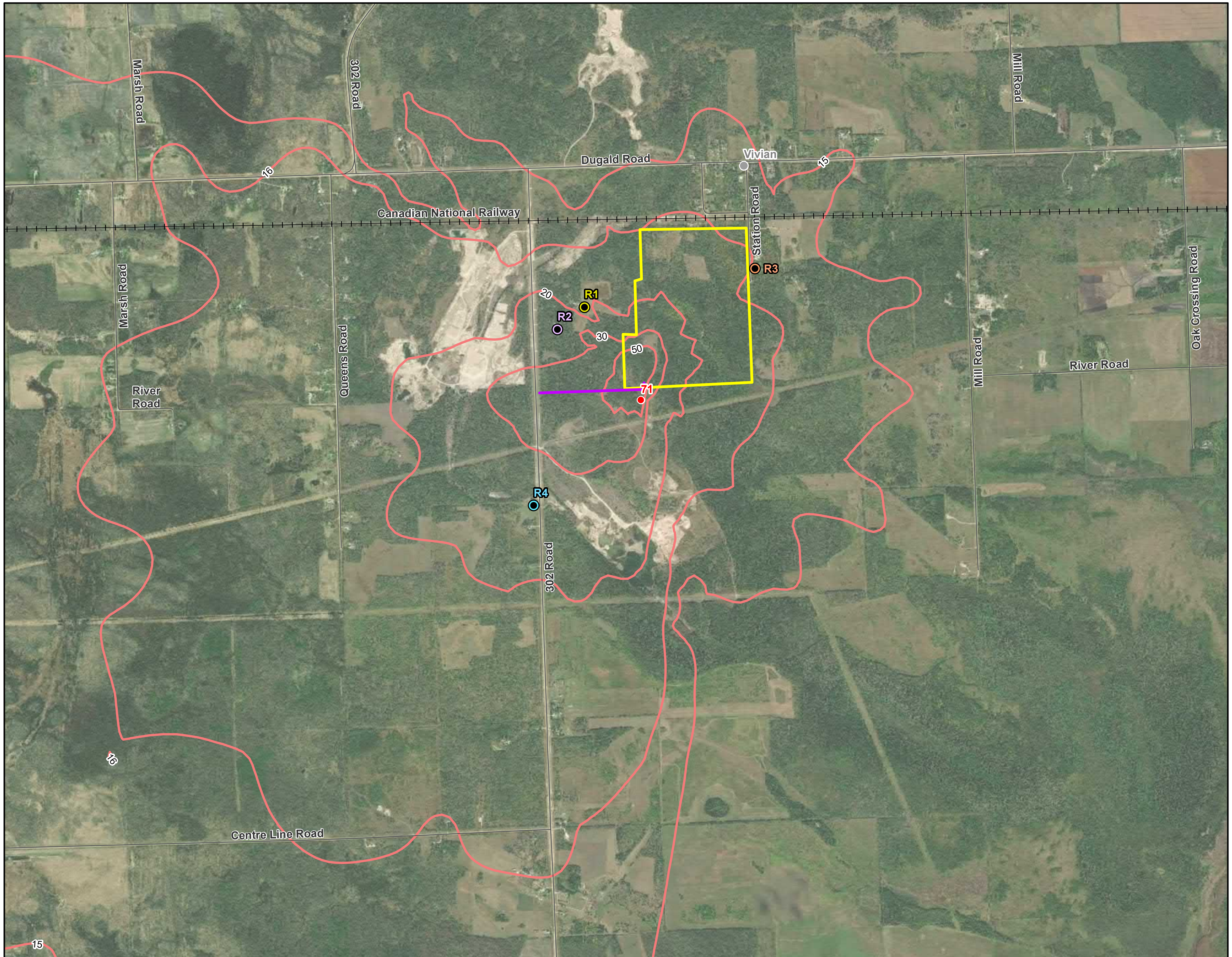
AECOM

Figure: B-6

MAXIMUM 24-HOUR AVERAGE $PM_{2.5}$ CONCENTRATIONS (µg/m^3)

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-25

Last saved by: PAIGE.CROSSMAN (2020-06-25) Last Plotted: Thu Jun 25, 2020 Project Management Initials: Designer: Checked: Approved: ANSI B 279.4mm x 431.8mm
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-3_60625356_ISOPLETH_PM25.MXD



Legend

Road

Railway

Model Features

Fenceline

Permanent Access Road

Maximum Modelled Concentration (μg/m^3)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 50 μg/m^3

Concentration Contour (μg/m^3)

Maximum Modelled Concentration = 71 (μg/m^3)
Background Concentration = 14 (μg/m^3)

N
W E
S

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Ortho-Imagery: ESRI World Imagery, Canvec

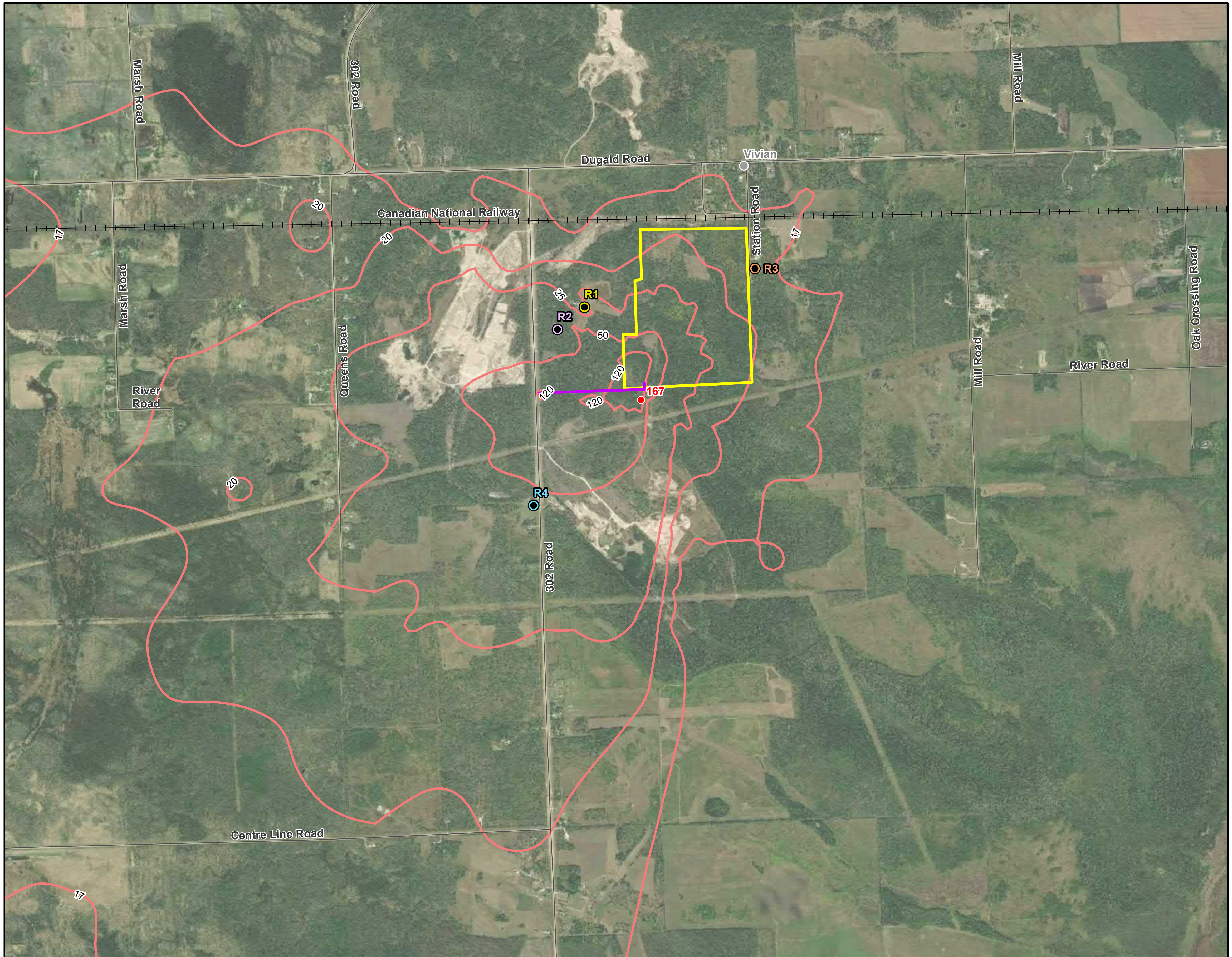
AECOM

Figure: B-7

MAXIMUM 24-HOUR AVERAGE PM_{10} CONCENTRATIONS (μg/m^3)

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-25

ANSI B 279.4mm x 431.8mm Approved: Checked: Designer: Project Management Initials:
Last saved by: PAIGE.CROSSMAN (2020-06-25) Last Plotted: Thu Jun 25, 2020
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-4_60625356_ISOPLETH_PM10.MXD



Legend

Road

Railway

Model Features

Fenceline

Permanent Access Road

Maximum Modelled Concentration (µg/m³)

Sensitive Receptors

R1 (Nearest Residence)

R2 (Nearest Residence)

R3 (Nearest Residence)

R4 (Nearest Residence)

Manitoba Air Quality Criteria = 120 µg/m³

Concentration Contour (µg/m³)

Maximum Modelled Concentration = 167 (µg/m³)
Background Concentration = 14 (µg/m³)

N E S W

1:30,000
NAD 1983 UTM Zone 14N

300 150 0 300 600 900 m

Ortho-Imagery: ESRI World Imagery, Canvec

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

AECOM

Figure: B-8

MAXIMUM 24-HOUR AVERAGE TSP CONCENTRATIONS (µg/m³)

VIVIAN SAND FACILITY PROJECT
AIR QUALITY ASSESSMENT REPORT
CANWHITE SANDS CORPORATION
Project No.: 60625356 Date: 2020-06-25

ANSI B 279.4mm x 431.8mm Approved: Checked: Designer: Project Management Initials:

Last saved by: PAIGE.CROSSMAN (2020-06-25) Last Plotted: Thu Jun 25, 2020
Filename: \\CAWPG1FP001\DATA\PROJECTS\60625356\900-CAD_GIS\920-929 (GIS-GRAPHICS)\02_MXDS\AIR DISPERSION MODELLING\B-5_60625356_ISOPLETH_TSP.MXD

aecom.com