

# *Wind Colebrook North*

Winsted-Norfolk Road  
and Rock Hall Road  
Colebrook, Connecticut

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Prepared for



Prepared by

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## Introduction

BNE Energy Inc. (“BNE”) proposes to install three wind turbines (“Wind Colebrook North” or the “Project”) at property located northeast of the intersection of Winsted-Norfolk Road (Route 44) and Rock Hall Road (identified herein as the “Property” or “Site”) in the Town of Colebrook, Connecticut. Vanasse Hangen Brustlin, Inc. (“VHB”) was retained by BNE to conduct this shadow flicker analysis for the Project.

The Project would consist of three General Electric 1.6 megawatt (“MW”) wind turbine generators with hub heights of 100 meters (328 feet) above ground level (“AGL”); one each to be located in the south-central, northeast and northwest portions of the Property, respectively. BNE is proposing to use turbines with rotor blades of 40.3 meters, but has requesting approval for rotor blades up to 50 meters in length. Therefore, this analysis was performed assuming turbine blades that would extend an additional 50 meters, resulting in a maximum blade tip height of 150 meters (492 feet) AGL. The wind turbines would be located at the following ground elevations at the Site:

**Table 1**  
**Wind Colebrook North Turbine Locations**

<b>Turbine Number</b>	<b>Location on Site</b>	<b>Elevation*</b>
Turbine 1	Western	452 feet AMSL
Turbine 2	Southeastern	508 feet AMSL
Turbine 3	Northeastern	547 feet AMSL

\*Expressed in feet Above Mean Sea Level (“AMSL”)

Identified in the Town of Colebrook land records as Map 7, Lot 4, the Property consists of approximately 125 acres, most of which is undeveloped, forested land. The western edge of the Property is cleared and used as golf driving range. The Property is bound on three sides by undeveloped woodlands; Winsted-Norfolk Road and five residences about a portion of the Property to the west. Rock Hall Road bounds the northwest portion of the Property. Land use within the vicinity of the Property is a mix of commercial and sparse residential development.

The topography within the Site vicinity is generally characterized by gently rolling to steep hills with ground elevations that range from approximately 519 feet AMSL to approximately 1720 feet AMSL. Vegetative cover on and around the Site consists mainly of mixed deciduous hardwood species, with some stands of intermixed conifers; the average tree canopy height is conservatively estimated to be approximately 65 feet AGL.



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## Shadow Flicker

For purposes of this evaluation, shadow flicker from wind turbines is defined as the effect of alternating changes in light intensity of the sun caused by the rotating blades of the turbine casting a moving shadow to a nearby area. The shadow may be perceived as a "flicker" due to the repeated shadow being cast by the rotating blades.

Shadow flicker occurs under a special set of circumstances when the sun passes behind the hub of a wind turbine and casts a shadow over neighboring terrain. Shadow flicker can occur through the windows of structures if a wind turbine is close enough to, and of a specific orientation with, a nearby building. When viewed from within a building, repetitive changes in the brightness of the room may occur as shadows cast from rotating wind turbine blades pass by and through the windows. When seen outdoors, a viewer may experience the shadows of the rotating blades moving on the ground. Intervening vegetation and other obstructions typically obstruct shadow flicker.

Four conditions must occur simultaneously to cause wind turbine shadow flicker:

1. The turbine must be operating and the blades rotating;
2. The sun must be shining;
3. The turbine must be between an observer and the sun; and,
4. The viewer must be close enough to the object to be within its shadow.

Additionally, the rotor plane of rotation must be close to perpendicular to the line between the sun and the viewer and the sun's rays for shadow flicker to occur.

### Shadow Length and Intensity

Shadow length and intensity varies depending on the angle of the sun in the sky and the distance between the turbine and the viewer. The intensity of the shadow flicker is strongest near the wind turbine and diminishes with distance from the turbine. Shadow distance is somewhat dependent on the size of the structure, and the factors that influence the length of a cast shadow include:

- Sun angle and intensity;
- Optic (atmospheric) conditions,, including cloud cover and fog, for example;
- Terrain; and,
- Other obstacles (e.g., intervening trees and buildings).

Regardless of the size of the object casting the shadow and the angle/intensity of the sun, the shadow will only stretch a certain distance. Various studies suggest that

maximum shadow distances can range from less than 300 meters (1,000± feet) to 1,500 meters (approximately 0.9 mile). At distances beyond 1,000 feet, shadow flicker is not considered to be a nuisance except during the morning and evening when shadows are long. However, sunlight intensity is also lower during the morning and evening hours, which tends to reduce shadow flicker effects.<sup>1</sup>

In Europe,<sup>2</sup> as another example, it is generally accepted that shadow flicker from wind turbines does not occur at a distance D, to a given wind turbine that is greater than that given by the following formula:

$$D = 10 \times (\text{hub height} + \text{rotor radius})$$

Using this formula at the Project Site, the maximum distance of shadow would be approximately 1.5 km (or 0.93 mile).

### Shadow Flicker Frequency

Shadow flicker frequency is determined by rotor blade speed and the number of blades on the rotor. This value is measured in Hertz (Hz), with 1 Hz being equivalent to 1 flicker per second. The proposed turbine model, assuming a rotor diameter of 100 meters, will have a nominal speed range of 9.75 to 16.18 revolutions per minute (rpm). This corresponds to a flicker frequency of 0.49 to 0.81 Hz. While flicker frequencies within this range may be considered an annoyance under certain circumstances, exposure to such low frequencies is deemed harmless. The consensus of international experts gathered by the Epilepsy Foundation is that flicker frequencies of 5 to 30 Hz are most likely to trigger seizures in individuals suffering from photosensitive epilepsy. In order to be safe, the consensus recommends that exposure to photosensitive individuals should not exceed 3 Hz.<sup>3</sup> Epilepsy Action, a working name for the British Epilepsy Foundation, indicates that there is no evidence that wind farms can trigger seizures. This finding is based on the fact that newer wind turbines are typically built to operate at a frequency of 1 Hz or less.<sup>4</sup>



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### Shadow Flicker Analysis Methodology

An analysis of potential shadow flicker occurrences resulting from the Project was conducted using the SHADOW module of WindPRO software, a widely-accepted modular-based software package developed by EMD International and designed specifically for the planning and evaluation of wind power projects.

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<sup>1</sup> *Environmental Impacts of Wind Energy Projects*, National Academy Press, 2007, p. 160.

<sup>2</sup> Best Practice Guidelines for the Irish Wind Energy Industry; Irish Wind Energy Association, 2008

<sup>3</sup> Shedding Light on Photosensitivity, <http://www.epilepsyfoundation.org/about/photosensitivity/gerba.cfm>

<sup>4</sup> Photosensitive Epilepsy, <http://www.epilepsy.org.uk/info/photosensitive/triggers#turbines>

The software model can determine the duration of shadow flicker experienced at a specific viewing location, by using a geometric analysis which accounts for the relative positions of the sun (throughout the time of year and day), the locations of the wind turbines, and the viewing location. The SHADOW module calculates the duration of time that shadow flicker could occur at receptor locations within the program’s conservative, default distance of 2,000 meters (6,561 feet) from the Project wind turbine locations. The 2,000-meter distance has been used in this analysis as the “Study Area.”

This analysis calculated predicted shadow flicker occurrences for specific receptor locations. A “receptor” is defined as an occupied structure within the 2,000-meter study area. The receptors were located using a combination of aerial photography, online assessor information (<http://www.equalitycama.com/>), and selective field verification. Each receptor was modeled using the WindPRO SHADOW module’s “greenhouse” mode, which assumes windows are perpendicular to the wind turbines. The model’s default window dimensions were used in the analysis: one square meter (1-meter height by 1-meter width). The receptor windows were assumed to be at 1 meter above ground level. The default slope of the window is vertical 90°. A total of 138 receptors were identified within the 2,000-meter Study Area.

VHB first conducted a “worst case” analysis that assumes that the sun is always shining, the wind is always blowing, and the turbines are always functioning at optimum capacity. In addition, the receptors identified within the Study Area were input using the module’s “greenhouse mode,” which assumes that there can be windows on each side of the structure. The following data variables were input into the SHADOW module to conduct the worst case calculations:

**Table 2**  
**Worst Case Data Variables**

<b>Input Data</b>	<b>Data Source</b>
Wind Turbine Locations	Geographic Coordinates provided by Client
Wind Turbine Model Type	GE 1.6xl (100 meter hub height and 50 meter blade length)
2-foot Contours	Connecticut LiDAR-based Digital Elevation Data (collected in 2000)
Vegetation Cover	Polygon layer digitized by VHB using 2006 and 2010 aerial photographs
138 Receptors	Point layer digitized by VHB using 2010 aerial photographs to represent one point per building

The resultant shadow flicker calculations were prepared with a resolution of one minute; that is, if shadow flicker occurs within any one-minute period (regardless of the number of seconds in duration), the model records this as one minute of shadow flicker. The modeling software assumes that at distances greater than 2,000 meters from the turbines, the frequency of shadow flicker occurrences is low and its intensity is faint enough to not be a distraction to human activities. The WindPRO software accurately

calculates the potential locations and durations of shadow flicker, but it does not evaluate intensity and therefore, as a conservative measure, worst-case intensity is assumed at all receptors.

In actuality, shadow flicker occurrences will be less than the calculations because of the conservative simplifications used in the model. For instance:

- The modeling of the wind turbine blades as discs rather than individual blades results in an overestimate of shadow flicker duration. Turbine blades are of varying thickness, with the thickest part of the blade close to the hub and the thinnest part at its tip. Diffusion of sunlight can limit the maximum distance that a shadow can be perceived. This maximum distance will also be dependent on the thickness of the turbine blade, and the human threshold for perception of light intensity variation. As such, a shadow cast by the blade tip will be shorter than the shadow cast by the thickest part of the blade.
- The model does not incorporate a factor specifying the percentage of the sun's area covered by the turbine blade. As this percentage decreases, either by the sun location or the viewing distance from the turbine, the shadowing effect decreases significantly.
- The model applies a minimum sun angle of 3 degrees and considers topographic characteristics of surrounding terrain out to approximately 1.3 miles from the Project Site boundaries. Higher elevations beyond the Study Area could obstruct the sun at or above the 3-degree angle and further reduce the effect. This is most likely to occur during dusk/twilight time periods.

VHB reviewed the worst-case calculations and then conducted a modified analysis that considered those conditions that can inhibit shadow flicker occurrences, including: cloud cover; fog; dust/pollution; humidity; and times when the wind turbines are either not perpendicular to the sun (relative to the receptor location) or not functioning due to low and/or high wind conditions. A 50% reduction factor was considered reasonable given historic weather statistics and accounting for periodic operational limitations to provide a more realistic, or "probable case" scenario. All data variables listed above were applied, as were the following local climate sources:

Table 3  
Probable Case Data Variables

Input Data	Data Source
Percentage of Possible Sunshine	Climate of Connecticut; Climate Services Branch, National Climatic Data Center, <a href="http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals.pl">http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals.pl</a>
	Average Climate in Colebrook, Connecticut, <a href="http://www.city-data.com/city/Colebrook-Connecticut.html">http://www.city-data.com/city/Colebrook-Connecticut.html</a>
Percentage of Possible Humidity	Average Climate in Colebrook, Connecticut, <a href="http://www.city-data.com/city/Colebrook-Connecticut.html">http://www.city-data.com/city/Colebrook-Connecticut.html</a>

According to the National Climatic Data Center, the annual percentage of possible sunny days state-wide averages 55 to 60 percent (ranging from 45 percent in the interior during the months of November, December and January to near 65 along the coast in the summer). An average of 140 cloudy days occurs annually. One or more prolonged periods of cloudy skies are commonly observed during the winter and early spring.<sup>5</sup> Town-specific climate data supports this information, which indicates an annual average number of cloudy days of at least 45%.<sup>6</sup>

In addition to cloudy days, there are other real-world conditions that commonly occur that limit times when shadows may be cast; circumstances for which the WindPRO program does not account. These include:

- Times when the wind turbines are yawed so that the rotor is not perpendicular to the sun, relative to receptor locations (as the model assumes). Wind data collected over a 13-month period (12/12/08 through 1-24-10) at Wind Colebrook South documents that the wind blows from the general western direction (including WNW, W, and WSW) approximately 48% of the time; about 20% from the south; 14% from the east; and 17% of the time from north<sup>7</sup>. Based on this data, prevailing westerly winds occur slightly less than 50% annually. Potentially affected receptors lie generally east and west of the project site. It is evident that the positions of the turbines would not be perpendicular to receptors all the time; any other rotor orientation will reduce the area of a projected shadow and resultant shadow flicker. This data indicates that the turbine directions, relative to specific receptor locations, can be highly variable; the WindPRO calculations do not account for this factor.

<sup>5</sup> Climate Services Branch, National Climatic Data Center, <http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl>, *Climate of Connecticut*, p. 5.

<sup>6</sup> <http://www.city-data.com/city/Colebrook-Connecticut.html>

<sup>7</sup> Percentages presented are approximate and add up to 99% due to omission of fractions of percents.

- Times when low/high winds (or operational maintenance activities) inhibit the turbine blades from spinning (at least 11% of the time annually).
- Partly cloudy days (20% to 25% annually in Colebrook).
- Fog, air pollution, high humidity and other atmospheric conditions that inhibit shadow casting (typically, higher percentage of occurrences in warm-weather months).
- The conservative simplifications used within the model (as discussed above) that can overestimate shadow flicker duration, including: modeling of the wind turbine blades as discs rather than individual blades; not incorporating a factor specifying the percentage of the sun's area covered by the turbine blade; and, the omission of terrain elevations beyond 2,000 meters of the project site boundaries.

Given these conditions, it is reasonable to expect additional reductions in the annual hours of shadow flicker predicted by the model under the worst-case scenario. For purposes of this study, VHB added 5% to the average annual percent of cloudy days (45%) to account for those conditions that could lessen or nullify shadow flicker occurrences, which ultimately lead to the 50% reduction factor used in the modified or probable-case scenario. No specific formula was used to create the additional 5% reduction factor. Instead it was reasoned that assigning one percent (1%) to each of these conditions was a sufficiently conservative estimate. As an example, if we were to assume that prevailing winds occurring 50% of the time from a direction other than the west was split between 25% of the time at night and 75% during daytime hours, those receptors to the east would experience a reduction of at least 12.5% of the time. In addition, note the contributions from partly cloudy days and the percentage of time when high/low wind speeds occur, rendering the turbine motionless.

The Study Area, receptor locations, and the analytical results are depicted in Figure 1, *Probable Case Shadow Flicker*. The resultant shadow flicker calculations expected per receptor are presented in Table 4, *Shadow Flicker Results – Receptor Locations*, located in Tables section. Table 5, *Receptor Locations*, located in Tables section, lists all of the receptors included in this evaluation by street address for reference. Appendix A includes the SHADOW module main results for all receptor locations and Appendix B provides a Calendar (by month and day) table for those receptors predicted to have at least one minute of shadow flicker.




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## Regulations and Guidelines

No federal, state or local regulations governing shadow flicker effect limits currently exist. Shadow flicker duration has been addressed elsewhere, however. In Europe guidelines have been established suggesting that shadow flicker impacts to dwellings be limited to 30 hours annually.<sup>8</sup> A German court ruled that 30 hours of actual shadow

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<sup>8</sup> Best Practice Guidelines for the Irish Wind Energy Industry; Irish Wind Energy Association, 2008



flicker per years was acceptable at a neighboring property.<sup>9</sup> In Austria, recommendations suggest that show flicker should not exceed 30 hours per year.<sup>10</sup> Guidelines for wind power development in Victoria, Australia specify that shadow flicker may not exceed 30 hours per year at any dwelling in the surrounding area.<sup>11</sup> Although wind energy ordinances currently exist in some communities throughout this country, many have no regulations in place<sup>12</sup>. In communities where ordinances or bylaws exist, and shadow flicker addressed, it is typically expected that potential shadow flicker will be analyzed for impacts to off-site structures, including the extent and duration (Long Lake Township, Michigan<sup>13</sup>, for example). In some instances, a project owner/operator is required to make every reasonable effort to minimize shadow flicker to occupied buildings (Antic Township, Pennsylvania; Rockland, Wisconsin<sup>14</sup>). Several applications for wind turbines in communities across the United States have adopted a 30-hour annual limit for shadow flicker occurrences, most likely as a result of there being no domestic regulations and relying on the European and Australian guidelines. For comparative purposes, the results of this analysis have been evaluated with respect to the 30 hours per year level.



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## Results

The Project was analyzed to determine the potential for shadow flicker impacts at the 138 receptors located within the Study Area using a combination of worst-case scenario modeling and the incorporation of a probable-case scenario. A total of 11 receptors are predicted to experience shadow flicker at some time during the year, with annual durations ranging from approximately one hour to 41 hours. Two receptors are predicted to experience more than 30 hours (31 and 41 hours, respectively) per year and nine receptors are predicted to experience less than 10 hours annually (ranging from slightly more than one hour to nearly 8 hours).

The two receptors (identified as receptors O and P on Figure 1) forecasted to experience more than 30 hours are commercial uses located west of the Property (112 Rock Hall Road and 177 Winsted-Norfolk Road, respectively). The Rock Hall Road property is developed with a pavilion used for outdoor events. The structure located at 177 Winsted-Norfolk Road is a lodge owned and operated by the Northwestern Connecticut Sportsmen's Association property. Based on a review of the WindPRO

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<sup>9</sup> Danish Wind Industry Association, June 8, 2003;  
<http://www.windpower.org/en/tour/env/shadow/index.htm>

<sup>10</sup> Dobesch and Kury (2001), Central Institute for Meteorology and Geodynamics (ZAMG) Vienna, Austria: "Basic Meteorological Concepts And Recommendations For The Exploitation of Wind Energy In The Atmospheric Boundary Layer",

<sup>11</sup> Sustainable Energy Authority Victoria, May 2003: "Policy and planning guidelines for development of wind energy facilities in Victoria", p.26.

<sup>12</sup> F. Oteri, *An Overview of Existing Wind Energy Ordinances*, December 2008)

<sup>13</sup> Ibid

<sup>14</sup> Ibid

SHADOW Calendar calculations, shadow flicker would occur at these locations in the early morning, generally within the first two and one-half hours after sunrise, when the sun is low on the horizon. Turbine number three is predicted to create the effect at 112 Rock Hall Road; this turbine would be located approximately 2,895 feet from the pavilion. All three turbines appear to contribute to potential shadow flicker at 177 Winsted-Norfolk Road; these units range in distance from approximately 1,437 and 3,678 feet away. One additional receptor (DK) west of the Property may experience shadow flicker within an hour of daybreak. The nearest turbine to this location lies approximately 2,756 feet away.

Shadow flicker is predicted to occur at eight locations generally east of the Site, typically within a half hour to 45 minutes prior to sunset, again when the sun is very low in the sky. Shadow flicker is predicted to occur in brief durations (anywhere from 1 to almost 10 minutes) on those days when the effect is estimated to take place. The distances of the turbines to these receptors range from approximately 3,655 feet to over 6,000 feet away.

The total amount of shadow flicker caused by each turbine is summarized in the table below.

**Table 6  
Shadow Flicker Per Turbine**

<b>Turbine No.</b>	<b>Total Flicker Hours/Year</b>
Turbine 1	35:50
Turbine 2	43:01
Turbine 3	147:00

The analysis of potential shadow flicker impacts from the Project on nearby receptors demonstrates that these occurrences within the Study Area are not expected to create a significant nuisance. The conservative calculations illustrate low occurrence of flicker throughout the majority of the Study Area. Of the 138 receptors evaluated, 11 are predicted to have some shadow flicker events (representing approximately 8% of the total receptor locations within the Study Area).

The results of this analysis are intentionally conservative. It is important to note that the WindPRO SHADOW analysis assumes that all the receptors and properties have direct lines-of-sight towards incoming shadow flicker sunlight from all sides of structures. The reality is that windows of many houses do not face the sun directly for the key shadow flicker impact times. In addition, this analysis determined the potential shadow flicker impacts from wind turbines at distances up to 2,000 meters away. Shadow flicker impacts will decrease in intensity the further the distance between receptor and turbine. At the times that shadow flicker is predicted to occur (within a few hours of sunset), the intensity of the sun is also diminished. Even the probable-case

scenario (that is, introducing a 50% reducing of the raw WindPRO SHADOW calculations) is considered conservative. The total shadow flicker hours are expected to be less than estimated in this analysis.



Figure 1

**Figure 1**  
**Probable Case Shadow Flicker**

Wind Colebrook North  
 BNE Energy, Inc.  
 Winsted-Norfolk Road  
 Colebrook, Connecticut

**Legend**

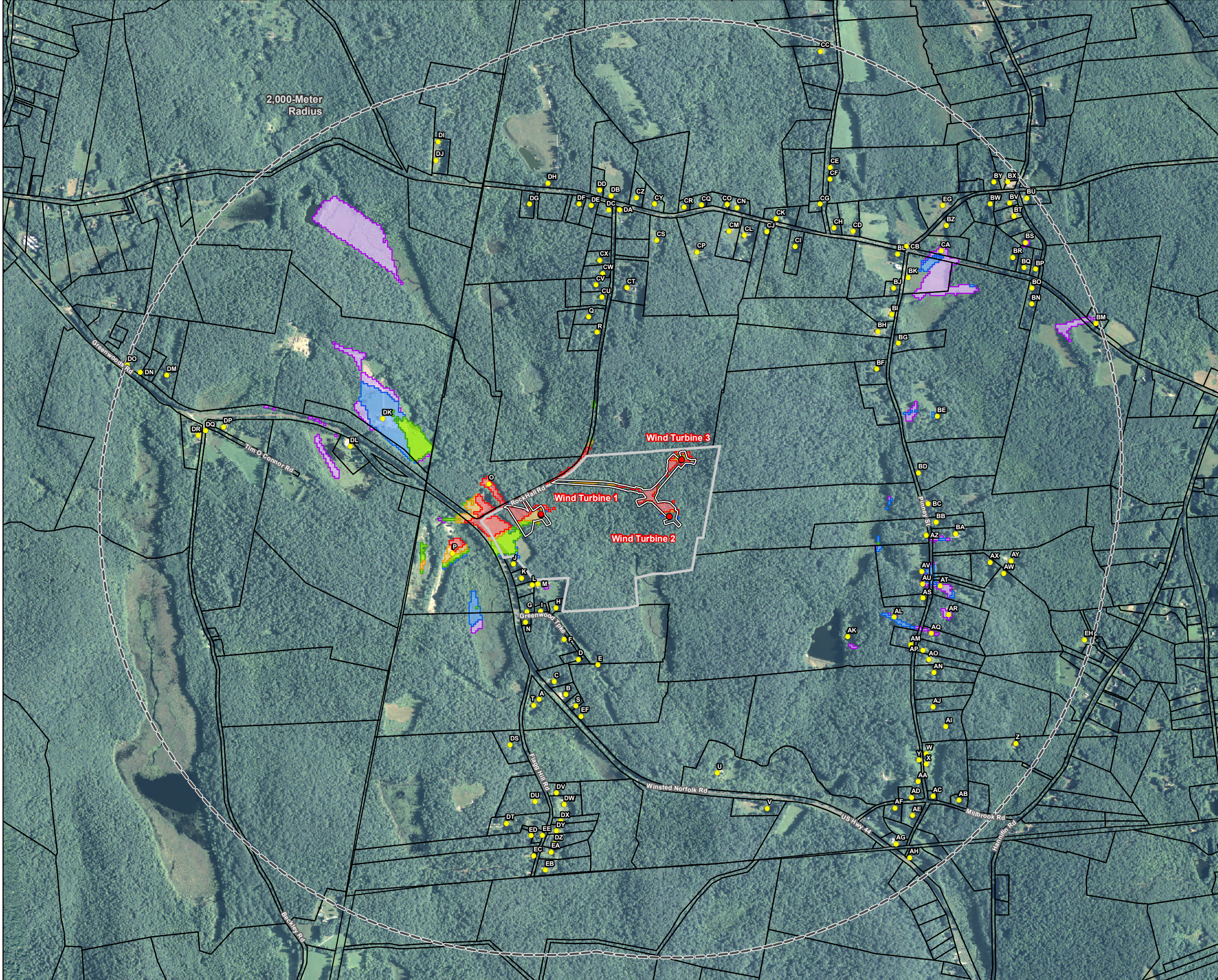
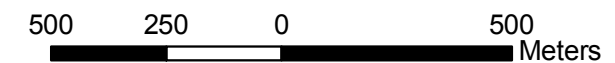
- Proposed Wind Turbine Location
- Receptor
- Proposed Clearing Limits & Access Road
- 2,000-Meter (1.24 - Miles) Radius
- Approximate Project Site Boundary
- Approximate Assessor Parcel Boundary

**Probable Case Shadow Flicker**

**Hours Per Year**

- <5
- 5 - 10
- 10 - 20
- 20 - 30
- >30

Base Map Source: 2010 aerial photography with 1-meter resolution.



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# Tables

**Table 4**  
**Shadow Flicker Results - Receptor Locations**

Map ID	Site Address	Worst-Case Analysis <sup>(1)</sup>		Probable Case Scenario <sup>(2)</sup>				Dates of Predicted Shadow Flicker	Land use	Approximate Distance to Wind Turbine 1	Approximate Distance to Wind Turbine 2	Approximate Distance to Wind Turbine 3
		Hours Per Year	Max minutes (min/day)	Hours Per Year	Max minutes (min/day)	% of Sun Hours/Year <sup>(3)</sup>	% of Hours/Year <sup>(4)</sup>					
O	112 Rock Hill Road	82:03:00	68	41:01:30	34.0	0.920%	0.468%	1/29-3/16; 9/27-11/13	Commercial	896 Ft	2,746 Ft	2,895 Ft
P	177 Winsted-Norfolk Road	61:56:00	47	30:58:00	23.5	0.695%	0.354%	4/10-4/22; 5/9-8/3; 8/20-9/2	Commercial	1,437 Ft	3,272 Ft	3,678 Ft
AL	117 Pinney Street	15:23:00	19	7:41:30	9.5	0.172%	0.088%	5/25-7/19	Residential	5,477 Ft	3,655 Ft	3,954 Ft
AR	114 Pinney Street	5:55:00	15	2:57:30	7.5	0.066%	0.034%	4/24-5/8; 5/7-5/21; 7/23-8/6; 8/15-8/19	Residential	6,255 Ft	4,409 Ft	4,606 Ft
AT	108 Pinney Street	12:53:00	16	6:26:30	8.0	0.144%	0.074%	4/27-5/8; 6/3-7/10; 8/4-8/16	Residential	6,084 Ft	4,207 Ft	4,343 Ft
AU	105 Pinney Street	2:34:00	10	1:17:00	5.0	0.029%	0.015%	6/12-7/1	Residential	5,752 Ft	3,879 Ft	4,007 Ft
AV	105 Pinney Street	5:45:00	17	2:52:30	8.5	0.065%	0.033%	4/22-5/4; 5/31-7/14; 8/9-8/21	Residential	5,756 Ft	3,865 Ft	3,973 Ft
BE	Pinney Street	9:48:00	17	4:54:00	8.5	0.110%	0.056%	2/16-2/26; 2/28-3/5; 3/12-3/21; 9/22-10/2; 10/9-10/13; 10/16-10/25	Residential	6,008 Ft	4,195 Ft	3,794 Ft
BS	7 Bunnell Street Ext	2:50:00	11	1:25:00	5.5	0.032%	0.016%	1/17-1/27; 11/15-11/25	Residential	8,262 Ft	6,675 Ft	6,055 Ft
CA	94 Stillman Hill Road	9:29:00	14	4:44:30	7.0	0.106%	0.054%	11/30-1/13	Residential	7,127 Ft	5,652 Ft	4,961 Ft
DK	599 Greenwoods Road E	13:34:00	19	6:47:00	9.5	0.152%	0.077%	1/3-1/28; 2/13-2/20; 3/6-3/14; 9/30-10/7; 10/22-10/29; 11/4-12/10	Residential	2,756 Ft	4,526 Ft	4,493 Ft

Notes: <sup>(1)</sup> Calculations developed from WindPRO SHADOW module using conservative simplifications and assumptions, including but not limited to: the sun is always shining, the wind is always blowing, the blades are always turning and receptors are perpendicular to the turbines.

<sup>(2)</sup> Calculations based on incorporation of 50% reduction value to account for operational and/or climate-related conditions that limit those times when shadows may be cast.

<sup>(3)</sup> Calculations of potential sun hours per year based on WindPRO Calendar values (4,459 hours annually, worst-case).

<sup>(4)</sup> Calculations of hours per year based on maximum of 8,760 hours per year.

**Table 5  
Receptor Locations**

<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>	<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>	<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>
A	1-15	8 FLAGG HILL ROAD	BF	14-1	49 PINNEY STREET	CL	14-47	147 STILLMAN HILL ROAD
AA	2-3	161 PINNEY STREET	BG	14-36	42 PINNEY STREET	CM	14-37	147A STILLMAN HILL ROAD
AB	2-11	121 MILLBROOK ROAD	BH	14-2-2	39 PINNEY STREET	CN	14-11	144 STILLMAN HILL ROAD
AC	2-10	166 PINNEY STREET	BI	14-2	33 PINNEY STREET	CO	14-10	152 STILLMAN HILL ROAD
AD	2-2	129 MILLBROOK ROAD	BJ	14-3	21 PINNEY STREET	CP	14-38	165 STILLMAN HILL ROAD
AE	2-30	132 MILLBROOK ROAD	BK	14-34	PINNEY STREET	CQ	14-9	158 STILLMAN HILL ROAD
AF	2-31	132 MILLBROOK ROAD	BL	14-4	3 PINNEY STREET	CR	14-8	164 STILLMAN HILL ROAD
AG	2-28	2 WINSTED-NORFOLK ROAD	BM	14-27	46 STILLMAN HILL ROAD	CS	13-25	173 STILLMAN HILL ROAD
AH	002/152/041	124 NORFOLK RD	BN	14-29	65 STILLMAN HILL ROAD	CT	13-27	19 ROCK HALL ROAD
AI	2-8	148 PINNEY STREET	BO	14-29	65 STILLMAN HILL ROAD	CU	13-8	32 ROCK HALL ROAD
AJ	2-7	142 PINNEY STREET	BP	14-30	1 BUNNELL STREET EXT	CV	13-9	28 ROCK HALL ROAD
AK	8-1	117 PINNEY STREET	BQ	14-31-2	68 STILLMAN HILL ROAD	CW	13-10	20 ROCK HALL ROAD
AL	8-1	117 PINNEY STREET	BR	14-31-1	70 STILLMAN HILL ROAD	CX	13-11	16 ROCK HALL ROAD
AM	8-2	121 PINNEY STREET	BS	14-31-3	7 BUNNELL STREET EXT	CY	13-24-1	174 STILLMAN HILL ROAD
AN	2-5	134 PINNEY STREET	BT	14-31-5	21 BUNNELL STREET EXT	CZ	13-24-2	178 STILLMAN HILL ROAD
AO	2-4	128 PINNEY STREET	BU	14-25	81 ROCKWELL ROAD	D	7-13	25 GREENWOODS TURNPIKE
AP	8-20	124 PINNEY STREET	BV	14-31-6	25 BUNNELL STREET EXT	DA	13-26	3 ROCK HALL ROAD
AQ	8-19	122 PINNEY STREET	BW	14-31-7	89 ROCKWELL ROAD	DB	13-23	188 STILLMAN HILL ROAD
AR	8-18	114 PINNEY STREET	BX	14-22	31 BUNNELL STREET	DC	13-14	191 STILLMAN HILL ROAD
AS	8-3	109 PINNEY STREET	BY	14-16-1	92 ROCKWELL ROAD	DD	13-22	190 STILLMAN HILL ROAD
AT	8-17-1	108 PINNEY STREET	BZ	14-32	109 ROCKWELL ROAD	DE	13-15	195 STILLMAN HILL ROAD
AU	8-5	105 PINNEY STREET	C	1-8	120 WINSTED-NORFOLK ROAD	DF	13-16	197 STILLMAN HILL ROAD
AV	8-5	105 PINNEY STREET	CA	14-33	94 STILLMAN HILL ROAD	DG	13-19	215 STILLMAN HILL ROAD
AW	8-17	106A PINNEY STREET	CB	14-19	STILLMAN HILL ROAD	DH	13-21	206 STILLMAN HILL ROAD
AX	8-17-3	106 PINNEY STREET	CC	20-1-4	69 PHELPS ROAD	DI	4-12 4	299 COLEBROOK RD
AY	8-16	102 PINNEY STREET	CD	14-18	118 STILLMAN HILL ROAD	DJ	4-12 4	299 COLEBROOK RD
AZ	8-6	95 PINNEY STREET	CE	14-16-5	96 PHELPS ROAD	DK	4-10 4	599 GREENWOODS RD E
B	1-9	114 WINSTED-NORFOLK ROAD	CF	14-16-5	96 PHELPS ROAD	DL	4-10 6	602 GREENWOODS RD E
BA	8-15	98 PINNEY STREET	CG	14-14	99 PHELPS ROAD	DM	5-10 43	473 GREENWOODS RD E
BB	8-13	94 PINNEY STREET	CH	14-17	124 STILLMAN HILL ROAD	DN	5-10 42	463 GREENWOODS RD E
BC	8-12	86 PINNEY STREET	CI	14-5-1	135 STILLMAN HILL ROAD	DO	5-10 41	453 GREENWOODS RD E
BD	8-11	78 PINNEY STREET	CJ	14-7	143 STILLMAN HILL ROAD	DP	4-10 3	542 GREENWOODS RD E
BE	14-35	PINNEY STREET	CK	14-12	136 STILLMAN HILL ROAD	DR	4-10 1	12 BECKLEY RD



**Table 5  
Receptor Locations**

<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>	<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>	<i>Receptor ID</i>	<i>MBL</i>	<i>Receptor Site Address</i>
DQ	4-10 2	5 BECKLEY RD	S	1-10	110 WINSTED-NORFOLK ROAD			
DS	1-6-1	17 FLAGG HILL ROAD	T	1-15	8 FLAGG HILL ROAD			
DT	1-4	26A FLAGG HILL ROAD	U	2-1	52 WINSTED-NORFOLK ROAD			
DU	1-5	33 FLAGG HILL ROAD	V	2-34	37 WINSTED-NORFOLK ROAD			
DV	1-16	28 FLAGG HILL ROAD	W	2-9	158 PINNEY STREET			
DW	1-17	30 FLAGG HILL ROAD	X	2-9	158 PINNEY STREET			
DX	1-18	36 FLAGG HILL ROAD	Y	2-3	161 PINNEY STREET			
DY	1-19	40 FLAGG HILL ROAD	Z	2-14	87 MILLBROOK ROAD			
DZ	1-20	42 FLAGG HILL ROAD						
E	7-12	WINSTED-NORFOLK ROAD						
EA	1-21	44 FLAGG HILL ROAD						
EB	1-22	48 FLAGG HILL ROAD						
EC	1-1	47 FLAGG HILL ROAD						
ED	1-2	45 FLAGG HILL ROAD						
EE	1-3	43 FLAGG HILL ROAD						
EF	7-12	WINSTED-NORFOLK ROAD						
EG	14-20	106 ROCKWELL ROAD						
EH	8-23	49 MILLBROOK ROAD						
F	7-14	17 GREENWOODS TURNPIKE						
G	7-8	4 GREENWOODS TURNPIKE						
H	7-11	12B GREENWOODS TURNPIKE						
I	7-9	10 GREENWOODS TURNPIKE						
J	7-5	160 WINSTED-NORFOLK ROAD						
K	7-6	154 WINSTED-NORFOLK ROAD						
L	7-7	150 WINSTED-NORFOLK ROAD						
M	7-10	12A GREENWOODS TURNPIKE						
N	7-15	1 GREENWOODS TURNPIKE						
O	7-3	112 ROCK HALL ROAD						
P	7-2	177 WINSTED-NORFOLK ROAD						
Q	13-5	40 ROCK HALL ROAD						
R	13-4	44 ROCK HALL ROAD						

---

# Appendix A

Project:

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Calculated:

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## SHADOW - Main Result

### Calculation: Colebrook North Shadow Flicker Results

...continued from previous page

UTM NAD27Ex Zone: 18

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
DX	654,131	4,647,070	415.8	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
DY	654,110	4,647,026	418.3	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
DZ	654,103	4,646,968	415.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EA	654,088	4,646,930	416.1	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EB	654,061	4,646,849	416.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EC	654,007	4,646,914	423.3	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
ED	653,996	4,647,004	432.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EE	654,048	4,647,007	425.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EF	654,223	4,647,546	388.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EG	655,864	4,649,864	372.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
EH	656,507	4,647,893	363.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

### Calculation Results

Shadow receptor

Shadow, worst case

No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	0:00	0	0:00
B	0:00	0	0:00
C	0:00	0	0:00
D	0:00	0	0:00
E	0:00	0	0:00
F	0:00	0	0:00
G	0:00	0	0:00
H	0:00	0	0:00
I	0:00	0	0:00
J	0:00	0	0:00
K	0:00	0	0:00
L	0:00	0	0:00
M	0:00	0	0:00
N	0:00	0	0:00
O	82:03	95	1:08
P	61:56	114	0:47
Q	0:00	0	0:00
R	0:00	0	0:00
S	0:00	0	0:00
T	0:00	0	0:00
U	0:00	0	0:00
V	0:00	0	0:00
W	0:00	0	0:00
X	0:00	0	0:00
Y	0:00	0	0:00
Z	0:00	0	0:00
AA	0:00	0	0:00
AB	0:00	0	0:00
AC	0:00	0	0:00
AD	0:00	0	0:00
AE	0:00	0	0:00
AF	0:00	0	0:00
AG	0:00	0	0:00
AH	0:00	0	0:00
AI	0:00	0	0:00

To be continued on next page...

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**SHADOW - Main Result****Calculation: Colebrook North Shadow Flicker Results**

...continued from previous page

**Shadow, worst case**

No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
AJ	0:00	0	0:00
AK	0:00	0	0:00
AL	17:06	72	0:19
AM	0:00	0	0:00
AN	0:00	0	0:00
AO	0:00	0	0:00
AP	0:00	0	0:00
AQ	0:00	0	0:00
AR	5:55	40	0:15
AS	0:00	0	0:00
AT	12:53	63	0:16
AU	2:34	20	0:10
AV	5:45	26	0:17
AW	0:00	0	0:00
AX	0:00	0	0:00
AY	0:00	0	0:00
AZ	0:00	0	0:00
BA	0:00	0	0:00
BB	0:00	0	0:00
BC	0:00	0	0:00
BD	0:00	0	0:00
BE	9:48	53	0:17
BF	0:00	0	0:00
BG	0:00	0	0:00
BH	0:00	0	0:00
BI	0:00	0	0:00
BJ	0:00	0	0:00
BK	0:00	0	0:00
BL	0:00	0	0:00
BM	0:00	0	0:00
BN	0:00	0	0:00
BO	0:00	0	0:00
BP	0:00	0	0:00
BQ	0:00	0	0:00
BR	0:00	0	0:00
BS	2:50	22	0:11
BT	0:00	0	0:00
BU	0:00	0	0:00
BV	0:00	0	0:00
BW	0:00	0	0:00
BX	0:00	0	0:00
BY	0:00	0	0:00
BZ	0:00	0	0:00
CA	9:29	46	0:14
CB	0:00	0	0:00
CC	0:00	0	0:00
CD	0:00	0	0:00
CE	0:00	0	0:00
CF	0:00	0	0:00
CG	0:00	0	0:00
CH	0:00	0	0:00
CI	0:00	0	0:00
CJ	0:00	0	0:00
CK	0:00	0	0:00

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**SHADOW - Main Result****Calculation:** Colebrook North Shadow Flicker Results

...continued from previous page

**Shadow, worst case**

No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
CL	0:00	0	0:00
CM	0:00	0	0:00
CN	0:00	0	0:00
CO	0:00	0	0:00
CP	0:00	0	0:00
CQ	0:00	0	0:00
CR	0:00	0	0:00
CS	0:00	0	0:00
CT	0:00	0	0:00
CU	0:00	0	0:00
CV	0:00	0	0:00
CW	0:00	0	0:00
CX	0:00	0	0:00
CY	0:00	0	0:00
CZ	0:00	0	0:00
DA	0:00	0	0:00
DB	0:00	0	0:00
DC	0:00	0	0:00
DD	0:00	0	0:00
DE	0:00	0	0:00
DF	0:00	0	0:00
DG	0:00	0	0:00
DH	0:00	0	0:00
DI	0:00	0	0:00
DJ	0:00	0	0:00
DK	13:34	86	0:19
DL	0:00	0	0:00
DM	0:00	0	0:00
DN	0:00	0	0:00
DO	0:00	0	0:00
DP	0:00	0	0:00
DQ	0:00	0	0:00
DR	0:00	0	0:00
DS	0:00	0	0:00
DT	0:00	0	0:00
DU	0:00	0	0:00
DV	0:00	0	0:00
DW	0:00	0	0:00
DX	0:00	0	0:00
DY	0:00	0	0:00
DZ	0:00	0	0:00
EA	0:00	0	0:00
EB	0:00	0	0:00
EC	0:00	0	0:00
ED	0:00	0	0:00
EE	0:00	0	0:00
EF	0:00	0	0:00
EG	0:00	0	0:00
EH	0:00	0	0:00

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## SHADOW - Main Result

### Calculation: Colebrook North Shadow Flicker Results

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	GE WIND ENERGY GE 1.5 xle 1500 82.5 !O! hub: 100.0 m (1)	35:50	
2	GE WIND ENERGY GE 1.5 xle 1500 82.5 !O! hub: 100.0 m (2)	43:01	
3	GE WIND ENERGY GE 1.5 xle 1500 82.5 !O! hub: 100.0 m (3)	147:00	

---

# Appendix B

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Calculated:

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### SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: O - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (16)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	January	February	March	April	May	June			
1	07:21 16:32	07:07	08:03 (3)	06:29	07:46 (3)	06:37	05:50	05:20	
2	07:21 16:33	17:07	08:35 (3)	17:42	64	08:50 (3)	19:18	19:51	20:21
3	07:21 16:34	17:08	08:01 (3)	06:28	63	07:46 (3)	06:35	05:49	05:20
4	07:21 16:35	17:05	08:37 (3)	17:44	63	08:49 (3)	19:19	19:52	20:22
5	07:21 16:36	17:05	08:00 (3)	06:26	61	07:47 (3)	06:34	05:48	05:20
6	07:21 16:37	17:10	08:39 (3)	17:45	61	08:48 (3)	19:20	19:53	20:22
7	07:21 16:38	17:04	07:58 (3)	06:25	60	07:47 (3)	06:32	05:46	05:19
8	07:21 16:39	17:11	08:41 (3)	17:46	60	08:47 (3)	19:21	19:54	20:23
9	07:21 16:40	17:02	07:57 (3)	06:23	58	07:48 (3)	06:30	05:45	05:19
10	07:21 16:41	17:12	08:43 (3)	17:47	58	08:46 (3)	19:22	19:55	20:24
11	07:21 16:42	17:01	07:56 (3)	06:21	57	07:48 (3)	06:29	05:44	05:18
12	07:21 16:43	17:14	08:44 (3)	17:48	57	08:45 (3)	19:23	19:57	20:25
13	07:21 16:44	17:00	07:55 (3)	06:20	55	07:48 (3)	06:27	05:42	05:18
14	07:21 16:45	17:15	08:46 (3)	17:50	55	08:43 (3)	19:25	19:58	20:25
15	07:21 16:46	17:02	07:53 (3)	06:18	52	08:50 (3)	06:25	05:41	05:18
16	07:21 16:47	17:16	08:46 (3)	18:51	52	09:42 (3)	19:26	19:59	20:26
17	07:21 16:48	17:08	07:53 (3)	07:16	50	08:50 (3)	06:24	05:40	05:18
18	07:21 16:49	17:18	08:48 (3)	18:52	50	09:40 (3)	19:27	20:00	20:26
19	07:21 16:50	17:07	07:52 (3)	07:15	47	08:51 (3)	06:22	05:39	05:17
20	07:21 16:51	17:19	08:49 (3)	18:53	47	09:38 (3)	19:28	20:00	20:27
21	07:21 16:52	17:05	07:50 (3)	07:13	44	08:52 (3)	06:20	05:38	05:17
22	07:21 16:53	17:20	08:49 (3)	18:54	44	09:36 (3)	19:29	20:01	20:28
23	07:21 16:54	17:08	07:50 (3)	07:11	40	08:54 (3)	06:19	05:37	05:17
24	07:21 16:55	17:21	08:50 (3)	18:55	40	09:34 (3)	19:30	20:02	20:28
25	07:21 16:56	17:05	07:50 (3)	07:10	35	08:56 (3)	06:17	05:36	05:17
26	07:21 16:57	17:23	08:51 (3)	18:57	35	09:31 (3)	19:31	20:03	20:29
27	07:21 16:58	17:08	07:48 (3)	07:08	31	08:57 (3)	06:16	05:34	05:17
28	07:21 16:59	17:24	08:51 (3)	18:58	31	09:28 (3)	19:32	20:04	20:29
29	07:21 17:00	17:05	07:48 (3)	07:06	24	09:01 (3)	06:14	05:33	05:17
30	07:21 17:01	17:25	08:52 (3)	18:59	24	09:25 (3)	19:33	20:05	20:30
31	07:21 17:02	17:09	07:48 (3)	07:05	14	09:05 (3)	06:12	05:32	05:17
Potential sun hours	295	296	370	400	451	455			
Total, worst case	59	1631	755						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)



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 Calculated:  
 2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

**Calculation:** Colebrook North Shadow Flicker Results **Shadow receptor:** O - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (16)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	July	August	September	October	November	December
1	05:21 20:33	05:46 20:14	06:18 19:28	06:49 18:36	08:34 (3) 09:12 (3)	06:25 16:48
2	05:21 20:32	05:47 20:12	06:19 19:26	06:50 18:34	08:31 (3) 09:13 (3)	06:26 16:47
3	05:22 20:32	05:48 20:11	06:20 19:25	06:51 18:33	08:29 (3) 09:15 (3)	06:27 16:46
4	05:23 20:32	05:49 20:10	06:21 19:23	06:52 18:31	08:29 (3) 09:17 (3)	06:29 16:44
5	05:23 20:32	05:50 20:09	06:22 19:21	06:54 18:29	08:27 (3) 09:18 (3)	06:30 16:43
6	05:24 20:32	05:51 20:08	06:23 19:20	06:55 18:28	08:25 (3) 09:19 (3)	06:31 16:42
7	05:24 20:31	05:52 20:07	06:24 19:18	06:56 18:26	08:24 (3) 09:20 (3)	06:32 16:41
8	05:25 20:31	05:53 20:05	06:25 19:16	06:57 18:24	08:23 (3) 09:21 (3)	06:33 16:40
9	05:26 20:31	05:54 20:04	06:26 19:14	06:58 18:22	08:22 (3) 09:21 (3)	06:35 16:39
10	05:26 20:30	05:55 20:03	06:27 19:13	06:59 18:21	08:21 (3) 09:22 (3)	06:36 16:38
11	05:27 20:30	05:56 20:01	06:28 19:11	07:00 18:19	08:20 (3) 09:22 (3)	06:37 16:37
12	05:28 20:30	05:57 20:00	06:29 19:09	07:01 18:18	08:20 (3) 09:23 (3)	06:38 16:36
13	05:29 20:29	05:58 19:57	06:30 19:07	07:02 18:16	08:19 (3) 09:24 (3)	06:40 16:35
14	05:29 20:29	05:59 19:56	06:31 19:06	07:04 18:14	08:18 (3) 09:24 (3)	06:41 16:34
15	05:30 20:28	06:00 19:54	06:32 19:04	07:05 18:13	08:18 (3) 09:24 (3)	06:42 16:33
16	05:31 20:27	06:01 19:53	06:33 19:02	07:06 18:11	08:17 (3) 09:24 (3)	06:43 16:32
17	05:32 20:27	06:02 19:52	06:34 19:00	07:07 18:10	08:18 (3) 09:25 (3)	06:45 16:31
18	05:33 20:26	06:03 19:50	06:35 18:59	07:08 18:08	08:17 (3) 09:24 (3)	06:46 16:30
19	05:34 20:25	06:04 19:49	06:37 18:57	07:09 18:06	08:17 (3) 09:24 (3)	06:47 16:29
20	05:34 20:25	06:05 19:47	06:38 18:55	07:10 18:05	08:16 (3) 09:24 (3)	06:48 16:29
21	05:35 20:24	06:06 19:46	06:39 18:53	07:12 18:03	08:16 (3) 09:23 (3)	06:49 16:28
22	05:36 20:23	06:07 19:44	06:40 18:52	07:13 18:02	08:17 (3) 09:24 (3)	06:51 16:27
23	05:37 20:22	06:08 19:42	06:41 18:50	07:14 18:00	08:17 (3) 09:23 (3)	06:52 16:27
24	05:38 20:21	06:10 19:41	06:42 18:48	07:15 17:59	08:17 (3) 09:23 (3)	06:53 16:26
25	05:39 20:21	06:11 19:39	06:43 18:46	07:16 17:58	08:17 (3) 09:22 (3)	06:54 16:25
26	05:40 20:20	06:12 19:38	06:44 18:45	07:18 17:56	08:18 (3) 09:22 (3)	06:55 16:25
27	05:41 20:19	06:13 19:36	06:45 18:43	07:19 17:55	08:18 (3) 09:22 (3)	06:56 16:24
28	05:42 20:18	06:14 19:35	06:46 18:41	07:20 18:43 (3)	08:18 (3) 09:04 (3)	06:57 16:24
29	05:43 20:17	06:15 19:33	06:47 18:39	07:21 18:41	08:20 (3) 09:07 (3)	06:59 16:24
30	05:44 20:16	06:16 19:31	06:48 18:38	07:22 18:39	08:20 (3) 09:10 (3)	07:00 16:23
31	05:45 20:15	06:17 19:30		07:24 17:49	08:20 (3) 09:19 (3)	07:21 16:31
Potential sun hours	462	430	375	344	295	285
Total, worst case			90	1873	515	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Colebrook\_CT\_North

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2/18/2011 2:05 PM / 17

Licensed user:

Vanasse Hangen Brustlin, Inc.

1001 Walnut Street

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Nicole Dentamaro, ndentamaro@vhb.com

Calculated:

2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: P - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (17)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	January	February	March	April	May	June		
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21		05:55 (3) 06:39 (3)
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	05:20 20:22	44	05:56 (3) 06:40 (3)
3	07:21 16:34	07:05 17:10	06:26 17:45	06:34 19:20	05:48 19:53	05:20 20:22	44	05:56 (3) 06:41 (3)
4	07:21 16:35	07:04 17:11	06:25 17:46	06:32 19:21	05:46 19:54	05:19 20:23	45	05:55 (3) 06:40 (3)
5	07:21 16:36	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24	45	05:56 (3) 06:41 (3)
6	07:21 16:37	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:57	05:18 20:25	45	05:56 (3) 06:42 (3)
7	07:21 16:38	07:00 17:15	06:20 17:50	06:27 19:25	05:42 19:58	05:18 20:25	46	05:56 (3) 06:41 (3)
8	07:21 16:39	06:59 17:16	07:18 18:51	06:25 19:26	05:41 19:59	05:18 20:26	45	05:56 (3) 06:42 (3)
9	07:21 16:40	06:58 17:18	07:16 18:52	06:24 19:27	05:40 20:00	05:18 20:26	46	05:56 (3) 06:42 (3)
10	07:21 16:41	06:57 17:19	07:15 18:53	06:22 19:28	06:44 (2) 06:51 (2)	05:39 20:00	2	06:06 (1) 06:08 (1)
11	07:20 16:42	06:55 17:20	07:13 18:54	06:20 19:29	06:41 (2) 06:54 (2)	05:38 20:01	8	06:03 (1) 06:11 (1)
12	07:20 16:43	06:54 17:21	07:11 18:55	06:19 19:30	06:39 (2) 06:54 (2)	05:37 20:02	12	06:01 (1) 06:13 (1)
13	07:20 16:44	06:53 17:23	07:10 18:57	06:17 19:31	06:38 (2) 06:55 (2)	05:36 20:03	14	06:00 (1) 06:14 (1)
14	07:19 16:45	06:51 17:24	07:08 18:58	06:16 19:32	06:37 (2) 06:56 (2)	05:35 20:04	16	05:59 (1) 06:23 (3)
15	07:19 16:46	06:50 17:25	07:06 18:59	06:14 19:33	06:36 (2) 06:55 (2)	05:33 20:05	24	05:58 (1) 06:26 (3)
16	07:19 16:47	06:49 17:26	07:05 19:00	06:12 19:35	06:36 (2) 06:56 (2)	05:32 20:06	28	05:58 (1) 06:28 (3)
17	07:18 16:48	06:47 17:28	07:03 19:01	06:11 19:36	06:36 (2) 06:55 (2)	05:31 20:07	30	05:58 (1) 06:29 (3)
18	07:18 16:50	06:46 17:29	07:01 19:02	06:09 19:37	06:36 (2) 06:55 (2)	05:31 20:08	31	05:59 (1) 06:31 (3)
19	07:17 16:51	06:44 17:30	07:00 19:03	06:08 19:38	06:36 (2) 06:54 (2)	05:30 20:09	32	05:59 (1) 06:32 (3)
20	07:16 16:52	06:43 17:31	06:58 19:05	06:06 19:39	06:37 (2) 06:53 (2)	05:29 20:10	33	05:59 (1) 06:33 (3)
21	07:16 16:53	06:42 17:33	06:56 19:06	06:05 19:40	06:38 (2) 06:51 (2)	05:28 20:11	34	05:59 (1) 06:34 (3)
22	07:15 16:55	06:40 17:34	06:54 19:07	06:03 19:41	06:40 (2) 06:50 (2)	05:27 20:12	35	05:59 (1) 06:34 (3)
23	07:14 16:56	06:39 17:35	06:53 19:08	06:02 19:42	06:50 (2) 06:56 (2)	05:26 20:13	37	05:59 (3) 06:36 (3)
24	07:14 16:57	06:37 17:36	06:51 19:09	06:00 19:43	06:56 (2) 06:56 (2)	05:25 20:14	38	05:58 (3) 06:36 (3)
25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	06:56 (2) 06:56 (2)	05:25 20:15	39	05:57 (3) 06:36 (3)
26	07:12 17:00	06:34 17:39	06:47 19:11	05:57 19:46	06:56 (2) 06:56 (2)	05:24 20:16	41	05:57 (3) 06:38 (3)
27	07:11 17:01	06:33 17:40	06:46 19:12	05:56 19:47	06:56 (2) 06:56 (2)	05:23 20:17	41	05:57 (3) 06:38 (3)
28	07:10 17:02	06:31 17:41	06:44 19:13	05:54 19:48	06:56 (2) 06:56 (2)	05:23 20:17	42	05:56 (3) 06:38 (3)
29	07:10 17:03	06:31 17:41	06:44 19:13	05:54 19:48	06:56 (2) 06:56 (2)	05:23 20:17	42	05:56 (3) 06:38 (3)
30	07:09 17:05	06:30 17:42	06:43 19:14	05:53 19:49	06:56 (2) 06:56 (2)	05:22 20:18	43	05:56 (3) 06:39 (3)
31	07:08 17:06	06:29 17:43	06:42 19:15	05:52 19:50	06:56 (2) 06:56 (2)	05:22 20:19	43	05:56 (3) 06:39 (3)
Potential sun hours	295	296	370	400	451	455		1374
Total, worst case				205	702	1374		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

Project:

Colebrook\_CT\_North

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Licensed user:

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 Nicole Dentamaro, ndentamaro@vhb.com  
 Calculated:  
 2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

**Calculation:** Colebrook North Shadow Flicker Results **Shadow receptor:** P - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (17)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	July	August	September	October	November	December
1	05:21 20:33	06:01 (3) 06:47 (3)	05:46 20:14	06:11 (1) 06:24 (1)	06:18 19:28	06:40 (2) 18:36
2	05:21 20:32	06:01 (3) 06:47 (3)	05:47 20:12	06:12 (1) 06:23 (1)	06:19 19:26	06:43 (2) 18:34
3	05:22 20:32	06:01 (3) 06:47 (3)	05:48 20:11	06:14 (1) 06:21 (1)	06:20 19:25	06:50 (2) 18:33
4	05:23 20:32	06:01 (3) 06:47 (3)	05:49 20:10	06:21 19:23	06:21 18:31	06:52 16:44
5	05:23 20:32	06:02 (3) 06:47 (3)	05:50 20:09	06:22 19:21	06:22 18:29	06:54 16:43
6	05:24 20:32	06:02 (3) 06:48 (3)	05:51 20:08	06:23 19:20	06:23 18:28	06:55 16:42
7	05:24 20:31	06:02 (3) 06:47 (3)	05:52 20:07	06:24 19:18	06:24 18:26	06:56 16:41
8	05:25 20:31	06:03 (3) 06:48 (3)	05:53 20:05	06:25 19:16	06:25 18:24	06:57 16:40
9	05:26 20:31	06:03 (3) 06:48 (3)	05:54 20:04	06:26 19:14	06:26 18:22	06:58 16:39
10	05:26 20:30	06:03 (3) 06:47 (3)	05:55 20:03	06:27 19:13	06:27 18:21	06:59 16:38
11	05:27 20:30	06:04 (3) 06:48 (3)	05:56 20:01	06:28 19:11	06:28 18:19	06:37 16:37
12	05:28 20:30	06:04 (3) 06:48 (3)	05:57 20:00	06:29 19:09	06:29 18:18	06:38 16:36
13	05:29 20:29	06:04 (3) 06:47 (3)	05:58 19:57	06:30 19:07	06:30 18:16	06:40 16:35
14	05:29 20:29	06:05 (3) 06:47 (3)	05:59 19:56	06:31 19:06	06:31 18:14	06:41 16:34
15	05:30 20:28	06:05 (3) 06:47 (3)	06:00 19:54	06:32 19:04	06:32 18:13	06:42 16:33
16	05:31 20:27	06:06 (3) 06:47 (3)	06:01 19:53	06:33 19:02	06:33 18:11	06:43 16:32
17	05:32 20:27	06:07 (3) 06:47 (3)	06:02 19:52	06:34 19:00	06:34 18:10	06:45 16:31
18	05:33 20:26	06:07 (3) 06:46 (3)	06:03 19:50	06:35 18:59	06:35 18:08	06:46 16:30
19	05:34 20:25	06:07 (3) 06:46 (3)	06:04 19:49	06:37 18:57	06:37 18:06	06:47 16:29
20	05:34 20:25	06:08 (3) 06:46 (3)	06:05 19:47	06:38 18:55	06:38 18:05	06:48 16:29
21	05:35 20:24	06:09 (3) 06:45 (3)	06:06 19:46	06:39 18:53	06:39 18:03	06:49 16:28
22	05:36 20:23	06:10 (1) 06:45 (3)	06:07 19:44	06:40 18:52	06:40 18:02	06:51 16:27
23	05:37 20:22	06:09 (1) 06:44 (3)	06:08 19:42	06:41 (2) 18:50	06:41 18:00	06:52 16:27
24	05:38 20:21	06:09 (1) 06:43 (3)	06:10 19:41	06:42 (2) 18:48	06:42 17:59	06:53 16:26
25	05:39 20:21	06:08 (1) 06:41 (3)	06:11 19:39	06:39 (2) 18:46	06:39 17:58	06:54 16:26
26	05:40 20:20	06:08 (1) 06:40 (3)	06:12 19:38	06:39 (2) 18:44	06:39 17:56	06:55 16:25
27	05:41 20:19	06:09 (1) 06:39 (3)	06:13 19:36	06:38 (2) 18:43	06:38 17:55	06:56 16:24
28	05:42 20:18	06:09 (1) 06:37 (3)	06:14 19:35	06:38 (2) 18:41	06:38 17:53	06:57 16:24
29	05:43 20:17	06:09 (1) 06:35 (3)	06:15 19:33	06:38 (2) 18:39	06:38 17:52	06:59 16:24
30	05:44 20:16	06:10 (1) 06:32 (3)	06:16 19:31	06:39 (2) 18:38	06:39 17:51	07:00 16:23
31	05:45 20:15	06:10 (1) 06:25 (1)	06:17 19:30	06:39 (2) 18:38	06:39 17:49	07:21 16:31
Potential sun hours	462	430	375	344	295	285
Total, worst case	1193	222	20			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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Calculated:

2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: AL - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (39)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December				
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	19:21 (3) 19:27 (3)	05:20 20:21	19:34 (2) 20:32	05:21 20:32	19:40 (2) 20:13	05:46 20:13	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23	
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	19:22 (3) 19:29 (3)	05:20 20:21	19:35 (2) 20:32	05:21 20:32	19:40 (2) 20:12	05:47 20:12	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:23	
3	07:21 16:34	07:04 17:10	06:26 17:45	06:34 19:20	05:47 19:53	19:21 (3) 19:29 (3)	05:19 20:22	19:35 (2) 20:32	05:22 20:32	19:40 (2) 20:11	05:48 20:11	06:20 19:24	06:51 18:33	06:27 16:46	07:03 16:22	
4	07:21 16:35	07:03 17:11	06:25 17:46	06:32 19:21	05:46 19:54	19:22 (3) 19:30 (3)	05:19 20:23	19:34 (2) 20:32	05:22 20:32	19:40 (2) 20:10	05:49 20:10	06:21 19:23	06:52 18:31	06:28 16:44	07:04 16:22	
5	07:21 16:36	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	19:23 (3) 19:31 (3)	05:19 20:24	19:35 (2) 20:32	05:23 20:32	19:41 (2) 20:09	05:50 20:09	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22	
6	07:21 16:36	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:56	19:24 (3) 19:30 (3)	05:18 20:24	19:35 (2) 20:32	05:24 20:32	19:41 (2) 20:08	05:51 20:08	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22	
7	07:21 16:37	07:00 17:15	06:20 17:50	06:27 19:24	05:42 19:58	19:30 (3) 20:25	05:18 20:25	19:34 (2) 20:31	05:24 20:31	19:41 (2) 20:06	05:52 20:06	7 19:33 (3) 19:40 (3)	06:24 19:18	06:56 18:26	06:32 16:41	07:07 16:22
8	07:21 16:38	06:59 17:16	07:18 18:51	06:25 19:26	05:41 19:59	07:18 20:26	05:18 20:26	19:35 (2) 20:31	05:25 20:31	19:42 (2) 20:05	05:53 20:05	9 19:41 (3) 19:48 (3)	06:25 19:16	06:57 18:24	06:33 16:40	07:08 16:22
9	07:21 16:39	06:58 17:17	07:16 18:52	06:24 19:27	05:40 20:00	07:17 20:26	05:17 20:26	19:35 (2) 20:31	05:26 20:31	19:42 (2) 20:04	05:54 20:04	9 19:41 (3) 19:48 (3)	06:26 19:14	06:58 18:22	06:35 16:39	07:09 16:22
10	07:21 16:41	06:56 17:19	07:15 18:53	06:22 19:28	05:39 20:00	07:15 20:27	05:17 20:27	19:36 (2) 20:30	05:26 20:30	19:42 (2) 20:03	05:55 20:03	9 19:40 (3) 19:47 (3)	06:27 19:13	06:36 18:21	07:09 16:38	07:09 16:22
11	07:20 16:42	06:55 17:20	07:13 18:54	06:20 19:29	05:38 20:01	07:14 20:28	05:17 20:28	19:36 (2) 20:30	05:27 20:30	19:43 (2) 20:01	05:56 20:01	8 19:38 (3) 19:45 (3)	06:28 19:11	06:37 18:19	07:10 16:36	07:10 16:22
12	07:20 16:43	06:54 17:21	07:11 18:55	06:19 19:30	05:37 20:02	07:11 20:28	05:17 20:28	19:37 (2) 20:29	05:28 20:29	19:43 (2) 20:00	05:57 20:00	7 19:37 (3) 19:44 (3)	06:19 19:09	07:01 18:17	06:38 16:35	07:11 16:22
13	07:20 16:44	06:53 17:23	07:10 18:56	06:17 19:31	05:35 20:03	07:10 20:29	05:17 20:29	19:38 (2) 20:29	05:29 20:29	19:43 (2) 19:57	05:58 19:57	6 19:36 (3) 19:43 (3)	06:30 19:07	06:40 18:16	07:12 16:35	07:12 16:22
14	07:19 16:45	06:51 17:24	07:08 18:58	06:15 19:32	05:34 20:04	07:08 20:29	05:17 20:29	19:39 (2) 20:28	05:29 20:28	19:44 (2) 19:56	05:59 19:56	5 19:35 (3) 19:42 (3)	06:31 19:06	06:41 18:14	07:13 16:34	07:13 16:22
15	07:19 16:46	06:50 17:25	07:06 18:59	06:14 19:33	05:33 20:05	07:06 20:30	05:17 20:30	19:40 (2) 20:28	05:30 20:28	19:45 (2) 19:54	06:00 19:54	2 19:33 (3) 19:40 (3)	06:32 19:04	07:05 18:13	06:42 16:33	07:13 16:22
16	07:18 16:47	06:49 17:26	07:05 19:00	06:12 19:34	05:32 20:06	07:05 20:30	05:17 20:30	19:41 (2) 20:27	05:31 20:27	19:46 (2) 19:53	06:01 19:53	19:04 19:02	18:13 18:11	16:33 16:32	07:14 16:23	
17	07:18 16:48	06:47 17:28	07:03 19:01	06:11 19:36	05:31 20:07	07:03 20:30	05:17 20:30	19:42 (2) 20:27	05:32 20:27	19:46 (2) 19:51	06:02 19:51	06:34 19:00	07:07 18:09	06:44 16:31	07:15 16:23	
18	07:17 16:50	06:46 17:29	07:01 19:02	06:09 19:37	05:30 20:08	07:01 20:31	05:17 20:31	19:43 (2) 20:26	05:33 20:26	19:48 (2) 19:50	06:03 19:50	06:35 18:59	07:08 18:08	06:46 16:30	07:15 16:23	
19	07:17 16:51	06:44 17:30	06:59 19:03	06:08 19:38	05:30 20:09	07:01 20:31	05:17 20:31	19:44 (2) 20:25	05:33 20:25	19:51 (2) 19:49	06:04 19:49	06:36 18:57	07:09 18:06	06:47 16:29	07:16 16:24	
20	07:16 16:52	06:43 17:31	06:58 19:04	06:06 19:39	05:29 20:10	06:58 20:31	05:17 20:31	19:45 (2) 20:25	05:34 20:25	19:52 (2) 19:47	06:05 19:47	06:37 18:55	07:10 18:05	06:48 16:29	07:17 16:24	
21	07:16 16:53	06:42 17:33	06:56 19:06	06:04 19:40	05:28 20:11	06:56 20:32	05:17 20:32	19:46 (2) 20:24	05:35 20:24	19:53 (2) 19:45	06:06 19:45	06:39 18:53	07:12 18:03	06:49 16:28	07:17 16:24	
22	07:15 16:54	06:40 17:34	06:54 19:07	06:03 19:41	05:27 20:12	06:54 20:32	05:18 20:32	19:47 (2) 20:23	05:36 20:23	19:54 (2) 19:44	06:07 19:44	06:40 18:52	07:13 18:02	06:50 16:27	07:18 16:25	
23	07:14 16:56	06:39 17:35	06:53 19:08	06:01 19:42	05:26 20:13	06:53 20:32	05:18 20:32	19:48 (2) 20:22	05:37 20:22	19:51 (2) 19:42	06:08 19:42	06:41 18:50	07:14 18:00	06:52 16:27	07:18 16:25	
24	07:14 16:57	06:37 17:36	06:51 19:09	06:00 19:43	05:25 20:14	06:37 20:32	05:18 20:32	19:49 (2) 20:21	05:38 20:21	19:52 (2) 19:41	06:09 19:41	06:42 18:48	07:15 17:59	06:53 16:26	07:19 16:26	
25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	05:25 20:15	06:36 20:32	05:18 20:32	19:38 (2) 20:20	05:39 20:20	19:53 (2) 19:39	06:10 19:39	06:43 18:46	07:16 17:58	06:54 16:25	07:19 16:27	
26	07:12 16:59	06:34 17:39	06:47 19:11	05:57 19:45	05:24 20:16	06:34 20:32	05:19 20:32	19:39 (2) 20:20	05:40 20:20	19:54 (2) 19:38	06:12 19:38	06:44 18:45	07:17 17:56	06:55 16:25	07:20 16:27	
27	07:11 17:01	06:32 17:40	06:46 19:12	05:56 19:47	05:23 20:16	06:32 20:33	05:19 20:33	19:39 (2) 20:19	05:41 20:19	19:55 (2) 19:36	06:13 19:36	06:45 18:43	07:19 17:55	06:56 16:24	07:20 16:28	
28	07:10 17:02	06:30 17:41	06:44 19:13	05:54 19:48	05:23 20:17	06:32 20:33	05:20 20:33	19:39 (2) 20:18	05:42 20:18	19:57 (2) 19:34	06:14 19:34	06:46 18:41	07:20 17:53	06:57 16:24	07:20 16:29	
29	07:09 17:03	06:29 17:40	06:42 19:14	05:53 19:49	19:23 (3) 20:18	05:22 20:33	19:23 (3) 20:33	19:40 (2) 20:17	05:43 20:17	19:58 (2) 19:33	06:15 19:33	06:47 18:39	07:21 17:52	06:58 16:24	07:20 16:29	
30	07:09 17:05	06:29 17:41	06:41 19:15	05:51 19:50	19:22 (3) 20:19	05:21 20:33	19:22 (3) 20:33	19:39 (2) 20:16	05:44 20:16	19:59 (2) 19:31	06:16 19:31	06:48 18:38	07:22 17:51	07:00 16:23	07:21 16:30	
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Potential sun hours	295	296	370	400	451	451	455	462	430	430	375	344	295	285	285	
Total, worst case				7	127		549	290		53						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:  
Colebrook\_CT\_North

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2/18/2011 2:05 PM / 46

Licensed user:  
**Vanasse Hangen Brustlin, Inc.**  
1001 Walnut Street  
US-WATERTOWN, MA 02472  
+1 (617) 924 1770  
Nicole Dentamaro, ndentamaro@vhb.com  
Calculated:  
2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: AR - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (45)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
The sun is shining all the day, from sunrise to sunset  
The rotor plane is always perpendicular to the line from the WTG to the sun  
The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21	05:21 20:32	05:46 20:13	14 19:35 (2) 19:49 (2)	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	05:20 20:21	05:21 20:32	05:47 20:12	12 19:36 (2) 19:48 (2)	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:23
3	07:21 16:34	07:04 17:10	06:26 17:45	06:34 19:20	05:47 19:53	05:19 20:22	05:22 20:32	05:48 20:11	11 19:37 (2) 19:47 (2)	06:20 19:24	06:51 18:32	06:27 16:45	07:03 16:22
4	07:21 16:35	07:03 17:11	06:24 17:46	06:32 19:21	05:46 19:54	05:19 20:23	05:22 20:32	05:49 20:10	8 19:38 (2) 19:45 (2)	06:21 19:23	06:52 18:31	06:28 16:44	07:04 16:22
5	07:21 16:35	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24	05:23 20:32	05:50 20:09	6 19:38 (2) 19:44 (2)	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22
6	07:21 16:36	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:56	05:18 20:24	05:24 20:32	05:51 20:08	3 19:40 (2) 19:43 (2)	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22
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9	07:21 16:39	06:58 17:17	07:16 18:52	06:24 19:27	05:40 20:00	19:24 (2) 19:35 (2)	05:18 20:26	05:26 20:31	9 19:34 (2) 19:25 (2)	06:26 19:14	06:58 18:22	06:35 16:39	07:09 16:22
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15	07:19 16:46	06:50 17:25	07:06 18:59	06:14 19:33	05:33 20:05	19:25 (2) 19:39 (2)	05:17 20:30	05:30 20:28	14 19:39 (2) 19:25 (2)	06:32 19:04	07:05 18:13	06:42 16:33	07:13 16:22
16	07:18 16:47	06:49 17:26	07:05 19:00	06:12 19:34	05:32 20:06	19:25 (2) 19:39 (2)	05:17 20:30	05:31 20:27	4 19:32 (2) 19:26 (2)	06:33 19:02	07:06 18:11	06:43 16:32	07:14 16:23
17	07:18 16:48	06:47 17:28	07:03 19:01	06:11 19:36	05:31 20:07	19:25 (2) 19:38 (2)	05:17 20:30	05:32 20:27	3 19:32 (2) 19:26 (2)	06:34 19:00	07:07 18:09	06:44 16:31	07:15 16:23
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23	07:14 16:56	06:39 17:35	06:53 19:08	06:01 19:42	05:26 20:13	19:28 (2) 20:32	05:17 20:22	05:36 20:23	8 19:46 (2) 19:38 (2)	06:40 18:48	07:14 17:59	06:51 16:26	07:19 16:26
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25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	05:25 20:15	19:18 (3) 19:21 (3)	05:17 20:20	05:36 20:20	8 19:46 (2) 19:37 (2)	06:42 18:46	07:16 17:57	06:53 16:25	07:19 16:27
26	07:12 16:59	06:34 17:39	06:47 19:11	05:57 19:45	05:24 20:16	19:19 (3) 19:23 (3)	05:17 20:20	05:36 20:20	11 19:48 (2) 19:36 (2)	06:43 18:45	07:17 17:56	06:54 16:25	07:19 16:27
27	07:11 17:01	06:32 17:40	06:46 19:12	05:56 19:47	05:23 20:16	19:19 (3) 19:23 (3)	05:17 20:20	05:36 20:19	12 19:48 (2) 19:36 (2)	06:44 18:43	07:17 17:55	06:55 16:24	07:20 16:28
28	07:10 17:02	06:31 17:41	06:44 19:13	05:54 19:48	05:23 20:17	19:21 (3) 19:24 (3)	05:17 20:20	05:35 20:18	13 19:49 (2) 19:35 (2)	06:45 18:41	07:18 17:53	06:56 16:24	07:20 16:29
29	07:09 17:03	06:30 17:42	06:42 19:14	05:53 19:49	05:22 20:18	19:22 (3) 19:26 (3)	05:17 20:21	05:36 20:17	15 19:50 (2) 19:35 (2)	06:46 18:39	07:19 17:52	06:57 16:24	07:20 16:29
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31	07:08 17:06	06:29 17:44	06:41 19:17	05:51 20:20	05:21 20:20	19:28 (3) 19:32 (3)	05:17 20:23	05:36 20:15	15 19:50 (2) 19:35 (2)	06:48 18:37	07:21 17:49	06:59 16:31	07:21 16:31
Potential sun hours	295	296	370	400	451	455	462	430	69	375	344	296	285
Total, worst case				16	160		110						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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2/18/2011 2:05 PM / 48

Licensed user:

**Vanasse Hangen Brustlin, Inc.**  
 1001 Walnut Street  
 US-WATERTOWN, MA 02472  
 +1 (617) 924 1770  
 Nicole Dentamaro, ndentamaro@vhb.com  
 Calculated:  
 2/18/2011 2:02 PM/2.7.449

**SHADOW - Calendar**

**Calculation:** Colebrook North Shadow Flicker Results **Shadow receptor:** AT - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (47)

**Assumptions for shadow calculations**

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	19:10 (2) 05:20 19:26 (2)	05:21 20:32	19:50 (1) 20:13 20:04 (1)	05:46 20:13 05:47	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	19:10 (2) 05:20 19:26 (2)	05:21 20:32	19:50 (1) 20:12 20:03 (1)	05:47 20:12 05:48	06:19 19:26	06:36 18:34	06:26 16:47	07:02 16:23
3	07:21 16:34	07:04 17:10	06:26 17:45	06:34 19:20	05:47 19:53	19:10 (2) 05:19 19:25 (2)	05:19 20:32	19:51 (1) 20:11 20:03 (1)	05:48 20:11 05:49	06:20 19:24	06:51 18:33	06:27 16:45	07:03 16:22
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7	07:21 16:37	07:00 17:15	06:20 17:50	06:27 19:24	05:42 19:58	19:13 (2) 05:18 19:23 (2)	05:18 20:31	19:53 (1) 20:06 20:02 (1)	05:52 20:06 05:53	19:21 (2) 19:18 19:34 (2)	06:24 18:26	06:56 16:41	07:07 16:22
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10	07:21 16:41	06:56 17:19	07:15 18:53	06:22 19:28	05:39 20:00	05:17 20:27	05:17 20:30	19:56 (1) 20:03 19:59 (1)	05:55 20:03 05:56	19:19 (2) 19:13 19:35 (2)	06:27 18:21	06:59 16:38	07:09 16:22
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24	07:14 16:57	06:37 17:36	06:51 19:09	06:00 19:43	05:25 20:14	05:18 20:32	05:18 20:30	19:48 (1) 20:21 20:02 (1)	06:09 19:41 06:10	19:21 (2) 18:48 19:34 (2)	06:42 17:59	07:15 16:26	07:19 16:26
25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	05:25 20:15	05:18 20:32	05:18 20:30	19:48 (1) 20:20 20:02 (1)	06:10 19:39 06:12	19:21 (2) 18:46 19:34 (2)	06:43 17:57	07:16 16:25	07:19 16:27
26	07:12 16:59	06:34 17:39	06:47 19:11	05:57 19:45	05:24 20:16	05:19 20:32	05:19 20:30	19:48 (1) 20:20 20:03 (1)	06:12 19:38 06:13	19:21 (2) 18:45 19:34 (2)	06:44 17:56	07:17 16:25	07:20 16:27
27	07:11 17:01	06:32 17:40	06:46 19:12	05:56 19:47	05:23 20:16	05:19 20:33	05:19 20:30	19:48 (1) 20:19 20:03 (1)	06:13 19:36 06:14	19:21 (2) 18:43 19:34 (2)	06:45 17:55	07:19 16:24	07:20 16:28
28	07:10 17:02	06:31 17:41	06:44 19:13	05:54 19:48	05:23 20:17	05:19 20:33	05:19 20:30	19:48 (1) 20:18 20:03 (1)	06:14 19:34 06:15	19:21 (2) 18:41 19:34 (2)	06:46 17:53	07:20 16:24	07:20 16:29
29	07:09 17:03	06:30 17:42	06:43 19:14	05:53 19:49	05:22 20:18	05:20 20:33	05:20 20:30	19:49 (1) 20:17 20:03 (1)	06:15 19:33 06:16	19:21 (2) 18:39 19:34 (2)	06:47 17:52	07:21 16:24	07:20 16:29
30	07:08 17:05	06:29 17:43	06:42 19:15	05:52 19:50	05:21 20:19	05:20 20:33	05:20 20:30	19:49 (1) 20:16 20:03 (1)	06:16 19:31 06:17	19:21 (2) 18:38 19:34 (2)	06:48 17:51	07:22 16:23	07:21 16:30
31	07:08 17:06	06:29 17:43	06:42 19:16	05:52 19:50	05:21 20:20	05:20 20:33	05:20 20:30	19:49 (1) 20:16 20:03 (1)	06:17 19:31 06:18	19:21 (2) 18:38 19:34 (2)	06:49 17:51	07:23 16:23	07:21 16:30
Potential sun hours	295	296	370	400	47	451	455	462	430	375	344	295	285
Total, worst case					47	104	368	97	157				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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 Nicole Dentamaro, ndentamaro@vhb.com  
 Calculated:  
 2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

**Calculation:** Colebrook North Shadow Flicker Results **Shadow receptor:** AU - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (48)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21	05:21 20:32	19:56 (1) 19:57 (1)	05:46 20:13	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	05:20 20:21	05:21 20:32		05:47 20:12	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:23
3	07:21 16:34	07:04 17:10	06:26 17:45	06:34 19:20	05:47 19:53	05:19 20:22	05:19 20:32		05:48 20:11	06:20 19:24	06:51 18:33	06:27 16:45	07:03 16:22
4	07:21 16:35	07:03 17:11	06:25 17:46	06:32 19:21	05:46 19:54	05:19 20:23	05:19 20:32		05:49 20:10	06:21 19:23	06:52 18:31	06:28 16:44	07:04 16:22
5	07:21 16:35	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24	05:19 20:32		05:50 20:09	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22
6	07:21 16:36	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:56	05:18 20:24	05:18 20:32		05:51 20:08	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22
7	07:21 16:37	07:00 17:15	06:20 17:50	06:27 19:24	05:42 19:58	05:18 20:25	05:18 20:31		05:52 20:06	06:24 19:18	06:56 18:26	06:32 16:41	07:07 16:22
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9	07:21 16:39	06:58 17:17	07:16 18:52	06:24 19:27	05:40 20:00	05:18 20:26	05:18 20:31		05:54 20:04	06:26 19:14	06:58 18:22	06:35 16:39	07:09 16:22
10	07:21 16:41	06:56 17:19	07:15 18:53	06:22 19:28	05:39 20:00	05:17 20:27	05:17 20:30		05:55 20:03	06:27 19:13	06:59 18:21	06:36 16:38	07:09 16:22
11	07:20 16:42	06:55 17:20	07:13 18:54	06:20 19:29	05:38 20:01	05:17 20:28	05:17 20:30		05:56 20:01	06:28 19:11	07:00 18:19	06:37 16:36	07:10 16:22
12	07:20 16:43	06:54 17:21	07:11 18:55	06:19 19:30	05:37 20:02	05:17 20:28	19:51 (1) 19:55 (1)	05:28 20:29	05:57 20:00	06:29 19:09	07:01 18:17	06:38 16:35	07:11 16:22
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16	07:18 16:47	06:49 17:26	07:05 19:00	06:12 19:34	05:32 20:06	05:17 20:30	19:50 (1) 19:58 (1)	05:31 20:27	06:01 19:53	06:33 19:02	07:06 18:11	06:43 16:32	07:14 16:23
17	07:18 16:48	06:47 17:28	07:03 19:01	06:11 19:36	05:31 20:07	05:17 20:30	19:49 (1) 19:58 (1)	05:32 20:27	06:02 19:51	06:34 19:00	07:07 18:09	06:44 16:31	07:15 16:23
18	07:17 16:50	06:46 17:29	07:01 19:02	06:09 19:37	05:30 20:08	05:17 20:31	19:49 (1) 19:58 (1)	05:33 20:26	06:03 19:50	06:35 18:59	07:08 18:08	06:46 16:30	07:16 16:23
19	07:17 16:51	06:44 17:30	06:59 19:03	06:08 19:38	05:30 20:09	05:17 20:31	19:49 (1) 19:59 (1)	05:33 20:25	06:04 19:49	06:36 18:57	07:09 18:06	06:47 16:29	07:16 16:24
20	07:16 16:52	06:43 17:31	06:58 19:04	06:06 19:39	05:29 20:10	05:17 20:31	19:49 (1) 19:59 (1)	05:34 20:25	06:05 19:47	06:37 18:55	07:10 18:05	06:48 16:29	07:17 16:24
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22	07:15 16:54	06:40 17:34	06:54 19:07	06:03 19:41	05:27 20:12	05:18 20:32	19:49 (1) 19:50 (1)	05:36 20:23	06:07 19:44	06:40 18:52	07:13 18:02	06:50 16:27	07:18 16:25
23	07:14 16:56	06:39 17:35	06:53 19:08	06:01 19:42	05:26 20:13	05:18 20:32	19:50 (1) 20:00 (1)	05:37 20:22	06:08 19:42	06:41 18:50	07:14 18:00	06:52 16:27	07:18 16:25
24	07:14 16:57	06:37 17:36	06:51 19:09	06:00 19:43	05:25 20:14	05:18 20:32	19:50 (1) 20:00 (1)	05:38 20:21	06:09 19:41	06:42 18:48	07:15 17:59	06:53 16:26	07:19 16:26
25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	05:25 20:15	05:18 20:32	19:50 (1) 19:59 (1)	05:39 20:20	06:10 19:39	06:43 18:46	07:16 17:58	06:54 16:25	07:19 16:27
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27	07:11 17:01	06:32 17:40	06:46 19:12	05:56 19:47	05:23 20:16	05:19 20:33	19:52 (1) 20:00 (1)	05:41 20:19	06:13 19:36	06:45 18:43	07:19 17:55	06:56 16:24	07:20 16:28
28	07:10 17:02	06:31 17:41	06:44 19:13	05:54 19:48	05:23 20:17	05:20 20:33	19:52 (1) 19:53 (1)	05:42 20:18	06:14 19:34	06:46 18:41	07:20 17:53	06:57 16:24	07:20 16:29
29	07:09 17:03	06:30 17:42	06:42 19:14	05:53 19:49	05:22 20:18	05:20 20:33	19:53 (1) 19:54 (1)	05:43 20:17	06:15 19:33	06:47 18:39	07:21 17:52	06:58 16:24	07:20 16:29
30	07:08 17:05	06:29 17:43	06:41 19:15	05:51 19:50	05:21 20:19	05:20 20:33	19:54 (1) 19:58 (1)	05:44 20:16	06:16 19:31	06:48 18:38	07:22 17:51	07:00 16:23	07:21 16:30
31	07:08 17:06	06:29 17:44	06:39 19:16	06:39 19:51	06:39 20:20	06:39 20:33	06:39 20:15	06:39 20:15	06:17 19:30	06:23 17:49	06:23 17:49	06:23 16:31	06:23 16:31
Potential sun hours	295	296	370	400	451	455	462	430	375	344	295	285	
Total, worst case						152	2						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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Licensed user:

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Nicole Dentamaro, ndentamaro@vhb.com

Calculated:

2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: AV - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (49)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	19:02 (2) 19:16 (2)	05:20 20:21	05:21 20:32	05:46 20:13	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	19:03 (2) 19:16 (2)	05:20 20:21	05:21 20:32	05:47 20:12	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:23
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4	07:21 16:35	07:03 17:11	06:25 17:46	06:32 19:21	05:46 19:54	19:06 (2) 19:12 (2)	05:19 20:23	05:22 20:32	05:49 20:10	06:21 19:23	06:52 18:31	06:28 16:44	07:04 16:22
5	07:21 16:35	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55		05:19 20:24	05:23 20:32	05:50 20:09	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22
6	07:21 16:36	07:01 17:14	06:21 17:48	06:27 19:23	05:44 19:56		05:18 20:24	05:24 20:32	05:51 20:08	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22
7	07:21 16:37	07:00 17:15	06:20 17:50	06:27 19:24	05:42 19:58		05:18 20:25	05:24 20:31	05:52 20:06	06:24 19:18	06:56 18:26	06:32 16:41	07:07 16:22
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11	07:20 16:42	06:55 17:20	07:13 18:54	06:20 19:29	05:38 20:01		05:17 20:28	05:27 20:30	05:56 20:01	19:11 (2) 19:25 (2)	06:28 18:19	07:00 16:36	07:10 16:22
12	07:20 16:43	06:54 17:21	07:11 18:55	06:19 19:30	05:37 20:02		05:17 20:28	05:28 20:29	05:57 20:00	19:10 (2) 19:25 (2)	06:29 18:17	07:01 16:35	07:11 16:22
13	07:20 16:44	06:53 17:23	07:10 18:56	06:17 19:31	05:35 20:03		05:17 20:29	05:29 20:29	05:58 19:57	19:10 (2) 19:26 (2)	06:30 18:16	07:02 16:34	07:12 16:22
14	07:19 16:45	06:51 17:24	07:08 18:58	06:15 19:32	05:34 20:04		05:17 20:29	05:29 20:28	05:59 19:56	19:09 (2) 19:26 (2)	06:31 18:14	07:03 16:34	07:13 16:22
15	07:19 16:46	06:50 17:25	07:06 18:59	06:14 19:33	05:33 20:05		05:17 20:30	05:30 20:28	06:00 19:54	19:09 (2) 19:26 (2)	06:32 18:13	07:05 16:33	07:13 16:22
16	07:18 16:47	06:49 17:26	07:05 19:00	06:12 19:34	05:32 20:06		05:17 20:30	05:31 20:27	06:01 19:53	19:09 (2) 19:25 (2)	06:33 18:11	06:43 16:32	07:14 16:23
17	07:18 16:48	06:47 17:28	07:03 19:01	06:11 19:36	05:31 20:07		05:17 20:30	05:32 20:27	06:02 19:51	19:09 (2) 19:25 (2)	06:34 18:09	07:07 16:31	07:15 16:23
18	07:17 16:50	06:46 17:29	07:01 19:02	06:09 19:37	05:30 20:08		05:17 20:31	05:33 20:26	06:03 19:50	19:09 (2) 19:24 (2)	06:35 18:08	07:08 16:30	07:16 16:23
19	07:17 16:51	06:44 17:30	06:59 19:03	06:08 19:38	05:30 20:09		05:17 20:31	05:33 20:25	06:04 19:49	19:10 (2) 19:23 (2)	06:36 18:06	07:09 16:29	07:16 16:24
20	07:16 16:52	06:43 17:31	06:58 19:04	06:06 19:39	05:29 20:10		05:17 20:31	05:34 20:25	06:05 19:47	19:11 (2) 19:21 (2)	06:37 18:05	07:10 16:29	07:17 16:24
21	07:16 16:53	06:41 17:33	06:56 19:06	06:04 19:40	05:28 20:11		05:17 20:32	05:35 20:24	06:06 19:45	19:13 (2) 19:19 (2)	06:38 18:53	07:12 16:28	07:17 16:24
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23	07:14 16:56	06:39 17:35	06:53 19:08	06:01 19:42	05:26 20:13	19:05 (2) 19:16 (2)	05:26 20:22	05:37 20:22	06:08 19:42	19:09 (2) 18:50	06:39 17:14	07:13 16:27	07:19 16:25
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25	07:13 16:58	06:36 17:38	06:49 19:10	05:59 19:44	05:25 20:15	19:02 (2) 19:17 (2)	05:25 20:20	05:39 20:20	06:10 19:39	19:11 (2) 18:46	06:41 17:58	07:15 16:25	07:21 16:27
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28	07:10 17:02	06:31 17:41	06:44 19:13	05:54 19:48	05:23 20:17	19:01 (2) 19:18 (2)	05:23 20:18	05:40 20:18	06:14 19:34	19:14 (2) 18:41	06:44 17:53	07:18 16:24	07:24 16:29
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30	07:08 17:05		06:41 19:16	05:51 19:50	05:21 20:19	19:01 (2) 19:17 (2)	05:21 20:19	05:44 20:16	06:16 19:31	19:16 (2) 18:38	06:48 17:22	07:20 16:23	07:26 16:30
31	07:08 17:06		06:39 19:17		05:21 20:20		05:21 20:15	06:17 19:30	06:17 430		07:23 17:49	16:23 295	16:31 285
Potential sun hours	295	296	370	400	451		455	462	430		375	344	295
Total, worst case				127	44				174				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)



Project:  
Colebrook\_CT\_North

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Nicole Dentamaro, ndentamaro@vhb.com  
Calculated:  
2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: BE - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (58)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
The sun is shining all the day, from sunrise to sunset  
The rotor plane is always perpendicular to the line from the WTG to the sun  
The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:21 16:32	07:07 17:07	06:29 17:42	17:16 (3) 19:18	06:37 19:51	05:50 20:21	05:20 20:33	05:21 20:13	05:46 19:28	06:18 18:36	17:54 (1) 18:05 (1)	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	17:15 (3) 19:19	06:35 19:52	05:49 20:21	05:20 20:32	05:21 20:12	05:47 19:26	06:19 18:34	17:56 (1) 18:01 (1)	06:26 16:47	07:02 16:22
3	07:21 16:34	07:05 17:10	06:26 17:45	17:16 (3) 19:20	06:34 19:53	05:47 20:22	05:19 20:32	05:22 20:11	05:48 19:24	06:20 18:32	18:01 (1)	06:27 16:45	07:03 16:22
4	07:21 16:35	07:03 17:11	06:25 17:46	17:16 (3) 19:21	06:32 19:54	05:46 20:23	05:19 20:32	05:22 20:10	05:49 19:23	06:21 18:31		06:28 16:44	07:04 16:22
5	07:21 16:35	07:02 17:12	06:23 17:47	17:17 (3) 19:22	06:30 19:55	05:45 20:24	05:19 20:32	05:23 20:09	05:50 19:21	06:22 18:29		06:30 16:43	07:05 16:22
6	07:21 16:36	07:01 17:14	06:21 17:48	17:23 (3) 19:23	06:29 19:56	05:44 20:24	05:18 20:32	05:24 20:08	05:51 19:19	06:23 18:27		06:31 16:42	07:06 16:22
7	07:21 16:37	07:00 17:15	06:20 17:50	17:24 (3) 19:24	06:27 19:58	05:42 20:25	05:18 20:31	05:24 20:06	05:52 19:18	06:24 18:26		06:32 16:41	07:07 16:22
8	07:21 16:38	06:59 17:16	06:18 18:51	18:22 (3) 19:26	06:25 19:59	05:41 20:26	05:18 20:31	05:25 20:05	05:53 19:16	06:25 18:24		06:33 16:40	07:08 16:22
9	07:21 16:39	06:58 17:17	06:16 18:52	18:23 (3) 19:27	06:24 20:00	05:40 20:26	05:18 20:31	05:26 20:04	05:54 19:14	06:26 18:22	17:52 (3) 17:59 (3)	06:35 16:39	07:09 16:22
10	07:21 16:41	06:56 17:19	06:15 18:53	18:24 (3) 19:28	06:22 20:00	05:39 20:27	05:17 20:30	05:26 20:03	05:55 19:13	06:27 18:21	17:50 (3) 17:58 (3)	06:36 16:37	07:09 16:22
11	07:20 16:42	06:55 17:20	06:13 18:54	18:25 (3) 19:29	06:20 20:01	05:38 20:28	05:17 20:30	05:27 20:01	05:56 19:11	06:28 18:19	17:53 (3) 17:56 (3)	06:37 16:36	07:10 16:22
12	07:20 16:43	06:54 17:21	06:11 18:55	18:16 (1) 18:25 (1)	06:19 19:30	05:37 20:02	05:17 20:28	05:28 20:29	05:57 20:00	06:29 19:09	17:50 (3) 17:55 (3)	06:38 16:35	07:11 16:22
13	07:20 16:44	06:53 17:23	06:10 18:56	18:14 (1) 18:26 (1)	06:17 19:31	05:35 20:03	05:17 20:29	05:29 20:29	05:58 19:07	06:30 19:07	17:53 (3) 17:53 (3)	06:40 16:34	07:12 16:22
14	07:19 16:45	06:51 17:24	06:08 18:58	18:12 (1) 18:27 (1)	06:15 19:32	05:34 20:04	05:17 20:28	05:29 20:28	05:59 19:06	06:31 19:06	17:50 (3) 17:53 (3)	06:41 16:34	07:13 16:22
15	07:19 16:46	06:50 17:25	06:06 18:59	18:12 (1) 18:28 (1)	06:14 19:33	05:33 20:05	05:17 20:30	05:30 20:28	06:00 19:54	06:32 19:04	17:50 (3) 17:24 (2)	06:42 16:33	07:13 16:22
16	07:18 16:47	06:49 17:26	06:05 16:57 (2)	18:11 (1) 18:28 (1)	06:12 19:34	05:32 20:06	05:17 20:30	05:31 20:27	06:01 19:53	06:33 19:02	17:22 (2) 17:32 (2)	06:43 16:32	07:14 16:22
17	07:18 16:48	06:47 17:28	06:04 16:52 (2)	18:11 (1) 18:27 (1)	06:11 19:36	05:31 20:07	05:17 20:30	05:32 20:27	06:02 19:51	06:34 19:00	17:22 (2) 17:33 (2)	06:44 16:31	07:15 16:23
18	07:17 16:50	06:46 17:29	06:03 16:51 (2)	18:10 (1) 18:26 (1)	06:09 19:37	05:30 20:08	05:17 20:31	05:33 20:26	06:03 19:50	06:35 18:59	17:21 (2) 17:35 (2)	06:46 16:30	07:15 16:23
19	07:17 16:51	06:44 17:30	06:02 16:50 (2)	18:12 (1) 18:26 (1)	06:08 19:38	05:29 20:09	05:17 20:31	05:33 20:25	06:04 19:49	06:36 18:57	17:20 (2) 17:35 (2)	06:47 16:29	07:16 16:23
20	07:16 16:52	06:43 17:31	06:01 16:49 (2)	18:12 (1) 18:24 (1)	06:06 19:39	05:29 20:10	05:17 20:31	05:34 20:25	06:05 19:47	06:37 18:55	17:20 (2) 17:35 (2)	06:48 16:29	07:17 16:24
21	07:16 16:53	06:42 17:33	06:00 16:49 (2)	18:14 (1) 18:22 (1)	06:04 19:40	05:28 20:11	05:17 20:32	05:35 20:24	06:06 19:45	06:38 18:53	17:19 (2) 17:34 (2)	06:49 16:28	07:17 16:24
22	07:15 16:54	06:40 17:34	05:59 16:49 (2)	18:22 (1) 19:01	06:03 19:41	05:27 20:12	05:18 20:32	05:36 20:23	06:07 19:44	06:40 18:52	18:00 (1) 18:06 (1)	06:50 16:27	07:18 16:25
23	07:14 16:56	06:39 17:35	05:58 16:49 (2)	19:01 19:42	06:02 19:42	05:26 20:13	05:18 20:32	05:37 20:22	06:08 19:42	06:41 18:50	17:57 (1) 18:08 (1)	06:52 16:27	07:18 16:25
24	07:14 16:57	06:37 17:36	05:57 16:50 (2)	19:08 19:43	06:01 19:43	05:25 20:14	05:18 20:32	05:38 20:21	06:09 19:41	06:42 18:48	17:55 (1) 18:09 (1)	06:53 16:27	07:19 16:26
25	07:13 16:58	06:36 17:38	05:56 16:51 (2)	19:09 19:44	05:59 19:44	05:25 20:15	05:18 20:32	05:39 20:20	06:10 19:39	06:43 18:46	17:54 (1) 18:09 (1)	06:54 16:27	07:19 16:27
26	07:12 16:59	06:34 17:39	05:55 16:53 (2)	19:10 19:45	05:57 19:45	05:24 20:16	05:19 20:32	05:40 20:20	06:12 19:38	06:44 18:45	17:53 (1) 18:10 (1)	06:55 16:25	07:20 16:27
27	07:11 17:01	06:32 17:40	05:54 17:01 (2)	19:11 19:12	05:56 19:47	05:23 20:16	05:19 20:33	05:41 20:19	06:13 19:36	06:45 18:43	17:53 (1) 18:09 (1)	06:56 16:24	07:20 16:28
28	07:10 17:02	06:31 17:41	05:53 17:18 (3)	19:13 19:13	05:54 19:48	05:23 20:17	05:19 20:33	05:42 20:18	06:14 19:34	06:46 18:41	17:52 (1) 18:09 (1)	06:57 16:24	07:20 16:29
29	07:09 17:03	06:30 17:41	05:52 17:03 (2)	19:14 19:14	05:53 19:49	05:22 20:18	05:20 20:33	05:43 20:17	06:15 19:33	06:47 18:39	17:53 (1) 18:08 (1)	06:58 16:24	07:20 16:29
30	07:09 17:05	06:29 17:42	05:51 17:04 (2)	19:15 19:15	05:51 19:50	05:21 20:19	05:20 20:33	05:44 20:16	06:16 19:31	06:48 18:38	17:53 (1) 18:06 (1)	07:00 16:23	07:21 16:30
31	07:08 17:06	06:28 17:43	05:50 17:05 (2)	19:16 19:16	05:50 19:49	05:20 20:18	05:19 20:33	05:45 20:15	06:17 19:30	06:49 18:37	17:54 (1) 18:07 (1)	07:01 16:24	07:21 16:31
Potential sun hours	295	296	296	370	400	451	455	462	430	375	344	295	285
Total, worst case			126	166						124	172		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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2/18/2011 2:05 PM / 73

Licensed user:

**Vanasse Hangen Brustlin, Inc.**  
 1001 Walnut Street  
 US-WATERTOWN, MA 02472  
 +1 (617) 924 1770  
 Nicole Dentamaro, ndentamaro@vhb.com  
 Calculated:  
 2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

**Calculation:** Colebrook North Shadow Flicker Results **Shadow receptor:** BS - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (72)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21	05:21 20:33	05:46 20:13	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23
2	07:21 16:33	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	05:20 20:21	05:21 20:32	05:47 20:12	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:22
3	07:21 16:34	07:05 17:10	06:26 17:45	06:34 19:20	05:47 19:53	05:19 20:22	05:22 20:32	05:48 20:11	06:20 19:24	06:51 18:32	06:27 16:45	07:03 16:22
4	07:21 16:34	07:03 17:11	06:24 17:46	06:32 19:21	05:46 19:54	05:19 20:23	05:22 20:32	05:49 20:10	06:21 19:23	06:52 18:31	06:28 16:44	07:04 16:22
5	07:21 16:35	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24	05:23 20:32	05:50 20:09	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22
6	07:21 16:36	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:56	05:18 20:24	05:24 20:32	05:51 20:08	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22
7	07:21 16:37	07:00 17:15	06:20 17:49	06:27 19:24	05:42 19:58	05:18 20:25	05:24 20:31	05:52 20:06	06:24 19:18	06:56 18:26	06:32 16:41	07:07 16:22
8	07:21 16:38	06:59 17:16	07:18 18:51	06:25 19:26	05:41 19:59	05:18 20:26	05:25 20:31	05:53 20:05	06:25 19:16	06:57 18:24	06:33 16:40	07:08 16:21
9	07:21 16:39	06:58 17:17	07:16 18:52	06:24 19:27	05:40 20:00	05:17 20:26	05:26 20:31	05:54 20:04	06:26 19:14	06:58 18:22	06:35 16:39	07:09 16:21
10	07:21 16:40	06:56 17:19	07:15 18:53	06:22 19:28	05:39 20:00	05:17 20:27	05:26 20:30	05:55 20:03	06:27 19:13	06:59 18:21	06:36 16:37	07:09 16:21
11	07:20 16:42	06:55 17:20	07:13 18:54	06:20 19:29	05:38 20:01	05:17 20:28	05:27 20:30	05:56 20:01	06:28 19:11	07:00 18:19	06:37 16:36	07:10 16:22
12	07:20 16:43	06:54 17:21	07:11 18:55	06:19 19:30	05:36 20:02	05:17 20:28	05:28 20:29	05:57 20:00	06:29 19:09	07:01 18:17	06:38 16:35	07:11 16:22
13	07:20 16:44	06:53 17:23	07:10 18:56	06:17 19:31	05:35 20:03	05:17 20:29	05:28 20:29	05:58 19:57	06:30 19:07	07:02 18:16	06:40 16:34	07:12 16:22
14	07:19 16:45	06:51 17:24	07:08 18:58	06:15 19:32	05:34 20:04	05:17 20:29	05:29 20:28	05:59 19:56	06:31 19:06	07:03 18:14	06:41 16:34	07:13 16:22
15	07:19 16:46	06:50 17:25	07:06 18:59	06:14 19:33	05:33 20:05	05:17 20:30	05:30 20:28	06:00 19:54	06:32 19:04	07:05 18:13	06:42 16:33	07:13 16:22
16	07:18 16:47	06:49 17:26	07:05 19:00	06:12 19:34	05:32 20:06	05:17 20:30	05:31 20:27	06:01 19:53	06:33 19:02	07:06 18:11	06:43 16:32	07:14 16:22
17	07:18 16:48	16:20 (1) 16:23 (1)	06:47 17:28	07:03 19:01	06:11 19:36	05:17 20:07	05:32 20:30	06:02 19:51	06:34 19:00	07:07 18:09	06:44 16:31	07:15 16:23
18	07:17 16:50	16:19 (1) 16:24 (1)	06:46 17:29	07:01 19:02	06:09 19:37	05:17 20:08	05:33 20:31	06:03 19:50	06:35 18:59	07:08 18:08	06:46 16:30	07:15 16:23
19	07:17 16:51	16:18 (1) 16:25 (1)	06:44 17:30	06:59 19:03	06:08 19:38	05:17 20:09	05:33 20:25	06:04 19:49	06:36 18:57	07:09 18:06	06:47 16:29	07:16 16:23
20	07:16 16:52	16:19 (1) 16:26 (1)	06:43 17:31	06:58 19:04	06:06 19:39	05:17 20:10	05:34 20:25	06:05 19:47	06:37 18:55	07:10 18:05	06:48 16:29	07:17 16:24
21	07:16 16:53	16:18 (1) 16:27 (1)	06:41 17:33	06:56 19:06	06:04 19:40	05:17 20:11	05:35 20:24	06:06 19:45	06:38 18:53	07:12 18:03	06:49 16:28	07:17 16:24
22	07:15 16:54	16:18 (1) 16:29 (1)	06:40 17:34	06:54 19:07	06:03 19:41	05:27 20:12	05:36 20:23	06:07 19:44	06:40 18:52	07:13 18:02	06:50 16:27	07:18 16:25
23	07:14 16:56	16:20 (1) 16:30 (1)	06:39 17:35	06:53 19:08	06:01 19:42	05:26 20:13	05:37 20:32	06:08 19:42	06:41 18:50	07:14 18:00	06:52 16:27	07:18 16:25
24	07:14 16:57	16:20 (1) 16:30 (1)	06:37 17:36	06:51 19:09	06:00 19:43	05:25 20:14	05:38 20:32	06:09 19:41	06:42 18:48	07:15 17:59	06:53 16:26	07:19 16:26
25	07:13 16:58	16:21 (1) 16:30 (1)	06:36 17:37	06:49 19:10	05:58 19:44	05:25 20:15	05:39 20:32	06:10 19:39	06:43 18:46	07:16 17:57	06:54 16:25	07:19 16:26
26	07:12 16:59	16:22 (1) 16:29 (1)	06:34 17:39	06:47 19:11	05:57 19:45	05:24 20:16	05:19 20:32	06:11 19:38	06:44 18:45	07:17 17:56	06:55 16:25	07:20 16:27
27	07:11 17:01	16:23 (1) 16:28 (1)	06:32 17:40	06:46 19:12	05:56 19:47	05:23 20:16	05:19 20:33	06:13 19:36	06:45 18:43	07:19 17:55	06:56 16:24	07:20 16:28
28	07:10 17:02	16:21 (1) 17:41	06:31 17:41	06:44 19:13	05:54 19:48	05:23 20:17	05:19 20:33	06:14 19:34	06:46 18:41	07:20 17:53	06:57 16:24	07:20 16:28
29	07:09 17:03	17:03	06:42 19:14	05:53 19:49	05:22 20:18	05:20 20:33	05:43 20:17	06:15 19:33	06:47 18:39	07:21 17:52	06:58 16:23	07:20 16:29
30	07:09 17:04	17:04	06:40 19:16	05:51 19:50	05:21 20:19	05:20 20:33	05:44 20:16	06:16 19:31	06:48 18:38	07:22 17:51	07:00 16:23	07:21 16:30
31	07:08 17:06	17:06	06:39 19:17	05:21 20:20	05:21 20:20	05:17 20:15	06:17 19:29	06:17 17:49	07:23 17:49	16:23	07:21 16:31	07:21 16:31
Potential sun hours	295	296	370	400	451	455	462	430	375	344	295	285
Total, worst case	83										87	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:  
Colebrook\_CT\_North

Printed/Page  
2/18/2011 2:05 PM / 81  
Licensed user:  
**Vanasse Hangen Brustlin, Inc.**  
1001 Walnut Street  
US-WATERTOWN, MA 02472  
+1 (617) 924 1770  
Nicole Dentamaro, ndentamaro@vhb.com  
Calculated:  
2/18/2011 2:02 PM/2.7.449

### SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: CA - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (80)

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
The sun is shining all the day, from sunrise to sunset  
The rotor plane is always perpendicular to the line from the WTG to the sun  
The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December		
1	07:21 16:32	15:44 (1) 15:58 (1)	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21	05:21 20:33	05:46 20:13	06:18 19:28	06:49 18:36	06:25 16:48	07:01 16:23	15:32 (1) 15:42 (1)
2	07:21 16:33	15:45 (1) 15:58 (1)	07:06 17:08	06:28 17:44	06:35 19:19	05:49 19:52	05:20 20:22	05:21 20:32	05:47 20:12	06:19 19:26	06:50 18:34	06:26 16:47	07:02 16:22	15:33 (1) 15:44 (1)
3	07:21 16:34	15:45 (1) 15:59 (1)	07:05 17:10	06:26 17:45	06:34 19:20	05:47 19:53	05:19 20:22	05:22 20:32	05:48 20:11	06:20 19:25	06:51 18:32	06:27 16:45	07:03 16:22	15:33 (1) 15:44 (1)
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5	07:21 16:35	15:46 (1) 16:00 (1)	07:02 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24	05:23 20:32	05:50 20:09	06:22 19:21	06:53 18:29	06:30 16:43	07:05 16:22	15:33 (1) 15:46 (1)
6	07:21 16:36	15:47 (1) 16:00 (1)	07:01 17:14	06:21 17:48	06:29 19:23	05:44 19:56	05:18 20:24	05:24 20:32	05:51 20:08	06:23 19:19	06:55 18:27	06:31 16:42	07:06 16:22	15:33 (1) 15:46 (1)
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8	07:21 16:38	15:48 (1) 16:00 (1)	07:00 17:16	06:20 17:48	06:25 19:26	05:41 19:59	05:18 20:26	05:25 20:31	05:53 20:05	06:25 19:16	06:57 18:24	06:33 16:40	07:08 16:22	15:34 (1) 15:47 (1)
9	07:21 16:39	15:49 (1) 16:00 (1)	06:58 17:17	07:16 18:52	07:16 19:27	06:24 20:00	05:40 20:26	05:26 20:31	05:54 20:04	06:26 19:14	06:58 18:22	06:35 16:39	07:09 16:21	15:34 (1) 15:48 (1)
10	07:21 16:40	15:50 (1) 16:01 (1)	06:56 17:19	07:15 18:53	07:15 19:28	06:22 20:00	05:39 20:27	05:26 20:30	05:55 20:03	06:27 19:13	06:59 18:21	06:36 16:37	07:09 16:22	15:34 (1) 15:47 (1)
11	07:20 16:42	15:50 (1) 16:00 (1)	06:55 17:20	07:13 18:54	07:13 19:29	06:20 20:01	05:38 20:28	05:27 20:30	05:56 20:01	06:28 19:11	07:00 18:19	06:37 16:36	07:10 16:22	15:34 (1) 15:48 (1)
12	07:20 16:43	15:52 (1) 16:00 (1)	06:54 17:21	07:11 18:55	07:11 19:30	06:19 20:02	05:37 20:28	05:28 20:29	05:57 20:00	06:29 19:09	07:01 18:17	06:38 16:35	07:11 16:22	15:35 (1) 15:49 (1)
13	07:20 16:44	15:54 (1) 15:59 (1)	06:53 17:23	07:10 18:56	07:10 19:31	06:17 20:03	05:35 20:29	05:28 20:29	05:58 19:57	06:30 19:07	07:02 18:16	06:40 16:34	07:12 16:22	15:36 (1) 15:49 (1)
14	07:19 16:45	15:59 (1) 17:24	07:08 18:58	07:08 19:32	06:15 20:04	05:34 20:04	05:17 20:29	05:29 20:28	05:59 19:56	06:31 19:06	07:03 18:14	06:41 16:34	07:13 16:22	15:36 (1) 15:50 (1)
15	07:19 16:46	16:00 (1) 17:25	07:06 18:59	07:06 19:33	06:14 20:05	05:33 20:05	05:17 20:30	05:30 20:28	06:00 19:54	06:32 19:04	07:05 18:13	06:42 16:33	07:13 16:22	15:36 (1) 15:50 (1)
16	07:18 16:47	16:00 (1) 17:26	07:05 19:00	07:05 19:34	06:12 20:06	05:32 20:06	05:17 20:30	05:31 20:27	06:01 19:53	06:33 19:02	07:06 18:11	06:43 16:32	07:14 16:22	15:37 (1) 15:50 (1)
17	07:18 16:48	16:00 (1) 17:28	07:03 19:01	07:03 19:36	06:11 20:07	05:31 20:07	05:17 20:30	05:32 20:27	06:02 19:51	06:34 19:00	07:07 18:09	06:44 16:31	07:15 16:23	15:38 (1) 15:51 (1)
18	07:17 16:50	16:00 (1) 17:29	07:01 19:02	07:01 19:37	06:09 20:08	05:30 20:08	05:17 20:31	05:33 20:26	06:03 19:50	06:35 18:59	07:08 18:08	06:46 16:30	07:16 16:23	15:38 (1) 15:51 (1)
19	07:17 16:51	16:00 (1) 17:30	07:00 19:03	07:00 19:38	06:08 20:09	05:29 20:09	05:17 20:31	05:33 20:25	06:04 19:49	06:36 18:57	07:09 18:06	06:47 16:29	07:16 16:23	15:38 (1) 15:52 (1)
20	07:16 16:52	16:00 (1) 17:31	06:59 19:04	06:59 19:39	06:08 20:10	05:29 20:10	05:17 20:31	05:33 20:25	06:05 19:47	06:37 18:55	07:10 18:05	06:48 16:29	07:17 16:24	15:39 (1) 15:52 (1)
21	07:16 16:53	16:00 (1) 17:33	06:58 19:06	06:58 19:40	06:07 20:11	05:28 20:11	05:17 20:32	05:35 20:24	06:06 19:45	06:38 18:53	07:12 18:03	06:49 16:28	07:17 16:24	15:39 (1) 15:52 (1)
22	07:15 16:54	16:00 (1) 17:34	06:54 19:07	06:54 19:41	06:03 20:12	05:27 20:12	05:18 20:32	05:36 20:23	06:07 19:44	06:40 18:52	07:13 18:02	06:50 16:27	07:18 16:25	15:39 (1) 15:52 (1)
23	07:14 16:56	16:00 (1) 17:35	06:53 19:08	06:53 19:42	06:01 20:13	05:26 20:13	05:18 20:32	05:37 20:22	06:08 19:42	06:41 18:50	07:14 18:00	06:52 16:27	07:18 16:25	15:40 (1) 15:53 (1)
24	07:14 16:57	16:00 (1) 17:36	06:53 19:09	06:53 19:43	06:00 20:14	05:25 20:14	05:18 20:32	05:38 20:21	06:09 19:41	06:42 18:48	07:15 17:59	06:53 16:26	07:19 16:26	15:40 (1) 15:54 (1)
25	07:13 16:58	16:00 (1) 17:38	06:49 19:10	06:49 19:44	05:58 20:15	05:25 20:15	05:18 20:32	05:39 20:20	06:10 19:39	06:43 18:46	07:16 17:57	06:54 16:25	07:19 16:27	15:42 (1) 15:55 (1)
26	07:12 16:59	16:00 (1) 17:39	06:47 19:11	06:47 19:45	05:57 20:16	05:24 20:16	05:19 20:33	05:40 20:20	06:11 19:38	06:44 18:45	07:17 17:56	06:55 16:25	07:20 16:27	15:42 (1) 15:55 (1)
27	07:11 17:01	16:00 (1) 17:40	06:46 19:12	06:46 19:47	05:56 20:17	05:23 20:17	05:19 20:33	05:41 20:19	06:13 19:36	06:45 18:43	07:19 17:55	06:56 16:24	07:20 16:28	15:42 (1) 15:55 (1)
28	07:10 17:02	16:00 (1) 17:41	06:44 19:13	06:44 19:48	05:54 20:18	05:23 20:18	05:19 20:33	05:42 20:18	06:14 19:34	06:46 18:41	07:20 17:53	06:57 16:24	07:20 16:28	15:43 (1) 15:56 (1)
29	07:09 17:03	16:00 (1) 17:42	06:42 19:14	06:42 19:49	05:53 20:19	05:22 20:19	05:20 20:33	05:43 20:17	06:15 19:33	06:47 18:39	07:21 17:52	06:58 16:23	07:20 16:29	15:43 (1) 15:57 (1)
30	07:09 17:05	16:00 (1) 17:43	06:40 19:16	06:40 19:50	05:51 20:20	05:21 20:20	05:20 20:33	05:44 20:16	06:16 19:31	06:48 18:38	07:22 17:51	07:00 16:23	07:21 16:30	15:43 (1) 15:57 (1)
31	07:08 17:06	16:00 (1) 17:44	06:39 19:17	06:39 19:51	05:50 20:21	05:20 20:21	05:20 20:33	05:45 20:15	06:17 19:30	06:49 17:49	07:23 17:52	07:01 16:24	07:21 16:31	15:44 (1) 15:57 (1)
Potential sun hours	295	296	370	400	451	455	462	430	375	344	295	285	13	405
Total, worst case	151													

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Colebrook\_CT\_North

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Licensed user:

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Nicole Dentamaro, ndentamaro@vhb.com

Calculated:

2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: DK - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (116)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	January	February	March	April	May	June
1	07:21 16:32	07:07 17:07	06:29 17:42	06:37 19:18	05:50 19:51	05:20 20:21
2	07:21 16:33	07:06 17:09	06:28 17:44	06:36 19:19	05:49 19:52	05:20 20:22
3	07:21 16:34	07:44 (3) 07:45 (3) 17:10	06:26 17:45	06:34 19:20	05:48 19:53	05:20 20:22
4	07:21 16:35	07:44 (3) 07:46 (3) 17:11	06:25 17:46	06:32 19:21	05:46 19:54	05:19 20:23
5	07:21 16:36	07:44 (3) 07:47 (3) 17:12	06:23 17:47	06:30 19:22	05:45 19:55	05:19 20:24
6	07:21 16:37	07:44 (3) 07:48 (3) 17:14	06:21 17:48	06:41 (1) 06:42 (1) 19:23	06:29 19:57	05:18 20:25
7	07:21 16:38	07:44 (3) 07:49 (3) 17:15	06:20 17:50	06:39 (1) 06:43 (1) 19:25	06:27 19:58	05:18 20:25
8	07:21 16:39	07:43 (3) 07:49 (3) 17:16	07:18 18:51	07:38 (1) 07:44 (1) 19:26	06:25 19:59	05:18 20:26
9	07:21 16:40	07:43 (3) 07:50 (3) 17:18	07:16 18:52	07:36 (1) 07:44 (1) 19:27	06:24 20:00	05:18 20:26
10	07:21 16:41	07:43 (3) 07:51 (3) 17:19	07:15 18:53	07:34 (1) 07:43 (1) 19:28	06:22 20:00	05:17 20:27
11	07:20 16:42	07:43 (3) 07:52 (3) 17:20	07:13 18:54	07:33 (1) 07:43 (1) 19:29	06:20 20:01	05:17 20:28
12	07:20 16:43	07:42 (3) 07:52 (3) 17:21	07:11 18:55	07:31 (1) 07:42 (1) 19:30	06:19 20:02	05:17 20:28
13	07:20 16:44	07:42 (3) 07:53 (3) 17:23	07:10 18:57	07:31 (1) 07:40 (1) 19:31	06:17 20:03	05:17 20:29
14	07:19 16:45	07:41 (3) 07:53 (3) 17:24	07:12 (2) 07:16 (2) 18:58	07:08 07:36 (1) 19:32	06:16 20:04	05:17 20:29
15	07:19 16:46	07:41 (3) 07:54 (3) 17:25	07:10 (2) 07:16 (2) 18:59	07:06 19:33	06:14 20:05	05:17 20:30
16	07:19 16:47	07:40 (3) 07:53 (3) 17:26	07:09 (2) 07:16 (2) 19:00	07:05 19:35	06:12 20:06	05:17 20:30
17	07:18 16:48	07:40 (3) 07:54 (3) 17:28	07:07 (2) 07:15 (2) 19:01	07:03 19:36	06:11 20:07	05:17 20:30
18	07:18 16:50	07:39 (3) 07:54 (3) 17:29	07:06 (2) 07:15 (2) 19:02	07:01 19:37	06:09 20:08	05:17 20:31
19	07:17 16:51	07:39 (3) 07:55 (3) 17:30	07:04 (2) 07:13 (2) 19:03	07:00 19:38	06:08 20:09	05:17 20:31
20	07:16 16:52	07:38 (3) 07:55 (3) 17:31	07:02 (2) 07:10 (2) 19:05	06:58 19:39	06:06 20:10	05:17 20:31
21	07:16 16:53	07:37 (3) 07:54 (3) 17:33	06:56 19:06	06:05 19:40	05:28 20:11	05:17 20:32
22	07:15 16:55	07:36 (3) 07:54 (3) 17:34	06:54 19:07	06:03 19:41	05:27 20:12	05:18 20:32
23	07:14 16:56	07:36 (3) 07:55 (3) 17:35	06:53 19:08	06:02 19:42	05:26 20:13	05:18 20:32
24	07:14 16:57	07:35 (3) 07:54 (3) 17:36	06:51 19:09	06:00 19:43	05:25 20:14	05:18 20:32
25	07:13 16:58	07:35 (3) 07:53 (3) 17:38	06:49 19:10	05:59 19:45	05:25 20:15	05:19 20:33
26	07:12 17:00	07:37 (3) 07:52 (3) 17:39	06:47 19:11	05:57 19:46	05:24 20:16	05:19 20:33
27	07:11 17:01	07:38 (3) 07:51 (3) 17:40	06:46 19:12	05:56 19:47	05:23 20:17	05:19 20:33
28	07:10 17:02	07:41 (3) 07:49 (3) 17:41	06:44 19:13	05:54 19:48	05:23 20:17	05:20 20:33
29	07:10 17:03		06:42 19:15	05:53 19:49	05:22 20:18	05:20 20:33
30	07:09 17:05		06:41 19:16	05:52 19:50	05:22 20:19	05:20 20:33
31	07:08 17:06		06:39 19:17		05:21 20:20	
Potential sun hours	295	296	370	400	451	455
Total, worst case	294	48	61			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

Colebrook\_CT\_North

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Calculated:

2/18/2011 2:02 PM/2.7.449

## SHADOW - Calendar

Calculation: Colebrook North Shadow Flicker Results Shadow receptor: DK - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (116)

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

	July	August	September	October	November	December
1	05:21 20:33	05:46 20:14	06:18 19:28	06:49 18:36	07:09 (1) 07:20 (1)	06:25 16:48
2	05:21 20:33	05:47 20:12	06:19 19:26	06:50 18:34	07:10 (1) 07:21 (1)	06:26 16:47
3	05:22 20:32	05:48 20:11	06:20 19:25	06:51 18:33	07:12 (1) 07:22 (1)	06:27 16:46
4	05:23 20:32	05:49 20:10	06:21 19:23	06:52 18:31	07:13 (1) 07:22 (1)	06:29 16:44
5	05:23 20:32	05:50 20:09	06:22 19:21	06:54 18:29	07:14 (1) 07:21 (1)	06:30 16:43
6	05:24 20:32	05:51 20:08	06:23 19:20	06:55 18:28	07:15 (1) 07:20 (1)	06:31 16:42
7	05:24 20:31	05:52 20:07	06:24 19:18	06:56 18:26	07:16 (1) 07:18 (1)	06:32 16:41
8	05:25 20:31	05:53 20:05	06:25 19:16	06:57 18:24	06:33 16:40	06:33 16:40
9	05:26 20:31	05:54 20:04	06:26 19:14	06:58 18:23	06:35 16:39	06:35 16:39
10	05:26 20:30	05:55 20:03	06:27 19:13	06:59 18:21	06:36 16:38	06:36 16:38
11	05:27 20:30	05:56 20:01	06:28 19:11	07:00 18:19	06:37 16:37	06:37 16:37
12	05:28 20:30	05:57 20:00	06:29 19:09	07:01 18:18	06:38 16:36	06:38 16:36
13	05:29 20:29	05:58 19:57	06:30 19:07	07:02 18:16	06:40 16:35	06:40 16:35
14	05:29 20:29	05:59 19:56	06:31 19:06	07:04 18:14	06:41 16:34	07:13 (3) 07:22 (3)
15	05:30 20:28	06:00 19:55	06:32 19:04	07:05 18:13	06:42 16:33	07:11 (3) 07:24 (3)
16	05:31 20:27	06:01 19:53	06:33 19:02	07:06 18:11	06:43 16:32	07:09 (3) 07:25 (3)
17	05:32 20:27	06:02 19:52	06:34 19:00	07:07 18:10	06:45 16:31	07:09 (3) 07:27 (3)
18	05:33 20:26	06:03 19:50	06:35 18:59	07:08 18:08	06:46 16:30	07:09 (3) 07:28 (3)
19	05:34 20:25	06:04 19:49	06:37 18:57	07:09 18:06	06:47 16:29	07:10 (3) 07:29 (3)
20	05:34 20:25	06:05 19:47	06:38 18:55	07:10 18:05	06:48 16:29	07:11 (3) 07:29 (3)
21	05:35 20:24	06:06 19:46	06:39 18:53	07:12 18:03	06:49 16:28	07:13 (3) 07:30 (3)
22	05:36 20:23	06:07 19:44	06:40 18:52	07:13 18:02	06:51 16:27	07:14 (3) 07:31 (3)
23	05:37 20:22	06:08 19:43	06:41 18:50	07:14 18:01	06:52 16:27	07:15 (3) 07:31 (3)
24	05:38 20:21	06:10 19:41	06:42 18:48	07:15 17:59	06:53 16:26	07:16 (3) 07:31 (3)
25	05:39 20:21	06:11 19:39	06:43 18:46	07:16 17:58	06:54 16:26	07:18 (3) 07:32 (3)
26	05:40 20:20	06:12 19:38	06:44 18:45	07:18 17:56	06:55 16:25	07:19 (3) 07:33 (3)
27	05:41 20:19	06:13 19:36	06:45 18:43	07:19 17:55	06:56 16:24	07:20 (3) 07:33 (3)
28	05:42 20:18	06:14 19:35	06:46 18:41	07:20 17:53	06:57 16:24	07:21 (3) 07:33 (3)
29	05:43 20:17	06:15 19:33	06:47 18:39	07:21 17:52	06:59 16:24	07:22 (3) 07:33 (3)
30	05:44 20:16	06:16 19:31	06:48 18:38	07:22 07:11 (1)	07:00 07:00	07:23 (3) 07:21
31	05:45 20:15	06:17 19:30	06:49 18:37	07:24 17:49	07:01 17:51	07:24 (3) 16:31
Potential sun hours	462	430	375	344	295	285
Total, worst case			8	104	251	48

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)