Shadow Flicker Assessment

For the

Sugar Maple Wind Power Project

Prepared For:

CBCL Ltd.
1505 Barrington Street, Suite 901
Halifax
Nova Scotia
B3J 2R7

March 20, 2026

Prepared By:

Nortek Resource Solutions Inc.
26 Church Road
Sutherlands River, Nova Scotia
B0K 1W0
www.nortekresources.com

Table of Contents

1.0 Introduction

The proposed Sugar Maple Wind Power Project is located approximately 20 km southwest of Town of Antigonish and 7 km North of Garden of Eden Lake, Nova Scotia. The proposed project is expected to be built with wind turbine generators (WTG's) which will have hub heights up to 118 m and maximum rotor diameters of 163 m. For the purposes of this assessment, the Nordex N163 6.X WTG rated at 7.0 MW was used as it has a similar hub height to the other WTG's under consideration for the project and has the largest rotor diameter of the WTG's being considered.

The rotating blades of a wind turbine create moving shadows known as shadow flicker that are noticeable in close proximity to the turbine. The potential impact depends on the time of year, the physical characteristics of the wind turbine, the orientation of the blades relative to the sun, the presence of wind and of course, the presence of sunlight.

The following report summarizes the results of shadow flicker assessment which will be incorporated into the Nova Scotia Environmental Assessment Registration Document.

2.0 Methodology

2.1 Shadow Flicker Analysis

The shadow flicker analysis was completed using WindPRO 4.2.285 which provides a comprehensive suite of wind farm design and modeling software.

The locations of the 16 proposed turbines are summarized in Table 1. In addition to the proposed turbines, turbines currently under construction at the nearby Weavers Mountain Wind Energy Project were included in the model. The locations of the Weavers Mountain turbines are summarized in Table 2. The turbine model specific parameters of the proposed turbines are shown in Table 3 and Table 4 shows the specifications of the existing Weavers Mountain turbines.

The shadow flicker analysis was based on developing a theoretical or worst-case scenario and a realistic scenario that provides an understanding of the extent of shadow flicker as a result of the existing and proposed turbines.

2.2 Digital Elevation Model

A digital elevation model (DEM) that was derived from aerial LiDAR (Light Detection and Ranging) data was used to model the shadow flicker in this analysis. The original DEM was resampled from 1 m

Table 1: Proposed Turbine Locations.

Id	Model	Easting (m)*	Northing (m)*
S1	N163/6.X-7,000	560,047	5,034,628
S2	N163/6.X-7,000	558,751	5,034,733
S3	N163/6.X-7,000	558,041	5,035,211
S4	N163/6.X-7,000	558,515	5,035,890
S5	N163/6.X-7,000	557,678	5,036,180
S6	N163/6.X-7,000	558,577	5,036,948
S7	N163/6.X-7,000	559,745	5,035,971
S8	N163/6.X-7,000	560,957	5,036,249
S9	N163/6.X-7,000	561,605	5,034,810
S10	N163/6.X-7,000	561,602	5,036,905
S11	N163/6.X-7,000	564,428	5,038,216
S12	N163/6.X-7,000	563,307	5,038,318
S13	N163/6.X-7,000	564,543	5,037,219
S14	N163/6.X-7,000	564,890	5,036,561
S15	N163/6.X-7,000	564,927	5,034,956
S16	N163/6.X-7,000	565,981	5,035,320

* UTM, NAD83(CSRS), Zone 20

Table 1: Turbine Locations Currently Under Construction – Weavers Mountain Wind Energy Project.

Id	Model	Easting (m)*	Northing (m)*
1	N163/5.X-5,900	562,304	5,043,507
2	N163/5.X-5,900	561,202	5,041,276
3	N163/5.X-5,900	561,034	5,041,908
4	N163/5.X-5,900	563,844	5,043,125
5	N163/5.X-5,900	559,700	5,041,766
6	N163/5.X-5,900	559,531	5,039,204
7	N163/5.X-5,900	558,854	5,041,065
8	N163/5.X-5,900	564,579	5,043,164
9	N163/5.X-5,900	562,192	5,042,730
10	N163/5.X-5,900	565,653	5,043,456
11	N163/5.X-5,900	560,162	5,041,007
12	N163/5.X-5,900	559,246	5,040,288
13	N163/5.X-5,900	562,868	5,041,675
14	N163/5.X-5,900	561,085	5,042,639
15	N163/5.X-5,900	561,338	5,043,938
16	N163/5.X-5,900	561,813	5,041,825

* UTM, NAD83(CSRS), Zone 20

Table 3: Proposed Turbine Specifications.

Item	Specification
Manufacturer	Nordex
Model	N163 6.X 7000
Hub Height	118 m
Rotor Diameter	163 m
Operation Mode	Full Power
Rated Power Output	7,000 kW

Table 4: Existing Turbine Specifications – Weavers Mountain Wind Energy Project.

Item	Specification
Manufacturer	Nordex
Model	N163 5.X
Hub Height	125 m
Rotor Diameter	163 m
Operation Mode	Full Power
Rated Power Output	5,900 kW

to 4 m resolution to minimize the file size for the project and adjacent areas.

2.3 Theoretical (Worst) Case

In this highly conservative scenario, existing shadowing objects such as forests and single trees were not included in the analysis. This scenario provides an understanding of the maximum amount of shadow flicker that could theoretically be experienced at the modeled receptors under the following conditions:

- The sun shines 100% of the time when it is above the horizon.
- The turbine rotor is always perpendicular to the sun.
- Shadow flicker starts as the sun moves above 3 degrees from the horizon.
- The shadows dissipate at a maximum distance from the blade as a result of atmospheric conditions and light diffusion, and.
- The rotor blades are always spinning.

The total length of the shadow influence in the atmosphere is calculated from the physical dimensions of the turbine blade. In this analysis, the maximum shadow distance for the N163 6.X 7000 kW was calculated to be 1,788 m. This scenario represents conditions that will not be experienced in the real world with continuous sunshine, constant operation of the turbines, no obstacles or trees and turbine rotors are always perpendicular to the sun.

2.4 Realistic Case

The realistic case was modeled by incorporating site specific wind conditions and monthly sunshine probabilities into the analysis. As with the theoretical case, shadowing objects were not included in the model; therefore, there still is some conservatism with this case as the model does not provide an accurate representation of the forests and outbuildings within the study area.

Statistical climate data in the form of average sunshine probabilities per month were obtained from the closest, representative coastal weather station (that records sunshine data).

2.5 Climate Data

Monthly sunshine data were used to provide a realistic condition for calculating shadow flicker. The realistic scenario was modeled using site specific wind conditions and monthly sunshine probabilities obtained from the closest observatory at Charlottetown, PEI. The monthly daily sunshine hours used in the analysis are shown in Table 5.

Table 5: Monthly Average Sunshine Hours for Charlottetown, Prince Edward Island.

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Average Daily Sunshine Hours	3.37	4.18	4.42	5.04	6.34	7.54	7.95	7.19	5.76	3.98	2.63	2.31

2.6 Shadow Receptors

A total of 22 non-participating receptors were identified and modeled in this analysis. All receptors were identified using satellite and aerial imagery to locate buildings that can be considered as dwellings. Each building was assumed to have windows facing in all directions. This modeling approach is referred to as 'greenhouse mode' and ensures that the orientation of individual receptor windows are not a factor in estimating shadow flicker. These factors ensure that the modeling results are based on the best available data. Table 6 shows the locations of the 22 receptors used in the analysis.

Table 2:Shadow Flicker Receptor Locations.

Receptor ID	Easting (m)*	Northing (m)*	Elevation (m)
A	564,404	5,033,176	166.0
B	564,784	5,033,194	149.9
C	564,374	5,033,223	171.1
D	564,466	5,033,239	160.9
E	559,774	5,033,630	211.2
F	560,325	5,031,966	188.9
G	560,313	5,031,984	189.8
H	560,344	5,031,985	189.6
I	564,953	5,033,495	171.1
J	565,109	5,032,013	142.4
K	564,992	5,032,028	142.0
L	565,054	5,032,080	144.9
M	557,366	5,037,306	229.4
N	555,953	5,037,452	223.0
O	556,272	5,037,786	224.9
P	557,252	5,037,838	227.0
Q	560,667	5,038,095	223.7
R	557,633	5,038,482	248.2
S	563,050	5,039,446	223.6
T	562,627	5,040,679	218.6
U	557,655	5,037,336	241.8
V	562,621	5,040,697	219.5

* UTM, NAD83(CSRS), Zone 20

3.0 Shadow Flicker Analysis Results and Discussion

A generally accepted guideline that originates from Europe is that shadow flicker exposure be limited to a maximum of 30 hours per year.   In Nova Scotia, developers are required to demonstrate that no receptor will receive more than 30 hours per year or more than 30 minutes per day off shadow flicker.

Figure 1 shows the results of the modeling and the spatial extent of the threshold of 30 shadow hours per year. Receptor specific results are provided for in Table 7.

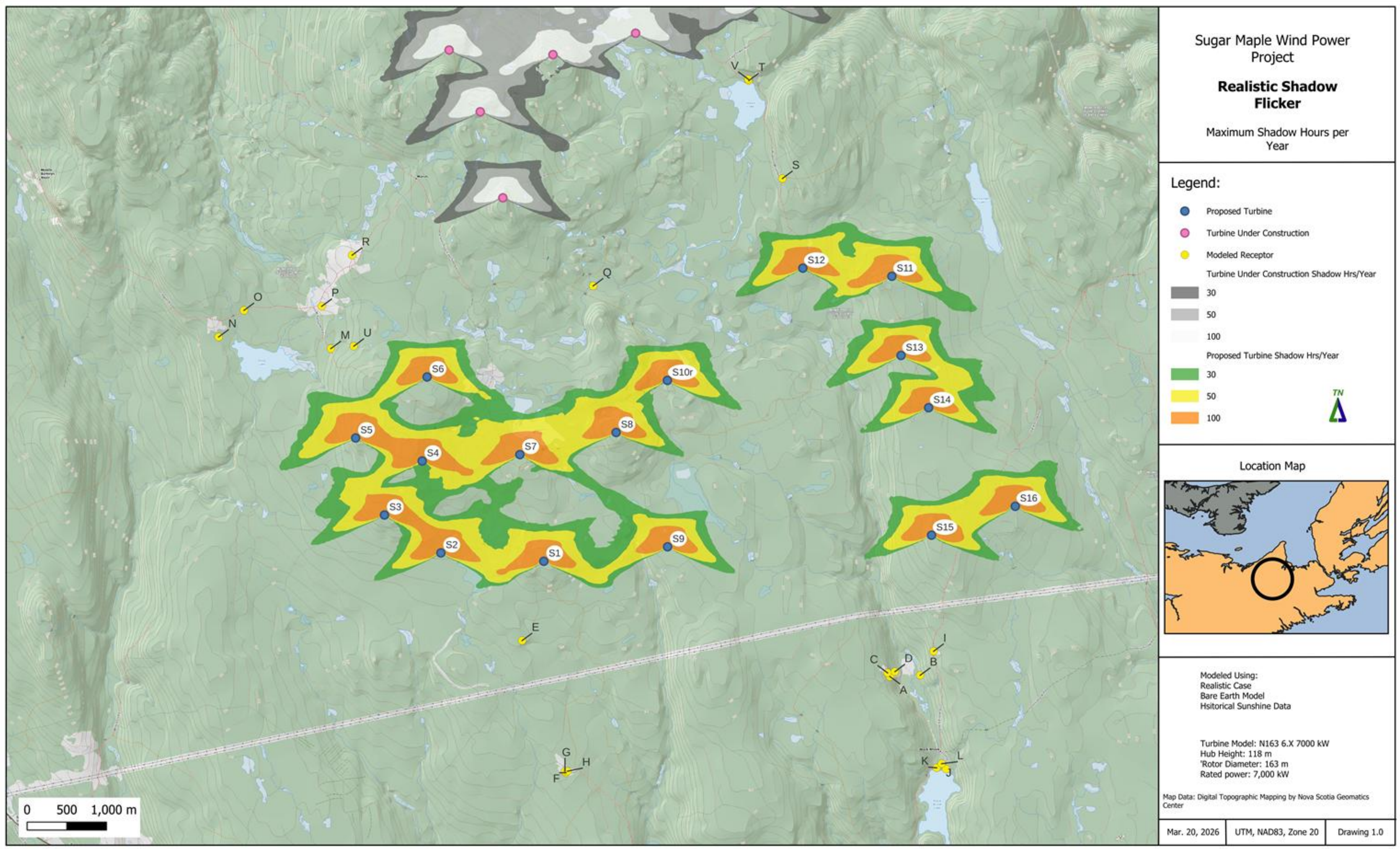

Figure 1: Shadow Flicker per Year Based on Realistic Scenario for the Proposed Sugar Maple Wind Power Project.

Table 7: Predicted Shadow Flicker for Local Receptors Based on Theoretical (Worst) and Realistic Case Scenario's.

Receptor ID	Theoretical Case		Realistic Case
	Shadow Hrs/Yr	Max. Shadow Minutes per Day	Shadow Hours per Year
A	0:00	0:00	0:00
B	0:00	0:00	0:00
C	0:00	0:00	0:00
D	0:00	0:00	0:00
E	0:00	0:00	0:00
F	0:00	0:00	0:00
G	0:00	0:00	0:00
H	0:00	0:00	0:00
I	0:00	0:00	0:00
J	0:00	0:00	0:00
K	0:00	0:00	0:00
L	0:00	0:00	0:00
M	15:03	0:30	5:36
N	0:00	0:00	0:00
O	0:00	0:00	0:00
P	15:34	0:25	5:02
Q	0:00	0:00	0:00
R	0:00	0:00	0:00
S	0:00	0:00	0:00
T	19:05	0:26	9:06
U	25:23	0:38	9:37
V	17:42	0:26	8:23

The results of the theoretical (Worst) case indicate that none of the 22 receptors would experience greater than 30 hours of shadow flicker per year and one receptor would experience more than 30 minutes per day (Table 7). This analysis is completed to obtain a baseline understanding of project impact on receptors. Exceedance of the maximum shadow hours per year or 30 minutes per day is common when using the worst-case scenario due to the conservative nature of the analysis. Exceedance of the worst-case scenario has been reported for a number of approved Environmental Assessments for wind projects in Nova Scotia (Setapuktuk Wind Project, Kmtnuk Wind Power Project, Bear Lake Wind Project, and the Wedgeport Wind Farm Project).

The realistic case scenario provides a more comprehensive analysis as the assumptions in the theoretical case are very conservative in nature and do not represent conditions which would occur in the real world.

By applying monthly sunshine probabilities into the model, more precise annual results can be generated, however the maximum shadow flicker per day cannot be calculated. This is a result of using monthly sunshine probabilities which cannot be scaled to minute time steps. The realistic case scenario, which includes the sunshine probabilities, shows that all the receptors are expected to receive less than 30 hours per year of shadow flicker (Table 7). It is noted that the realistic case is also conservative as it does not include any obstacles or trees, assumes turbines are always operating and that receptor windows are always facing the turbine.

4.0 Conclusion

The shadow flicker analysis based on the realistic case indicates that the modeled non-participating receptors are expected to receive less than 30 hours per year of shadow flicker. The realistic values range from 0 to 9.6 hours per year which are well below the 30 hour per year threshold value.

These modeled results indicate that the proposed wind project meets the current guidelines as defined by the Nova Scotia Department of Environment and Climate Change.

5.0 References

Nova Scotia Department of Environment and Climate Change. Environmental Assessment Supplemental Checklist: Wind Energy Projects, https://novascotia.ca/nse/ea/docs/environmental-assessment-supplemental-checklist-wind-energy-projects-en.pdf

Nova Scotia Topographic Database, https://nsgi.novascotia.ca/datalocator/indexing.html

Nova Scotia Elevation Explorer, https://nsgi.novascotia.ca/datalocator/elevation/