Supplemental Shadow Flicker Analysis

Wind Colebrook South

17 and 29 Flagg Hill Road
Colebrook, Connecticut

Prepared for

Prepared by

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Introduction

BNE Energy Inc. ("BNE") proposes to install three wind turbines ("Wind Colebrook South" or the "Project") at 17 and 29 Flagg Hill Road (collectively identified herein as the "Property" or "Site") in the Town of Colebrook, Connecticut. 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 41.25 meters (135+ feet). Vanasse Hangen Brustlin, Inc. ("VHB") conducted this supplemental shadow flicker analysis for the Project to evaluate a maximum blade tip height of 141.25 meters (463± feet) AGL and to account for changes in clearing limits resulting from recent Project design modifications.

The wind turbines would be located at the following ground elevations at the Site:

Table 1
Wind Colebrook South Turbine Locations

Turbine Number	**Location on Site**	**Elevation***
Turbine 1	Southern	1,450-feet
Turbine 2	Northeastern	1,452-feet
Turbine 3	Northwestern	1,446-feet

*Expressed in feet Above Mean Sea Level ("AMSL")

The Property is identified in the Town of Colebrook land records as Map 1, Lot 6 (29 Flagg Hill Road) and Map 1, Lot 6-1 (17 Flagg Hill Road) and consists of 79.44 acres of land. A 3.5± acre open field is located in its eastern portion and a 6.7± acre beaver pond lies in the southwest corner. The Property is abutted to the west by the municipal boundary with Norfolk and dense, wooded, and undeveloped land owned by the Nature Conservancy. To the north is wooded and vacant land maintained by the Northwestern Connecticut Sportsmen's Association. Flagg Hill Road, undeveloped woodlands, and a residence bound the Property to the east. About a dozen private residences are located along Flagg Hill Road. Heavily wooded tracts of land lie further east. A residence and additional undeveloped woodlands bound the Property to the south.

Topography surrounding the Site is generally characterized by gently rolling to steep hills with ground elevations that range from approximately 613 feet AMSL to approximately 1,760 feet AMSL. Vegetative cover on and near the Site consists primarily of mixed deciduous hardwood trees, with some stands of intermixed conifers; the average height of the tree canopy 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.[1]

In Europe,[2] 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 x (hub height + rotor radius)

[1] *Environmental Impacts of Wind Energy Projects*, National Academy Press, 2007, p. 160.
[2] Best Practice Guidelines for the Irish Wind Energy Industry; Irish Wind Energy Association, 2008

Using this formula at the Project Site, the maximum distance of shadow would be approximately 1.4 km (or 0.84 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 82.5 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 0.94 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.[3] 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.[4]

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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 modular-based software package developed by EMD International that was designed specifically for the planning and evaluation of wind power projects.

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; the "greenhouse" mode sensors can see in all directions, as if the receptor were an entirely glass structure (similar to a greenhouse), with no obstructions to block incoming light (or shadows). Under this scenario, an occupant of the structure would see a shadow from a blade regardless of the direction from which it was coming. The model's default receptor dimensions were used in the analysis: one square meter (1-meter height by 1-meter width). The receptor locations were assumed to be at 1 meter above ground level. The default slope of the window is vertical 90°. A total of 75 receptors were identified within the 2,000-meter Study Area.

[3] Shedding Light on Photosensitivity, http://www.epilepsyfoundation.org/about/photosensitivity/gerba.cfm
[4] Photosensitive Epilepsy, http://www.epilepsy.org.uk/info/photosensitive/triggers#turbines

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

Input Data	**Data Source**
Wind Turbine Locations	Geographic Coordinates provided by Client
Wind Turbine Model Type	GE 1.6xl (100 meter hub height and 41.25 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
75 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:

- As previously discussed, the software's "greenhouse" mode sensors see in all directions, as if the receptor were a glass structure with no obstructions to block incoming shadow light.

- 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, http://cdo.ncdc.noaa.gov/cgi-bin/climatenornals.pl
	Average Climate in Colebrook, Connecticut, http://www.city-data.com/city/Colebrook-Connecticut.html
Percentage of Possible Humidity	Average Climate in Colebrook, Connecticut, http://www.city-data.com/city/Colebrook-Connecticut.html

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.[5] Town-specific climate data supports this information, which indicates an annual average number of cloudy days of approximately 45%.[6]

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). Site-specific wind data (over a 13-month period; 12/12/08 through 1-24-10) 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[7]. Based on site-specific wind data, prevailing westerly winds occur slightly less than 50% annually. Potentially affected receptors lie generally east 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.

[5] Climate Services Branch, National Climatic Data Center, **http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl,** *Climate of Connecticut*, p. 5.
[6] http://www.city-data.com/city/Colebrook-Connecticut.html
[7] 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 (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*, located at the end of this report. Note this figure was developed using a raster image created from the WindPRO software calculations. The WindPro raster image of shadow flicker is a 10-meter by 10-meter grid cell dataset that contains values based on the tabulated report values. Due to the 10-meter resolution of the grid cells, the resulting raster image is not as accurate as the tabulated values, and thus has been incorporated into Figure 1 to depict a generalization of the shadow flicker results.

The resultant shadow flicker calculations expected per receptor are presented in Table 4, *Shadow Flicker Results – Receptor Locations,* located in the Tables section at the end of this report. Table 5, *Receptor Locations*, also 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.[8] A German court ruled that 30 hours of actual shadow flicker per years was acceptable at a neighboring property.[9] In

[8] Best Practice Guidelines for the Irish Wind Energy Industry; Irish Wind Energy Association, 2008
[9] Danish Wind Industry Association, June 8, 2003; http://www.windpower.org/en/tour/env/shadow/index.htm

Austria, recommendations suggest that show flicker should not exceed 30 hours per year.[10] 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.[11] Although wind energy ordinances currently exist in some communities throughout this country, many have no regulations in place[12]. 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[13], 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[14]). Numerous applications for wind turbines in communities across the United States and elsewhere appear to have adopted a 30-hour annual benchmark for evaluating shadow flicker occurrences, most likely as a result of there being no domestic regulations and relying on the European and Australian guidelines. The results of this analysis have been evaluated with respect to the 30 hours per year level for comparative purposes only.

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Results

The Project was analyzed to determine the potential for shadow flicker impacts at the 75 receptors located within the Study Area using a combination of worst-case scenario modeling and incorporating a probable-case scenario. A total of seven receptors are predicted to experience shadow flicker at some time during the year, with annual durations ranging from nearly 10 hours to over 48 hours. One receptor is predicted to experience more than 30 hours per year; three receptors are predicted to experience between 20 and 30 hours; and three receptors between approximately 10 and 17 hours annually. The receptor predicted to experience more than 30 hours annually is the residence located on the Property at 17 Flagg Hill Road[15].

The neighboring property at 29A Flagg Hill Road is predicted to experience approximately 27.5 hours of shadow flicker resulting from Turbine 1. Two additional receptors are forecasted to experience shadow flicker between 20 and 21.5 hours; these receptors are located at 8 Flagg Hill Road (receptors L and M on Figure 1), southeast of the intersection of Flagg Hill Road and Route 44. Across Route 44 to the east/northeast, three additional receptors are predicted to experience shadow flicker between approximately 10 and 17 hours annually. Turbine 2 appears to be the unit that most influences shadow flicker at these receptors, this turbine would be located at distances ranging from approximately 1,280 to 1,790 feet away. Contribution from Turbine 1 is expected to occur at one receptor (L) for about a four week period (December-January); Turbine 1 is located approximately 2,440 feet from this receptor. Based on a review of the WindPRO SHADOW Calendar calculations, shadow flicker would occur in the late afternoon, generally within one to two hours before sunset, when the sun is low on the horizon. On any

[10] 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",
[11] Sustainable Energy Authority Victoria, May 2003: "Policy and planning guidelines for development of wind energy facilities in Victoria", p.26.
[12] F. Oteri, *An Overview of Existing Wind Energy Ordinances*, December 2008)
[13] Ibid
[14] Ibid
[15]The 17 Flagg Hill Road property is owned by the principals of BNE.

given day when shadow flicker is predicted to occur, it appears that the duration of the effect would last less than one hour.

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

Table 6
Shadow Flicker Per Turbine

Turbine No.	**Total Flicker Hours/Year**
Turbine 1	61:45
Turbine 2	200:13
Turbine 3	0:00

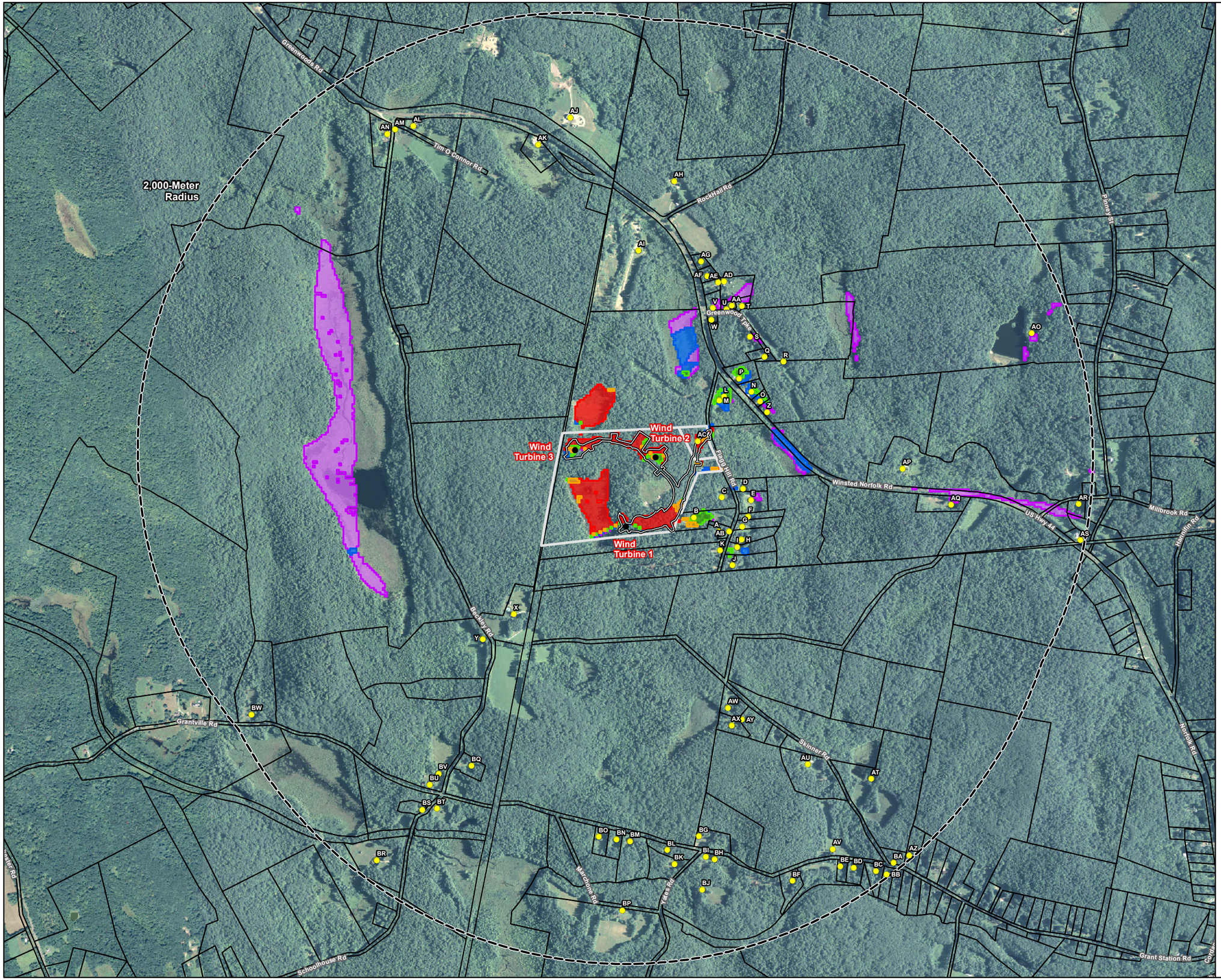
The analysis of potential shadow flicker impacts from the Project on nearby receptors demonstrates low occurrence of flicker throughout the majority of the Study Area. Of the 75 receptors evaluated, seven are predicted to have some shadow flicker events (representing approximately 9% of the total receptor 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 unobstructed lines-of-sight towards incoming shadow flicker sunlight from all sides. In reality, the windows of some structures do not fall directly within the sun-turbine vector. 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% reduction 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 South
BNE Energy, Inc.
17 & 29 Flagg Hill Road
Colebrook, Connecticut



Legend

- Receptor
- Proposed Wind Turbine Location
- 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

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- > 40

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

N

500 250 0 500 Meters

1,000 500 0 1,000 Feet

BNE Energy Inc.
Producer of green clean energy

VHB Vanasse Hangen Brustlin, Inc.

Tables

Table 4
Shadow Flicker Results - Receptor Locations

Map ID	Site Address	Worst-Case Analysis [1]		Probable Case Scenario [2]				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[3]	% of Hours/Year[4]					
AC	17 Flagg Hill Road	96:43:00	105	48:21:30	53	1.085%	0.552%	3/21-5/11; 8/2-9/23	Residential	1,668 Ft	682 Ft	1,847 Ft
B	29A Flagg Hill Road	55:04:00	77	27:32:00	39	0.617%	0.314%	3/24-4/30; 8/12-9/19	Residential	1,020 Ft	1,071 Ft	2,055 Ft
L	8 Flagg Hill Road	42:54:00	93	21:27:00	47	0.481%	0.245%	1/26-2/26; 10/15-11/16; 12/9-1/4	Residential	2,443 Ft	1,378 Ft	2,378 Ft
M	8 Flagg Hill Road	40:04:00	67	20:02:00	34	0.449%	0.229%	1/28-3/1; 10/12-11/14	Residential	2,349 Ft	1,284 Ft	2,287 Ft
P	120 Winsted-Norfolk Road	33:42:00	72	16:51:00	36	0.378%	0.192%	1/7-2/11; 10/31-12/5	Residential	2,791 Ft	1,730 Ft	2,689 Ft
N	114 Winsted-Norfolk Road	23:29:00	51	11:44:30	26	0.263%	0.134%	2/2-2/26; 10/15-11/9	Residential	2,761 Ft	1,741 Ft	2,789 Ft
O	110 Winsted-Norfolk Road	19:55:00	45	9:57:30	23	0.223%	0.114%	2/16-3/10; 10/4-10/25	Residential	2,758 Ft	1,789 Ft	2,880 Ft

Notes:

[1] 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.

[2] 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.

[3] Calculations of potential sun hours per year based on WindPRO Calendar values (4,459 hours annually, worst-case).

[4] Calculations of hours per year based on maximum of 8,760 hours per year.

Table 5

Receptor Locations

Receptor ID	*MBL*	*Receptor Site Address*	*Receptor ID*	*MBL*	*Receptor Site Address*	*Receptor ID*	*MBL*	*Receptor Site Address*
A	1-2	45 FLAGG HILL ROAD	BD	008/155/015Z-5	165 DANBURY QTR RD	N	1-9	114 WINSTED-NORFOLK ROAD
AA	7-9	10 GREENWOODS TURNPIKE	BE	008/155/015Z-6	167 DANBURY QTR RD	O	1-10	110 WINSTED-NORFOLK ROAD
AB	1-3	43 FLAGG HILL ROAD	BF	008/155/015YA	177 DANBURY QTR RD	P	1-8	120 WINSTED-NORFOLK ROAD
AC	1-6-1	17 FLAGG HILL ROAD	BG	007/155/015C	206 DANBURY QTR RD	Q	7-13	25 GREENWOODS TURNPIKE
AD	7-10	12A GREENWOODS TURNPIKE	BH	007/155/013	105 GRANTVILLE RD	R	7-12	WINSTED-NORFOLK ROAD
AE	7-7	150 WINSTED-NORFOLK ROAD	BI	007/155/013	105 GRANTVILLE RD	S	7-14	17 GREENWOODS TURNPIKE
AF	7-6	154 WINSTED-NORFOLK ROAD	BJ	007/155/013	105 GRANTVILLE RD	T	7-11	12B GREENWOODS TURNPIKE
AG	7-5	160 WINSTED-NORFOLK ROAD	BK	007/155/013X	104 GRANTVILLE RD	U	7-9	10 GREENWOODS TURNPIKE
AH	7-3	112 ROCK HALL ROAD	BL	007/155/013A	195 DANBURY QTR RD	V	7-8	4 GREENWOODS TURNPIKE
AI	7-2	177 WINSTED-NORFOLK ROAD	BM	007/155/019A	199 DANBURY QTR RD	W	7-15	1 GREENWOODS TURNPIKE
AJ	4-10 4	599 GREENWOODS RD E	BN	007/155/019B-2	201 DANBURY QTR RD	X	4-08 8	319 BECKLEY RD
AK	4-10 6	602 GREENWOODS RD E	BO	007/155/019B-1	203 DANBURY QTR RD	Y	4-08 1	324 BECKLEY RD
AL	4-10 3	542 GREENWOODS RD E	BP	013/155/012	152 GRANTVILLE RD	Z	7-12	WINSTED-NORFOLK ROAD
AM	4-10 2	5 BECKLEY RD	BQ	4-06 10-1	393 BECKLEY RD			
AN	4-10 1	12 BECKLEY RD	BR	4-06 5	211 SCHOOLHOUSE RD			
AO	8-1	117 PINNEY STREET	BS	4-06 6-1	243 SCHOOLHOUSE RD			
AP	2-1	52 WINSTED-NORFOLK ROAD	BT	4-06 11	248 SCHOOLHOUSE RD			
AQ	2-34	37 WINSTED-NORFOLK ROAD	BU	4-06 8	289 GRANTVILLE RD			
AR	2-31	132 MILLBROOK ROAD	BV	4-06 8	289 GRANTVILLE RD			
AS	2-28	2 WINSTED-NORFOLK ROAD	BW	5-06 8	171 GRANTVILLE RD			
AT	008/155/015X	126 SKINNER RD	C	1-5	33 FLAGG HILL ROAD			
AU	008/155/015A	121 SKINNER RD	D	1-16	28 FLAGG HILL ROAD			
AV	007/155/015	178 DANBURY QTR RD	E	1-17	30 FLAGG HILL ROAD			
AW	007/155/016X-4	129 SKINNER RD	F	1-18	36 FLAGG HILL ROAD			
AX	007/155/016X-6	135 SKINNER RD	G	1-19	40 FLAGG HILL ROAD			
AY	008/155/016X-3	127 SKINNER RD	H	1-20	42 FLAGG HILL ROAD			
AZ	008/155/006Y-11	164 DANBURY QTR RD	I	1-21	44 FLAGG HILL ROAD			
B	1-4	29A FLAGG HILL ROAD	J	1-22	48 FLAGG HILL ROAD			
BA	008/155/015B	168 DANBURY QTR RD	K	1-1	47 FLAGG HILL ROAD			
BB	008/155/015Z-2	159 DANBURY QTR RD	L	1-15	8 FLAGG HILL ROAD			
BC	008/155/015Z-3	157 DANBURY QTR RD	M	1-15	8 FLAGG HILL ROAD			

All receptor/property locations evaluated within 2,000 meters of project site.

Appendix A

Project:
Colebrook CT Wind Project

Printed/Page
3/10/2011 12:43 PM / 3
Licensed user:
Vanasse Hangen Brustlin, Inc.
1001 Walnut Street
US-WATERTOWN, MA 02472
+1 (617) 924 1770
Nicole Dentamaro / ndentamaro@vhb.com
Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Main Result

Calculation: new cleaning limits

...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]	[°]	[°]	
BV	652,721	4,645,897	377.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
BW	651,864	4,646,166	373.5	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	55:04	77	0:55
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	42:54	93	0:44
M	40:04	67	0:46
N	23:29	51	0:36
O	19:55	45	0:34
P	33:42	72	0:37
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	96:43	105	1:13
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
AJ	0:00	0	0:00
AK	0:00	0	0:00
AL	0:00	0	0:00
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	0:00	0	0:00

To be continued on next page...

Project:
Colebrook CT Wind Project

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3/10/2011 12:43 PM / 4

Licensed user:
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Nicole Dentamaro / ndentamaro@vhb.com

Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Main Result

Calculation: new cleaning limits

...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]
AS	0:00	0	0:00
AT	0:00	0	0:00
AU	0:00	0	0:00
AV	0:00	0	0:00
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	0:00	0	0:00
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	0:00	0	0:00
BT	0:00	0	0:00
BU	0:00	0	0:00
BV	0:00	0	0:00
BW	0:00	0	0:00

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)	61:45	
2	GE WIND ENERGY GE 1.5 xle 1500 82.5 !O! hub: 100.0 m (2)	200:13	
3	GE WIND ENERGY GE 1.5 xle 1500 82.5 !O! hub: 100.0 m (3)	0:00	

Appendix B

Project:

Colebrook CT Wind Project

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Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** B - Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (3)

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	07:07	06:29		06:37		17:24 (1)	05:50	05:20	05:21	05:46		06:18		17:17 (1)	06:49	06:25	07:01
	16:32	17:07	17:42		19:18	47	18:11 (1)	19:51	20:21	20:33	20:14		19:28	55	18:12 (1)	18:36	16:48	16:23
2	07:21	07:06	06:28		06:35		17:23 (1)	05:49	05:20	05:21	05:47		06:19		17:17 (1)	06:50	06:26	07:02
	16:33	17:09	17:44		19:19	49	18:12 (1)	19:52	20:22	20:32	20:12		19:26	55	18:12 (1)	18:34	16:47	16:23
3	07:21	07:05	06:26		06:34		17:22 (1)	05:48	05:20	05:22	05:48		06:20		17:16 (1)	06:51	06:27	07:03
	16:34	17:10	17:45		19:20	51	18:13 (1)	19:53	20:22	20:32	20:11		19:25	55	18:11 (1)	18:33	16:46	16:22
4	07:21	07:03	06:25		06:32		17:21 (1)	05:46	05:19	05:23	05:49		06:21		17:16 (1)	06:52	06:28	07:04
	16:35	17:11	17:46		19:21	52	18:13 (1)	19:54	20:23	20:32	20:10		19:23	55	18:11 (1)	18:31	16:44	16:22
5	07:21	07:02	06:23		06:30		17:21 (1)	05:45	05:19	05:23	05:50		06:22		17:16 (1)	06:54	06:30	07:05
	16:36	17:12	17:47		19:22	53	18:14 (1)	19:55	20:24	20:32	20:09		19:21	54	18:10 (1)	18:29	16:43	16:22
6	07:21	07:01	06:21		06:29		17:20 (1)	05:44	05:18	05:24	05:51		06:23		17:16 (1)	06:55	06:31	07:06
	16:37	17:14	17:48		19:23	53	18:13 (1)	19:57	20:24	20:32	20:08		19:19	54	18:10 (1)	18:28	16:42	16:22
7	07:21	07:00	06:20		06:27		17:19 (1)	05:42	05:18	05:24	05:52		06:24		17:16 (1)	06:56	06:32	07:07
	16:38	17:15	17:50		19:25	54	18:13 (1)	19:58	20:25	20:31	20:07		19:18	53	18:09 (1)	18:26	16:41	16:22
8	07:21	06:59	07:18		06:25		17:19 (1)	05:41	05:18	05:25	05:53		06:25		17:16 (1)	06:57	06:33	07:08
	16:39	17:16	18:51		19:26	55	18:14 (1)	19:59	20:26	20:31	20:05		19:16	52	18:08 (1)	18:24	16:40	16:22
9	07:21	06:58	07:16		06:24		17:18 (1)	05:40	05:18	05:26	05:54		06:26		17:16 (1)	06:58	06:35	07:09
	16:40	17:18	18:52		19:27	55	18:13 (1)	20:00	20:26	20:31	20:04		19:14	51	18:07 (1)	18:22	16:39	16:22
10	07:21	06:57	07:15		06:22		17:18 (1)	05:39	05:17	05:26	05:55		06:27		17:16 (1)	06:59	06:36	07:09
	16:41	17:19	18:53		19:28	55	18:13 (1)	20:00	20:27	20:30	20:03		19:13	50	18:06 (1)	18:21	16:38	16:22
11	07:20	06:55	07:13		06:20		17:18 (1)	05:38	05:17	05:27	05:56		06:28		17:17 (1)	07:00	06:37	07:10
	16:42	17:20	18:54		19:29	55	18:13 (1)	20:01	20:28	20:30	20:01		19:11	47	18:04 (1)	18:19	16:37	16:22
12	07:20	06:54	07:11		06:19		17:18 (1)	05:37	05:17	05:28	05:57		17:48 (1)		06:29	17:17 (1)	07:01	06:38	07:11
	16:43	17:21	18:55		19:30	55	18:13 (1)	20:02	20:28	20:29	20:00	7	17:55 (1)		19:09	46	18:03 (1)	18:18	16:36	16:22
13	07:20	06:53	07:10		06:17		17:17 (1)	05:36	05:17	05:29	05:58		17:43 (1)		06:30		17:18 (1)	07:02	06:40	07:12
	16:44	17:23	18:57		19:31	55	18:12 (1)	20:03	20:29	20:29	19:57	17	18:00 (1)		19:07	43	18:01 (1)	18:16	16:35	16:22
14	07:19	06:51	07:08		06:16		17:18 (1)	05:35	05:17	05:29	05:59		17:40 (1)		06:31		17:19 (1)	07:04	06:41	07:13
	16:45	17:24	18:58		19:32	54	18:12 (1)	20:04	20:29	20:28	19:56	22	18:02 (1)		19:06	41	18:00 (1)	18:14	16:34	16:22
15	07:19	06:50	07:06		06:14		17:18 (1)	05:33	05:17	05:30	06:00		17:37 (1)		06:32		17:20 (1)	07:05	06:42	07:13
	16:46	17:25	18:59		19:33	53	18:11 (1)	20:05	20:30	20:28	19:54	27	18:04 (1)		19:04	38	17:58 (1)	18:13	16:33	16:22
16	07:19	06:49	07:05		06:12		17:19 (1)	05:32	05:17	05:31	06:01		17:35 (1)		06:33		17:21 (1)	07:06	06:43	07:14
	16:47	17:26	19:00		19:35	52	18:11 (1)	20:06	20:30	20:27	19:53	31	18:06 (1)		19:02	34	17:55 (1)	18:11	16:32	16:23
17	07:18	06:47	07:03		06:11		17:18 (1)	05:32	05:17	05:32	06:02		17:33 (1)		06:34		17:23 (1)	07:07	06:44	07:15
	16:49	17:28	19:01		19:36	52	18:10 (1)	20:07	20:30	20:27	19:52	34	18:07 (1)		19:00	30	17:53 (1)	18:10	16:31	16:23
18	07:18	06:46	07:01		06:09		17:19 (1)	05:31	05:17	05:33	06:03		17:31 (1)		06:35		17:26 (1)	07:08	06:46	07:16
	16:50	17:29	19:02		19:37	51	18:10 (1)	20:08	20:31	20:26	19:50	37	18:08 (1)		18:59	23	17:49 (1)	18:08	16:30	16:23
19	07:17	06:44	06:59		06:08		17:20 (1)	05:30	05:17	05:34	06:04		17:30 (1)		06:37		17:30 (1)	07:09	06:47	07:16
	16:51	17:30	19:03		19:38	48	18:08 (1)	20:09	20:31	20:25	19:49	39	18:09 (1)		18:57	15	17:45 (1)	18:06	16:29	16:24
20	07:16	06:43	06:58		06:06		17:21 (1)	05:29	05:17	05:34	06:05		17:28 (1)		06:38			07:10	06:48	07:17
	16:52	17:31	19:05		19:39	47	18:08 (1)	20:10	20:31	20:25	19:47	42	18:10 (1)		18:55			18:05	16:29	16:24
21	07:16	06:42	06:56		06:05		17:21 (1)	05:28	05:18	05:35	06:06		17:27 (1)		06:39			07:12	06:49	07:17
	16:53	17:33	19:06		19:40	46	18:07 (1)	20:11	20:32	20:24	19:46	44	18:11 (1)		18:53			18:03	16:28	16:25
22	07:15	06:40	06:54		06:03		17:22 (1)	05:27	05:18	05:36	06:07		17:26 (1)		06:40			07:13	06:50	07:18
	16:55	17:34	19:07		19:41	44	18:06 (1)	20:12	20:32	20:23	19:44	45	18:11 (1)		18:52			18:02	16:27	16:25
23	07:14	06:39	06:53		06:02		17:23 (1)	05:26	05:18	05:37	06:08		17:24 (1)		06:41			07:14	06:52	07:18
	16:56	17:35	19:08		19:42	41	18:04 (1)	20:13	20:32	20:22	19:42	48	18:12 (1)		18:50			18:00	16:27	16:26
24	07:14	06:37	06:51		17:44 (1)	06:00		17:24 (1)	05:25	05:18	05:38		06:10		17:23 (1)	06:42			07:15	06:53	07:19
	16:57	17:36	19:09	12	17:56 (1)	19:43	39	18:03 (1)	20:14	20:32	20:21		19:41	49	18:12 (1)	18:48			17:59	16:26	16:26
25	07:13	06:36	06:49		17:38 (1)	05:59		17:25 (1)	05:25	05:19	05:39		06:11		17:22 (1)	06:43			07:16	06:54	07:19
	16:58	17:38	19:10	22	18:00 (1)	19:44	36	18:01 (1)	20:15	20:32	20:20		19:39	51	18:13 (1)	18:46			17:58	16:26	16:27
26	07:12	06:34	06:47		17:36 (1)	05:57		17:27 (1)	05:24	05:19	05:40		06:12		17:21 (1)	06:44			07:18	06:55	07:20
	17:00	17:39	19:11	28	18:04 (1)	19:46	33	18:00 (1)	20:16	20:33	20:20		19:38	52	18:13 (1)	18:45			17:56	16:25	16:27
27	07:11	06:33	06:46		17:33 (1)	05:56		17:28 (1)	05:23	05:19	05:41		06:13		17:20 (1)	06:45			07:19	06:56	07:20
	17:01	17:40	19:12	33	18:06 (1)	19:47	30	17:58 (1)	20:17	20:33	20:19		19:36	53	18:13 (1)	18:43			17:55	16:25	16:28
28	07:10	06:31	06:44		17:30 (1)	05:54		17:30 (1)	05:23	05:20	05:42		06:14		17:20 (1)	06:46			07:20	06:57	07:20
	17:02	17:41	19:13	37	18:07 (1)	19:48	26	17:56 (1)	20:17	20:33	20:18		19:34	53	18:13 (1)	18:41			17:53	16:24	16:29
29	07:09		06:42		17:28 (1)	05:53		17:33 (1)	05:22	05:20	05:43		06:15		17:19 (1)	06:47			07:21	06:59	07:20
	17:03		19:15	40	18:08 (1)	19:49	21	17:54 (1)	20:18	20:33	20:17		19:33	54	18:13 (1)	18:39			17:52	16:24	16:29
30	07:09		06:41		17:27 (1)	05:52		17:35 (1)	05:22	05:21	05:44		06:16		17:18 (1)	06:48			07:22	07:00	07:21
	17:05		19:16	43	18:10 (1)	19:50	15	17:50 (1)	20:19	20:33	20:16		19:31	55	18:13 (1)	18:38			17:51	16:23	16:30
31	07:08		06:39		17:25 (1)				05:21		05:45		06:17		17:18 (1)				07:24		07:21
	17:06		19:17	46	18:11 (1)				20:20		20:15		19:30	55	18:13 (1)				17:49		16:31
Potential sun hours	295	296	370			400			451	455	462		430			375			344	296	285
Total, worst case				261			1377							815			851				

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 Wind Project

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3/10/2011 12:49 PM / 12

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Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** L - Shadow Receptor: 1.0 × 1.0 Azimuth: 146.7° 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	July	August	September	October			November			December		
1	07:21		14:40 (1)	07:07		15:01 (2)	06:29	06:37	05:50	05:20	05:21	05:46	06:18	06:49			06:25		14:26 (2)	07:01		
	16:32	12	14:52 (1)	17:07	32	15:33 (2)	17:42	19:18	19:51	20:21	20:33	20:14	19:28	18:36			16:48	43	15:09 (2)	16:23		
2	07:21		14:41 (1)	07:06		15:00 (2)	06:28	06:35	05:49	05:20	05:21	05:47	06:19	06:50			06:26		14:27 (2)	07:02		
	16:33	11	14:52 (1)	17:08	35	15:35 (2)	17:44	19:19	19:52	20:22	20:32	20:12	19:26	18:34			16:47	43	15:10 (2)	16:23		
3	07:21		14:43 (1)	07:05		15:00 (2)	06:26	06:34	05:48	05:20	05:22	05:48	06:20	06:51			06:27		14:27 (2)	07:03		
	16:34	8	14:51 (1)	17:10	36	15:36 (2)	17:45	19:20	19:53	20:22	20:32	20:11	19:25	18:33			16:46	42	15:09 (2)	16:22		
4	07:21		14:45 (1)	07:03		14:59 (2)	06:25	06:32	05:46	05:19	05:23	05:49	06:21	06:52			06:28		14:27 (2)	07:04		
	16:35	5	14:50 (1)	17:11	38	15:37 (2)	17:46	19:21	19:54	20:23	20:32	20:10	19:23	18:31			16:44	41	15:08 (2)	16:22		
5	07:21			07:02		14:59 (2)	06:23	06:30	05:45	05:19	05:23	05:50	06:22	06:54			06:30		14:29 (2)	07:05		
	16:36			17:12	39	15:38 (2)	17:47	19:22	19:55	20:24	20:32	20:09	19:21	18:29			16:43	40	15:09 (2)	16:22		
6	07:21			07:01		14:59 (2)	06:21	06:29	05:44	05:18	05:24	05:51	06:23	06:55			06:31		14:29 (2)	07:06		
	16:37			17:14	40	15:39 (2)	17:48	19:23	19:57	20:24	20:32	20:08	19:19	18:28			16:42	39	15:08 (2)	16:22		
7	07:21			07:00		14:58 (2)	06:20	06:27	05:42	05:18	05:24	05:52	06:24	06:56			06:32		14:29 (2)	07:07		
	16:38			17:15	41	15:39 (2)	17:50	19:25	19:58	20:25	20:31	20:07	19:18	18:26			16:41	38	15:07 (2)	16:22		
8	07:21			06:59		14:57 (2)	07:18	06:25	05:41	05:18	05:25	05:53	06:25	06:57			06:33		14:31 (2)	07:08		14:34 (1)
	16:39			17:16	42	15:39 (2)	18:51	19:26	19:59	20:26	20:31	20:05	19:16	18:24			16:40	36	15:07 (2)	16:22	3	14:37 (1)
9	07:21			06:58		14:58 (2)	07:16	06:24	05:40	05:18	05:26	05:54	06:26	06:58			06:35		14:31 (2)	07:09		14:32 (1)
	16:40			17:18	42	15:40 (2)	18:52	19:27	20:00	20:26	20:31	20:04	19:14	18:22			16:39	34	15:05 (2)	16:22	8	14:40 (1)
10	07:21			06:57		14:58 (2)	07:15	06:22	05:39	05:17	05:26	05:55	06:27	06:59			06:36		14:32 (2)	07:09		14:30 (1)
	16:41			17:19	43	15:41 (2)	18:53	19:28	20:00	20:27	20:30	20:03	19:13	18:21			16:38	32	15:04 (2)	16:22	11	14:41 (1)
11	07:20			06:55		14:57 (2)	07:13	06:20	05:38	05:17	05:27	05:56	06:28	07:00			06:37		14:34 (2)	07:10		14:30 (1)
	16:42			17:20	43	15:40 (2)	18:54	19:29	20:01	20:28	20:30	20:01	19:11	18:19			16:37	30	15:04 (2)	16:22	12	14:42 (1)
12	07:20			06:54		14:57 (2)	07:11	06:19	05:37	05:17	05:28	05:57	06:29	07:01			06:38		14:35 (2)	07:11		14:30 (1)
	16:43			17:21	44	15:41 (2)	18:55	19:30	20:02	20:28	20:29	20:00	19:09	18:18			16:36	27	15:02 (2)	16:22	13	14:43 (1)
13	07:20			06:53		14:58 (2)	07:10	06:17	05:36	05:17	05:29	05:58	06:30	07:02			06:40		14:37 (2)	07:12		14:30 (1)
	16:44			17:23	43	15:41 (2)	18:57	19:31	20:03	20:29	20:29	19:57	19:07	18:16			16:35	23	15:00 (2)	16:22	14	14:44 (1)
14	07:19			06:51		14:57 (2)	07:08	06:16	05:35	05:17	05:29	05:59	06:31	07:04			06:41		14:39 (2)	07:13		14:30 (1)
	16:45			17:24	43	15:40 (2)	18:58	19:32	20:04	20:29	20:28	19:56	19:06	18:14			16:34	20	14:59 (2)	16:22	16	14:46 (1)
15	07:19			06:50		14:58 (2)	07:06	06:14	05:33	05:17	05:30	06:00	06:32	07:05		15:49 (2)	06:42		14:42 (2)	07:13		14:30 (1)
	16:46			17:25	43	15:41 (2)	18:59	19:33	20:05	20:30	20:28	19:54	19:04	18:13	7	15:56 (2)	16:33	15	14:57 (2)	16:22	16	14:46 (1)
16	07:19			06:49		14:59 (2)	07:05	06:12	05:32	05:17	05:31	06:01	06:33	07:06		15:43 (2)	06:43		14:46 (2)	07:14		14:30 (1)
	16:47			17:26	42	15:41 (2)	19:00	19:35	20:06	20:30	20:27	19:53	19:02	18:11	17	16:00 (2)	16:32	6	14:52 (2)	16:23	17	14:47 (1)
17	07:18			06:47		14:59 (2)	07:03	06:11	05:31	05:17	05:32	06:02	06:34	07:07		15:41 (2)	06:44			07:15		14:31 (1)
	16:49			17:28	41	15:40 (2)	19:01	19:36	20:07	20:30	20:27	19:52	19:00	18:10	22	16:03 (2)	16:31			16:23	17	14:48 (1)
18	07:18			06:46		15:00 (2)	07:01	06:09	05:31	05:17	05:33	06:03	06:35	07:08		15:38 (2)	06:46			07:16		14:30 (1)
	16:50			17:29	40	15:40 (2)	19:02	19:37	20:08	20:31	20:26	19:50	18:59	18:08	27	16:05 (2)	16:30			16:23	18	14:48 (1)
19	07:17			06:44		15:00 (2)	06:59	06:08	05:30	05:17	05:34	06:04	06:36	07:09		15:36 (2)	06:47			07:16		14:31 (1)
	16:51			17:30	38	15:38 (2)	19:03	19:38	20:09	20:31	20:25	19:49	18:57	18:06	30	16:06 (2)	16:29			16:24	18	14:49 (1)
20	07:16			06:43		15:02 (2)	06:58	06:06	05:29	05:17	05:34	06:05	06:38	07:10		15:34 (2)	06:48			07:17		14:32 (1)
	16:52			17:31	36	15:38 (2)	19:05	19:39	20:10	20:31	20:25	19:47	18:55	18:05	33	16:07 (2)	16:29			16:24	18	14:50 (1)
21	07:16			06:42		15:02 (2)	06:56	06:05	05:28	05:18	05:35	06:06	06:39	07:12		15:32 (2)	06:49			07:17		14:32 (1)
	16:53			17:33	35	15:37 (2)	19:06	19:40	20:11	20:32	20:24	19:46	18:53	18:03	35	16:07 (2)	16:28			16:24	18	14:50 (1)
22	07:15			06:40		15:04 (2)	06:54	06:03	05:27	05:18	05:36	06:07	06:40	07:13		15:32 (2)	06:50			07:18		14:33 (1)
	16:55			17:34	32	15:36 (2)	19:07	19:41	20:12	20:32	20:23	19:44	18:52	18:02	37	16:09 (2)	16:27			16:25	18	14:51 (1)
23	07:14			06:39		15:05 (2)	06:53	06:02	05:26	05:18	05:37	06:08	06:41	07:14		15:31 (2)	06:52			07:18		14:33 (1)
	16:56			17:35	29	15:34 (2)	19:08	19:42	20:13	20:32	20:22	19:42	18:50	18:00	38	16:09 (2)	16:27			16:25	18	14:51 (1)
24	07:14			06:37		15:08 (2)	06:51	06:00	05:25	05:18	05:38	06:10	06:42	07:15		15:29 (2)	06:53			07:19		14:33 (1)
	16:57			17:36	25	15:33 (2)	19:09	19:43	20:14	20:32	20:21	19:41	18:48	17:59	40	16:09 (2)	16:26			16:26	18	14:51 (1)
25	07:13			06:36		15:09 (2)	06:49	05:59	05:25	05:19	05:39	06:11	06:43	07:16		15:28 (2)	06:54			07:19		14:34 (1)
	16:58			17:38	21	15:30 (2)	19:10	19:44	20:15	20:32	20:21	19:39	18:46	17:58	41	16:09 (2)	16:26			16:27	18	14:52 (1)
26	07:12		15:13 (2)	06:34		15:13 (2)	06:47	05:57	05:24	05:19	05:40	06:12	06:44	07:18		15:28 (2)	06:55			07:20		14:35 (1)
	17:00	7	15:20 (2)	17:39	14	15:27 (2)	19:11	19:46	20:16	20:33	20:20	19:38	18:45	17:56	42	16:10 (2)	16:25			16:27	17	14:52 (1)
27	07:11		15:09 (2)	06:33			06:46	05:56	05:23	05:19	05:41	06:13	06:45	07:19		15:28 (2)	06:56			07:20		14:35 (1)
	17:01	15	15:24 (2)	17:40			19:12	19:47	20:17	20:33	20:19	19:36	18:43	17:55	42	16:10 (2)	16:24			16:28	17	14:52 (1)
28	07:10		15:06 (2)	06:31			06:44	05:54	05:23	05:20	05:42	06:14	06:46	07:20		15:27 (2)	06:57			07:20		14:37 (1)
	17:02	20	15:26 (2)	17:41			19:13	19:48	20:17	20:33	20:18	19:34	18:41	17:53	43	16:10 (2)	16:24			16:29	16	14:53 (1)
29	07:09		15:05 (2)				06:42	05:53	05:22	05:20	05:43	06:15	06:47	07:21		15:27 (2)	06:59			07:20		14:37 (1)
	17:03	24	15:29 (2)				19:15	19:49	20:18	20:33	20:17	19:33	18:39	17:52	44	16:11 (2)	16:24			16:29	16	14:53 (1)
30	07:09		15:03 (2)				06:41	05:52	05:22	05:20	05:44	06:16	06:48	07:22		15:27 (2)	07:00			07:21		14:38 (1)
	17:05	27	15:30 (2)				19:16	19:50	20:19	20:33	20:16	19:31	18:38	17:51	43	16:10 (2)	16:23			16:30	15	14:53 (1)
31	07:08		15:02 (2)				06:39		05:21		05:45	06:17		07:24		15:27 (2)				07:21		14:39 (1)
	17:06	30	15:32 (2)				19:17		20:20		20:15	19:30		17:49	43	16:10 (2)				16:31	13	14:52 (1)
Potential sun hours	295			296			370	400	451	455	462	430	375	344			296			285		
Total, worst case		159			957										584			509			365	

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 Wind Project

Printed/Page
3/10/2011 12:49 PM / 13

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1001 Walnut Street
US-WATERTOWN, MA 02472
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Nicole Dentamaro / ndentamaro@vhb.com

Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** M - Shadow Receptor: 1.0 × 1.0 Azimuth: 114.3° 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	July	August	September	October	November	December
1	07:21	07:07	14:58 (2) 06:29	15:07 (2) 06:37	05:50	05:20	05:21	05:46	06:18	06:49	06:25	14:21 (2) 07:01
	16:32	17:07 29	15:27 (2) 17:42	16 15:23 (2) 19:18	19:51	20:21	20:33	20:14	19:28	18:36	16:48 44	15:05 (2) 16:23
2	07:21	07:06	14:56 (2) 06:28	06:35	05:49	05:20	05:21	05:47	06:19	06:50	06:26	14:22 (2) 07:02
	16:33	17:08 32	15:28 (2) 17:44	19:19	19:52	20:22	20:32	20:12	19:26	18:34	16:47 43	15:05 (2) 16:23
3	07:21	07:05	14:56 (2) 06:26	06:34	05:48	05:20	05:22	05:48	06:20	06:51	06:27	14:22 (2) 07:03
	16:34	17:10 34	15:30 (2) 17:45	19:20	19:53	20:22	20:32	20:11	19:25	18:33	16:46 42	15:04 (2) 16:22
4	07:21	07:04	14:55 (2) 06:25	06:32	05:46	05:19	05:23	05:49	06:21	06:52	06:28	14:22 (2) 07:04
	16:35	17:11 36	15:31 (2) 17:46	19:21	19:54	20:23	20:32	20:10	19:23	18:31	16:44 41	15:03 (2) 16:22
5	07:21	07:02	14:54 (2) 06:23	06:30	05:45	05:19	05:23	05:50	06:22	06:54	06:30	14:24 (2) 07:05
	16:36	17:12 38	15:32 (2) 17:47	19:22	19:55	20:24	20:32	20:09	19:21	18:29	16:43 39	15:03 (2) 16:22
6	07:21	07:01	14:54 (2) 06:21	06:29	05:44	05:18	05:24	05:51	06:23	06:55	06:31	14:24 (2) 07:06
	16:37	17:14 40	15:34 (2) 17:48	19:23	19:57	20:24	20:32	20:08	19:19	18:28	16:42 38	15:02 (2) 16:22
7	07:21	07:00	14:52 (2) 06:20	06:27	05:42	05:18	05:24	05:52	06:24	06:56	06:32	14:25 (2) 07:07
	16:38	17:15 42	15:34 (2) 17:50	19:25	19:58	20:25	20:31	20:07	19:18	18:26	16:41 36	15:01 (2) 16:22
8	07:21	06:59	14:52 (2) 07:18	06:25	05:41	05:18	05:25	05:53	06:25	06:57	06:33	14:27 (2) 07:08
	16:39	17:16 43	15:35 (2) 18:51	19:26	19:59	20:26	20:31	20:05	19:16	18:24	16:40 34	15:01 (2) 16:22
9	07:21	06:58	14:52 (2) 07:16	06:24	05:40	05:18	05:26	05:54	06:26	06:58	06:35	14:28 (2) 07:09
	16:40	17:18 44	15:36 (2) 18:52	19:27	20:00	20:26	20:31	20:04	19:14	18:22	16:39 31	14:59 (2) 16:22
10	07:21	06:57	14:52 (2) 07:15	06:22	05:39	05:17	05:26	05:55	06:27	06:59	06:36	14:29 (2) 07:09
	16:41	17:19 44	15:36 (2) 18:53	19:28	20:00	20:27	20:30	20:03	19:13	18:21	16:38 28	14:57 (2) 16:22
11	07:20	06:55	14:51 (2) 07:13	06:20	05:38	05:17	05:27	05:56	06:28	07:00	06:37	14:31 (2) 07:10
	16:42	17:20 45	15:36 (2) 18:54	19:29	20:01	20:28	20:30	20:01	19:11	18:19	16:37 25	14:56 (2) 16:22
12	07:20	06:54	14:51 (2) 07:11	06:19	05:37	05:17	05:28	05:57	06:29	07:01 15:44 (2)	06:38	14:33 (2) 07:11
	16:43	17:21 46	15:37 (2) 18:55	19:30	20:02	20:28	20:29	20:00	19:09	18:18 10 15:54 (2)	16:36 21	14:54 (2) 16:22
13	07:20	06:53	14:51 (2) 07:10	06:17	05:36	05:17	05:29	05:58	06:30	07:02 15:39 (2)	06:40	14:35 (2) 07:12
	16:44	17:23 46	15:37 (2) 18:57	19:31	20:03	20:29	20:29	19:57	19:07	18:16 19 15:58 (2)	16:35 17	14:52 (2) 16:22
14	07:19	06:51	14:51 (2) 07:08	06:16	05:35	05:17	05:29	05:59	06:31	07:04 15:36 (2)	06:41	14:40 (2) 07:13
	16:45	17:24 46	15:37 (2) 18:58	19:32	20:04	20:29	20:28	19:56	19:06	18:14 24 16:00 (2)	16:34 8	14:48 (2) 16:22
15	07:19	06:50	14:51 (2) 07:06	06:14	05:33	05:17	05:30	06:00	06:32	07:05 15:33 (2)	06:42	07:13
	16:46	17:25 46	15:37 (2) 18:59	19:33	20:05	20:30	20:28	19:54	19:04	18:13 28 16:01 (2)	16:33	16:22
16	07:19	06:49	14:52 (2) 07:05	06:12	05:32	05:17	05:31	06:01	06:33	07:06 15:31 (2)	06:43	07:14
	16:47	17:26 46	15:38 (2) 19:00	19:35	20:06	20:30	20:27	19:53	19:02	18:11 31 16:02 (2)	16:32	16:23
17	07:18	06:47	14:51 (2) 07:03	06:11	05:31	05:17	05:32	06:02	06:34	07:07 15:29 (2)	06:44	07:15
	16:49	17:28 46	15:37 (2) 19:01	19:36	20:07	20:30	20:27	19:52	19:00	18:10 35 16:04 (2)	16:31	16:23
18	07:18	06:46	14:52 (2) 07:01	06:09	05:31	05:17	05:33	06:03	06:35	07:08 15:28 (2)	06:46	07:16
	16:50	17:29 45	15:37 (2) 19:02	19:37	20:08	20:31	20:26	19:50	18:59	18:08 37 16:05 (2)	16:30	16:23
19	07:17	06:44	14:52 (2) 06:59	06:08	05:30	05:17	05:34	06:04	06:36	07:09 15:26 (2)	06:47	07:16
	16:51	17:30 44	15:36 (2) 19:03	19:38	20:09	20:31	20:25	19:49	18:57	18:06 39 16:05 (2)	16:29	16:24
20	07:16	06:43	14:53 (2) 06:58	06:06	05:29	05:17	05:34	06:05	06:38	07:10 15:25 (2)	06:48	07:17
	16:52	17:31 43	15:36 (2) 19:05	19:39	20:10	20:31	20:25	19:47	18:55	18:05 41 16:06 (2)	16:29	16:24
21	07:16	06:42	14:53 (2) 06:56	06:05	05:28	05:18	05:35	06:06	06:39	07:12 15:23 (2)	06:49	07:17
	16:53	17:33 42	15:35 (2) 19:06	19:40	20:11	20:32	20:24	19:46	18:53	18:03 43 16:06 (2)	16:28	16:24
22	07:15	06:40	14:54 (2) 06:54	06:03	05:27	05:18	05:36	06:07	06:40	07:13 15:23 (2)	06:50	07:18
	16:55	17:34 41	15:35 (2) 19:07	19:41	20:12	20:32	20:23	19:44	18:52	18:02 44 16:07 (2)	16:27	16:25
23	07:14	06:39	14:55 (2) 06:53	06:02	05:26	05:18	05:37	06:08	06:41	07:14 15:22 (2)	06:52	07:18
	16:56	17:35 39	15:34 (2) 19:08	19:42	20:13	20:32	20:22	19:42	18:50	18:00 45 16:07 (2)	16:27	16:25
24	07:14	06:37	14:57 (2) 06:51	06:00	05:25	05:18	05:38	06:10	06:42	07:15 15:22 (2)	06:53	07:19
	16:57	17:36 36	15:33 (2) 19:09	19:43	20:14	20:32	20:21	19:41	18:48	17:59 45 16:07 (2)	16:26	16:26
25	07:13	06:36	14:58 (2) 06:49	05:59	05:25	05:19	05:39	06:11	06:43	07:16 15:21 (2)	06:54	07:19
	16:58	17:38 33	15:31 (2) 19:10	19:44	20:15	20:32	20:21	19:39	18:46	17:58 46 16:07 (2)	16:26	16:27
26	07:12	06:34	15:00 (2) 06:47	05:57	05:24	05:19	05:40	06:12	06:44	07:18 15:21 (2)	06:55	07:20
	17:00	17:39 30	15:30 (2) 19:11	19:46	20:16	20:33	20:20	19:38	18:45	17:56 46 16:07 (2)	16:25	16:27
27	07:11	06:33	15:01 (2) 06:46	05:56	05:23	05:19	05:41	06:13	06:45	07:19 15:21 (2)	06:56	07:20
	17:01	17:40 27	15:28 (2) 19:12	19:47	20:17	20:33	20:19	19:36	18:43	17:55 46 16:07 (2)	16:24	16:28
28	07:10 15:07 (2)	06:31	15:04 (2) 06:44	05:54	05:23	05:20	05:42	06:14	06:46	07:20 15:20 (2)	06:57	07:20
	17:02 9 15:16 (2)	17:41 23	15:27 (2) 19:13	19:48	20:17	20:33	20:18	19:34	18:41	17:53 46 16:06 (2)	16:24	16:29
29	07:09 15:03 (2)		06:42	05:53	05:22	05:20	05:43	06:15	06:47	07:21 15:21 (2)	06:59	07:20
	17:03 17 15:20 (2)		19:15	19:49	20:18	20:33	20:17	19:33	18:39	17:52 46 16:07 (2)	16:24	16:29
30	07:09 15:01 (2)		06:41	05:52	05:22	05:20	05:44	06:16	06:48	07:22 15:21 (2)	07:00	07:21
	17:05 22 15:23 (2)		19:16	19:50	20:19	20:33	20:16	19:31	18:38	17:51 45 16:06 (2)	16:23	16:30
31	07:08 14:59 (2)		06:39		05:21		05:45	06:17		07:24 15:21 (2)		07:21
	17:06 26 15:25 (2)		19:17		20:20		20:15	19:30		17:49 45 16:06 (2)		16:31
Potential sun hours	295	296	370	400	451	455	462	430	375	344	296	285
Total, worst case	74	1106	16							761	447	

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 Wind Project

Printed/Page
3/10/2011 12:49 PM / 14

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Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** N - Shadow Receptor: 1.0 × 1.0 Azimuth: 49.7° Slope: 90.0° (18)

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	07:07		06:29	06:37	05:50	05:20	05:21	05:46	06:18	06:49		06:25	15:03 (2)	07:01
	16:32	17:07		17:42	19:18	19:51	20:21	20:33	20:14	19:28	18:36		16:48	15:35 (2)	16:23
2	07:21	07:06	15:43 (2)	06:28	06:35	05:49	05:20	05:21	05:47	06:19	06:50		06:26	15:04 (2)	07:02
	16:33	17:08	11 15:54 (2)	17:44	19:19	19:52	20:22	20:32	20:12	19:26	18:34		16:47	32 15:36 (2)	16:23
3	07:21	07:05	15:41 (2)	06:26	06:34	05:48	05:20	05:22	05:48	06:20	06:51		06:27	15:04 (2)	07:03
	16:34	17:10	16 15:57 (2)	17:45	19:20	19:53	20:22	20:32	20:11	19:25	18:33		16:46	30 15:34 (2)	16:22
4	07:21	07:03	15:39 (2)	06:25	06:32	05:46	05:19	05:23	05:49	06:21	06:52		06:28	15:05 (2)	07:04
	16:35	17:11	21 16:00 (2)	17:46	19:21	19:54	20:23	20:32	20:10	19:23	18:31		16:44	28 15:33 (2)	16:22
5	07:21	07:02	15:38 (2)	06:23	06:30	05:45	05:19	05:23	05:50	06:22	06:54		06:30	15:07 (2)	07:05
	16:36	17:12	24 16:02 (2)	17:47	19:22	19:55	20:24	20:32	20:09	19:21	18:29		16:43	26 15:33 (2)	16:22
6	07:21	07:01	15:37 (2)	06:21	06:29	05:44	05:18	05:24	05:51	06:23	06:55		06:31	15:08 (2)	07:06
	16:37	17:14	26 16:03 (2)	17:48	19:23	19:57	20:24	20:32	20:08	19:19	18:27		16:42	23 15:31 (2)	16:22
7	07:21	07:00	15:35 (2)	06:20	06:27	05:42	05:18	05:24	05:52	06:24	06:56		06:32	15:09 (2)	07:07
	16:38	17:15	29 16:04 (2)	17:50	19:25	19:58	20:25	20:31	20:07	19:18	18:26		16:41	20 15:29 (2)	16:22
8	07:21	06:59	15:35 (2)	07:18	06:25	05:41	05:18	05:25	05:53	06:25	06:57		06:33	15:12 (2)	07:08
	16:39	17:16	30 16:05 (2)	18:51	19:26	19:59	20:26	20:31	20:05	19:16	18:24		16:40	16 15:28 (2)	16:22
9	07:21	06:58	15:34 (2)	07:16	06:24	05:40	05:18	05:26	05:54	06:26	06:58		06:35	15:15 (2)	07:09
	16:40	17:18	32 16:06 (2)	18:52	19:27	20:00	20:26	20:31	20:04	19:14	18:22		16:39	10 15:25 (2)	16:22
10	07:21	06:57	15:34 (2)	07:15	06:22	05:39	05:17	05:26	05:55	06:27	06:59		06:36		07:09
	16:41	17:19	33 16:07 (2)	18:53	19:28	20:00	20:27	20:30	20:03	19:13	18:21		16:38		16:22
11	07:20	06:55	15:33 (2)	07:13	06:20	05:38	05:17	05:27	05:56	06:28	07:00		06:37		07:10
	16:42	17:20	34 16:07 (2)	18:54	19:29	20:01	20:28	20:30	20:01	19:11	18:19		16:37		16:22
12	07:20	06:54	15:33 (2)	07:11	06:19	05:37	05:17	05:28	05:57	06:29	07:01		06:38		07:11
	16:43	17:21	34 16:07 (2)	18:55	19:30	20:02	20:28	20:29	20:00	19:09	18:18		16:36		16:22
13	07:20	06:53	15:33 (2)	07:10	06:17	05:36	05:17	05:29	05:58	06:30	07:02		06:40		07:12
	16:44	17:23	35 16:08 (2)	18:57	19:31	20:03	20:29	20:29	19:57	19:07	18:16		16:35		16:22
14	07:19	06:51	15:32 (2)	07:08	06:16	05:35	05:17	05:29	05:59	06:31	07:04		06:41		07:13
	16:45	17:24	36 16:08 (2)	18:58	19:32	20:04	20:29	20:28	19:56	19:06	18:14		16:34		16:22
15	07:19	06:50	15:33 (2)	07:06	06:14	05:33	05:17	05:30	06:00	06:32	07:05		16:20 (2)	06:42	07:13
	16:46	17:25	35 16:08 (2)	18:59	19:33	20:05	20:30	20:28	19:54	19:04	18:13	5	16:25 (2)	16:33	16:22
16	07:19	06:49	15:33 (2)	07:05	06:12	05:32	05:17	05:31	06:01	06:33	07:06		16:15 (2)	06:43	07:14
	16:47	17:26	35 16:08 (2)	19:00	19:35	20:06	20:30	20:27	19:53	19:02	18:11	14	16:29 (2)	16:32	16:23
17	07:18	06:47	15:33 (2)	07:03	06:11	05:31	05:17	05:32	06:02	06:34	07:07		16:13 (2)	06:44	07:15
	16:48	17:28	35 16:08 (2)	19:01	19:36	20:07	20:30	20:27	19:52	19:00	18:10	19	16:32 (2)	16:31	16:23
18	07:18	06:46	15:34 (2)	07:01	06:09	05:31	05:17	05:33	06:03	06:35	07:08		16:10 (2)	06:46	07:16
	16:50	17:29	34 16:08 (2)	19:02	19:37	20:08	20:31	20:26	19:50	18:59	18:08	24	16:34 (2)	16:30	16:23
19	07:17	06:44	15:34 (2)	06:59	06:08	05:30	05:17	05:34	06:04	06:36	07:09		16:08 (2)	06:47	07:16
	16:51	17:30	33 16:07 (2)	19:03	19:38	20:09	20:31	20:25	19:49	18:57	18:06	27	16:35 (2)	16:29	16:24
20	07:16	06:43	15:35 (2)	06:58	06:06	05:29	05:17	05:34	06:05	06:38	07:10		16:07 (2)	06:48	07:17
	16:52	17:31	31 16:06 (2)	19:05	19:39	20:10	20:31	20:25	19:47	18:55	18:05	28	16:35 (2)	16:29	16:24
21	07:16	06:42	15:35 (2)	06:56	06:05	05:28	05:17	05:35	06:06	06:39	07:12		16:05 (2)	06:49	07:17
	16:53	17:33	30 16:05 (2)	19:06	19:40	20:11	20:32	20:24	19:46	18:53	18:03	31	16:36 (2)	16:28	16:24
22	07:15	06:40	15:36 (2)	06:54	06:03	05:27	05:18	05:36	06:07	06:40	07:13		16:05 (2)	06:50	07:18
	16:55	17:34	29 16:05 (2)	19:07	19:41	20:12	20:32	20:23	19:44	18:52	18:02	32	16:37 (2)	16:27	16:25
23	07:14	06:39	15:37 (2)	06:53	06:02	05:26	05:18	05:37	06:08	06:41	07:14		16:04 (2)	06:52	07:18
	16:56	17:35	26 16:03 (2)	19:08	19:42	20:13	20:32	20:22	19:42	18:50	18:00	33	16:37 (2)	16:27	16:25
24	07:14	06:37	15:39 (2)	06:51	06:00	05:25	05:18	05:38	06:10	06:42	07:15		16:03 (2)	06:53	07:19
	16:57	17:36	23 16:02 (2)	19:09	19:43	20:14	20:32	20:21	19:41	18:48	17:59	34	16:37 (2)	16:26	16:26
25	07:13	06:36	15:41 (2)	06:49	05:59	05:25	05:19	05:39	06:11	06:43	07:16		16:02 (2)	06:54	07:19
	16:58	17:38	18 15:59 (2)	19:10	19:44	20:15	20:32	20:21	19:39	18:46	17:58	35	16:37 (2)	16:26	16:27
26	07:12	06:34	15:45 (2)	06:47	05:57	05:24	05:19	05:40	06:12	06:44	07:18		16:03 (2)	06:55	07:20
	17:00	17:39	12 15:57 (2)	19:11	19:46	20:16	20:33	20:20	19:38	18:45	17:56	35	16:38 (2)	16:25	16:27
27	07:11	06:33		06:46	05:56	05:23	05:19	05:41	06:13	06:45	07:19		16:02 (2)	06:56	07:20
	17:01	17:40		19:12	19:47	20:17	20:33	20:19	19:36	18:43	17:55	36	16:38 (2)	16:24	16:28
28	07:10	06:31		06:44	05:54	05:23	05:20	05:42	06:14	06:46	07:20		16:02 (2)	06:57	07:20
	17:02	17:41		19:13	19:48	20:17	20:33	20:18	19:34	18:41	17:53	35	16:37 (2)	16:24	16:29
29	07:09			06:42	05:53	05:22	05:20	05:43	06:15	06:47	07:21		16:03 (2)	06:59	07:20
	17:03			19:15	19:49	20:18	20:33	20:17	19:33	18:39	17:52	35	16:38 (2)	16:24	16:29
30	07:09			06:41	05:52	05:22	05:20	05:44	06:16	06:48	07:22		16:03 (2)	07:00	07:21
	17:05			19:16	19:50	20:19	20:33	20:16	19:31	18:38	17:51	34	16:37 (2)	16:23	16:30
31	07:08			06:39		05:21		05:45	06:17		07:24		16:03 (2)		07:21
	17:06			19:17		20:20		20:15	19:30		17:49	33	16:36 (2)		16:31
Potential sun hours	295	296		370	400	451	455	462	430	375	344		296		285
Total, worst case			702									490		217	

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 Wind Project

Printed/Page
3/10/2011 12:49 PM / 15

Licensed user:
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Nicole Dentamaro / ndentamaro@vhb.com

Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** O - Shadow Receptor: 1.0 × 1.0 Azimuth: 46.1° Slope: 90.0° (19)

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	07:07		06:29	15:55 (2)	06:37	05:50	05:20	05:21	05:46	06:18	06:49		06:25	07:01
	16:32	17:07		17:42 34	16:29 (2)	19:18	19:51	20:21	20:33	20:14	19:28	18:36		16:48	16:23
2	07:21	07:06		06:28	15:55 (2)	06:35	05:49	05:20	05:21	05:47	06:19	06:50		06:26	07:02
	16:33	17:08		17:44 33	16:28 (2)	19:19	19:52	20:22	20:32	20:12	19:26	18:34		16:47	16:23
3	07:21	07:05		06:26	15:56 (2)	06:34	05:48	05:20	05:22	05:48	06:20	06:51		06:27	07:03
	16:34	17:10		17:45 32	16:28 (2)	19:20	19:53	20:22	20:32	20:11	19:25	18:33		16:46	16:22
4	07:21	07:03		06:25	15:56 (2)	06:32	05:46	05:19	05:23	05:49	06:21	06:52	16:43 (2)	06:28	07:04
	16:35	17:11		17:46 31	16:27 (2)	19:21	19:54	20:23	20:32	20:10	19:23	18:31 12	16:55 (2)	16:44	16:22
5	07:21	07:02		06:23	15:58 (2)	06:30	05:45	05:19	05:23	05:50	06:22	06:54	16:39 (2)	06:30	07:05
	16:36	17:12		17:47 28	16:26 (2)	19:22	19:55	20:24	20:32	20:09	19:21	18:29 18	16:57 (2)	16:43	16:22
6	07:21	07:01		06:21	15:58 (2)	06:29	05:44	05:18	05:24	05:51	06:23	06:55	16:37 (2)	06:31	07:06
	16:37	17:14		17:48 27	16:25 (2)	19:23	19:56	20:24	20:32	20:08	19:19	18:27 22	16:59 (2)	16:42	16:22
7	07:21	07:00		06:20	15:59 (2)	06:27	05:42	05:18	05:24	05:52	06:24	06:56	16:35 (2)	06:32	07:07
	16:38	17:15		17:50 24	16:23 (2)	19:25	19:58	20:25	20:31	20:07	19:18	18:26 25	17:00 (2)	16:41	16:22
8	07:21	06:59		07:18	17:02 (2)	06:25	05:41	05:18	05:25	05:53	06:25	06:57	16:33 (2)	06:33	07:08
	16:39	17:16		18:51 19	17:21 (2)	19:26	19:59	20:26	20:31	20:05	19:16	18:24 27	17:00 (2)	16:40	16:22
9	07:21	06:58		07:16	17:04 (2)	06:24	05:40	05:18	05:26	05:54	06:26	06:58	16:31 (2)	06:35	07:09
	16:40	17:18		18:52 14	17:18 (2)	19:27	20:00	20:26	20:31	20:04	19:14	18:22 30	17:01 (2)	16:39	16:22
10	07:21	06:57		07:15	17:08 (2)	06:22	05:39	05:17	05:26	05:55	06:27	06:59	16:30 (2)	06:36	07:09
	16:41	17:19		18:53 5	17:13 (2)	19:28	20:00	20:27	20:30	20:03	19:13	18:21 31	17:01 (2)	16:38	16:22
11	07:20	06:55		07:13		06:20	05:38	05:17	05:27	05:56	06:28	07:00	16:29 (2)	06:37	07:10
	16:42	17:20		18:54		19:29	20:01	20:28	20:30	20:01	19:11	18:19 32	17:01 (2)	16:37	16:22
12	07:20	06:54		07:11		06:19	05:37	05:17	05:28	05:57	06:29	07:01	16:29 (2)	06:38	07:11
	16:43	17:21		18:55		19:30	20:02	20:28	20:29	20:00	19:09	18:18 33	17:02 (2)	16:36	16:22
13	07:20	06:53		07:10		06:17	05:36	05:17	05:29	05:58	06:30	07:02	16:28 (2)	06:40	07:12
	16:44	17:23		18:57		19:31	20:03	20:29	20:29	19:57	19:07	18:16 34	17:02 (2)	16:35	16:22
14	07:19	06:51		07:08		06:16	05:34	05:17	05:29	05:59	06:31	07:04	16:28 (2)	06:41	07:13
	16:45	17:24		18:58		19:32	20:04	20:29	20:28	19:56	19:06	18:14 34	17:02 (2)	16:34	16:22
15	07:19	06:50		07:06		06:14	05:33	05:17	05:30	06:00	06:32	07:05	16:27 (2)	06:42	07:13
	16:46	17:25		18:59		19:33	20:05	20:30	20:28	19:54	19:04	18:13 34	17:01 (2)	16:33	16:22
16	07:19	06:49	16:10 (2)	07:05		06:12	05:32	05:17	05:31	06:01	06:33	07:06	16:27 (2)	06:43	07:14
	16:47	17:26 7	16:17 (2)	19:00		19:34	20:06	20:30	20:27	19:53	19:02	18:11 34	17:01 (2)	16:32	16:23
17	07:18	06:47	16:05 (2)	07:03		06:11	05:31	05:17	05:32	06:02	06:34	07:07	16:28 (2)	06:44	07:15
	16:48	17:28 15	16:20 (2)	19:01		19:36	20:07	20:30	20:27	19:52	19:00	18:10 33	17:01 (2)	16:31	16:23
18	07:18	06:46	16:03 (2)	07:01		06:09	05:31	05:17	05:33	06:03	06:35	07:08	16:28 (2)	06:46	07:16
	16:50	17:29 20	16:23 (2)	19:02		19:37	20:08	20:31	20:26	19:50	18:59	18:08 32	17:00 (2)	16:30	16:23
19	07:17	06:44	16:01 (2)	06:59		06:08	05:30	05:17	05:34	06:04	06:36	07:09	16:28 (2)	06:47	07:16
	16:51	17:30 23	16:24 (2)	19:03		19:38	20:09	20:31	20:25	19:49	18:57	18:06 31	16:59 (2)	16:29	16:24
20	07:16	06:43	16:00 (2)	06:58		06:06	05:29	05:17	05:34	06:05	06:38	07:10	16:28 (2)	06:48	07:17
	16:52	17:31 26	16:26 (2)	19:05		19:39	20:10	20:31	20:25	19:47	18:55	18:05 30	16:58 (2)	16:29	16:24
21	07:16	06:42	15:58 (2)	06:56		06:05	05:28	05:17	05:35	06:06	06:39	07:12	16:29 (2)	06:49	07:17
	16:53	17:33 28	16:26 (2)	19:06		19:40	20:11	20:32	20:24	19:46	18:53	18:03 28	16:57 (2)	16:28	16:24
22	07:15	06:40	15:58 (2)	06:54		06:03	05:27	05:18	05:36	06:07	06:40	07:13	16:31 (2)	06:50	07:18
	16:55	17:34 30	16:28 (2)	19:07		19:41	20:12	20:32	20:23	19:44	18:52	18:02 25	16:56 (2)	16:27	16:25
23	07:14	06:39	15:56 (2)	06:53		06:02	05:26	05:18	05:37	06:08	06:41	07:14	16:32 (2)	06:52	07:18
	16:56	17:35 32	16:28 (2)	19:08		19:42	20:13	20:32	20:22	19:42	18:50	18:00 22	16:54 (2)	16:27	16:25
24	07:14	06:37	15:56 (2)	06:51		06:00	05:25	05:18	05:38	06:10	06:42	07:15	16:33 (2)	06:53	07:19
	16:57	17:36 33	16:29 (2)	19:09		19:43	20:14	20:32	20:21	19:41	18:48	17:59 19	16:52 (2)	16:26	16:26
25	07:13	06:36	15:55 (2)	06:49		05:59	05:25	05:19	05:39	06:11	06:43	07:16	16:35 (2)	06:54	07:19
	16:58	17:38 34	16:29 (2)	19:10		19:44	20:15	20:32	20:20	19:39	18:46	17:58 14	16:49 (2)	16:26	16:27
26	07:12	06:34	15:56 (2)	06:47		05:57	05:24	05:19	05:40	06:12	06:44	07:18		06:55	07:20
	17:00	17:39 33	16:29 (2)	19:11		19:46	20:16	20:33	20:20	19:38	18:45	17:56		16:25	16:27
27	07:11	06:33	15:55 (2)	06:46		05:56	05:23	05:19	05:41	06:13	06:45	07:19		06:56	07:20
	17:01	17:40 34	16:29 (2)	19:12		19:47	20:17	20:33	20:19	19:36	18:43	17:55		16:24	16:28
28	07:10	06:31	15:56 (2)	06:44		05:54	05:23	05:20	05:42	06:14	06:46	07:20		06:57	07:20
	17:02	17:41 33	16:29 (2)	19:13		19:48	20:17	20:33	20:18	19:34	18:41	17:53		16:24	16:29
29	07:09			06:42		05:53	05:22	05:20	05:43	06:15	06:47	07:21		06:59	07:20
	17:03			19:15		19:49	20:18	20:33	20:17	19:33	18:39	17:52		16:24	16:29
30	07:09			06:41		05:52	05:22	05:20	05:44	06:16	06:48	07:22		07:00	07:21
	17:05			19:16		19:50	20:19	20:33	20:16	19:31	18:38	17:51		16:23	16:30
31	07:08			06:39			05:21		05:45	06:17		07:24			07:21
	17:06			19:17			20:20		20:15	19:30		17:49			16:31
Potential sun hours	295	296		370		400	451	455	462	430	375	344		296	285
Total, worst case			348		247								600		

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 Wind Project

Printed/Page
3/10/2011 12:49 PM / 16

Licensed user:
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Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** P - Shadow Receptor: 1.0 × 1.0 Azimuth: 48.7° Slope: 90.0° (20)

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		07:07	15:03 (2)	06:29	06:37	05:50	05:20	05:21	05:46	06:18	06:49		06:25	14:43 (2)	07:01	14:48 (2)
	16:32		17:07	36 15:39 (2)	17:42	19:18	19:51	20:21	20:33	20:14	19:28	18:36		16:48	19 15:02 (2)	16:23	19 15:07 (2)
2	07:21		07:06	15:04 (2)	06:28	06:35	05:49	05:20	05:21	05:47	06:19	06:50		06:26	14:42 (2)	07:02	14:49 (2)
	16:33		17:08	35 15:39 (2)	17:44	19:19	19:52	20:22	20:32	20:12	19:26	18:34		16:47	22 15:04 (2)	16:23	17 15:06 (2)
3	07:21		07:05	15:05 (2)	06:26	06:34	05:48	05:20	05:22	05:48	06:20	06:51		06:27	14:40 (2)	07:03	14:51 (2)
	16:34		17:10	34 15:39 (2)	17:45	19:20	19:53	20:22	20:32	20:11	19:25	18:33		16:46	25 15:05 (2)	16:22	14 15:05 (2)
4	07:21		07:03	15:06 (2)	06:25	06:32	05:46	05:19	05:23	05:49	06:21	06:52		06:28	14:38 (2)	07:04	14:53 (2)
	16:35		17:11	33 15:39 (2)	17:46	19:21	19:54	20:23	20:32	20:10	19:23	18:31		16:44	28 15:06 (2)	16:22	11 15:04 (2)
5	07:21		07:02	15:07 (2)	06:23	06:30	05:45	05:19	05:23	05:50	06:22	06:54		06:30	14:38 (2)	07:05	14:56 (2)
	16:36		17:12	31 15:38 (2)	17:47	19:22	19:55	20:24	20:32	20:09	19:21	18:29		16:43	30 15:08 (2)	16:22	6 15:02 (2)
6	07:21		07:01	15:08 (2)	06:21	06:29	05:44	05:18	05:24	05:51	06:23	06:55		06:31	14:37 (2)	07:06	
	16:37		17:14	30 15:38 (2)	17:48	19:23	19:57	20:24	20:32	20:08	19:19	18:27		16:42	31 15:08 (2)	16:22	
7	07:21	15:11 (2)	07:00	15:08 (2)	06:20	06:27	05:42	05:18	05:24	05:52	06:24	06:56		06:32	14:36 (2)	07:07	
	16:38	6 15:17 (2)	17:15	28 15:36 (2)	17:50	19:25	19:58	20:25	20:31	20:07	19:18	18:26		16:41	32 15:08 (2)	16:22	
8	07:21	15:08 (2)	06:59	15:10 (2)	07:18	06:25	05:41	05:18	05:25	05:53	06:25	06:57		06:33	14:36 (2)	07:08	
	16:39	11 15:19 (2)	17:16	25 15:35 (2)	18:51	19:26	19:59	20:26	20:31	20:05	19:16	18:24		16:40	34 15:10 (2)	16:22	
9	07:21	15:07 (2)	06:58	15:12 (2)	07:16	06:24	05:40	05:18	05:26	05:54	06:26	06:58		06:35	14:35 (2)	07:09	
	16:40	14 15:21 (2)	17:18	22 15:34 (2)	18:52	19:27	20:00	20:26	20:31	20:04	19:14	18:22		16:39	35 15:10 (2)	16:22	
10	07:21	15:06 (2)	06:57	15:15 (2)	07:15	06:22	05:39	05:17	05:26	05:55	06:27	06:59		06:36	14:34 (2)	07:09	
	16:41	17 15:23 (2)	17:19	17 15:32 (2)	18:53	19:28	20:00	20:27	20:30	20:03	19:13	18:21		16:38	36 15:10 (2)	16:22	
11	07:20	15:06 (2)	06:55	15:17 (2)	07:13	06:20	05:38	05:17	05:27	05:56	06:28	07:00		06:37	14:35 (2)	07:10	
	16:42	19 15:25 (2)	17:20	12 15:29 (2)	18:54	19:29	20:01	20:28	20:30	20:01	19:11	18:19		16:37	36 15:11 (2)	16:22	
12	07:20	15:05 (2)	06:54		07:11	06:19	05:37	05:17	05:28	05:57	06:29	07:01		06:38	14:34 (2)	07:11	
	16:43	21 15:26 (2)	17:21		18:55	19:30	20:02	20:28	20:29	20:00	19:09	18:18		16:36	37 15:11 (2)	16:22	
13	07:20	15:05 (2)	06:53		07:10	06:17	05:36	05:17	05:29	05:58	06:30	07:02		06:40	14:34 (2)	07:12	
	16:44	23 15:28 (2)	17:23		18:57	19:31	20:03	20:29	20:29	19:57	19:07	18:16		16:35	37 15:11 (2)	16:22	
14	07:19	15:04 (2)	06:51		07:08	06:16	05:35	05:17	05:29	05:59	06:31	07:04		06:41	14:35 (2)	07:13	
	16:45	24 15:28 (2)	17:24		18:58	19:32	20:04	20:29	20:28	19:56	19:06	18:14		16:34	37 15:12 (2)	16:22	
15	07:19	15:04 (2)	06:50		07:06	06:14	05:33	05:17	05:30	06:00	06:32	07:05		06:42	14:35 (2)	07:13	
	16:46	26 15:30 (2)	17:25		18:59	19:33	20:05	20:30	20:28	19:54	19:04	18:13		16:33	36 15:11 (2)	16:22	
16	07:19	15:03 (2)	06:49		07:05	06:12	05:32	05:17	05:31	06:01	06:33	07:06		06:43	14:35 (2)	07:14	
	16:47	28 15:31 (2)	17:26		19:00	19:35	20:06	20:30	20:27	19:53	19:02	18:11		16:32	36 15:11 (2)	16:23	
17	07:18	15:03 (2)	06:47		07:03	06:11	05:31	05:17	05:32	06:02	06:34	07:07		06:44	14:35 (2)	07:15	
	16:48	29 15:32 (2)	17:28		19:01	19:36	20:07	20:30	20:27	19:52	19:00	18:10		16:31	36 15:11 (2)	16:23	
18	07:18	15:02 (2)	06:46		07:01	06:09	05:31	05:17	05:33	06:03	06:35	07:08		06:46	14:36 (2)	07:16	
	16:50	31 15:33 (2)	17:29		19:02	19:37	20:08	20:31	20:26	19:50	18:59	18:08		16:30	36 15:12 (2)	16:23	
19	07:17	15:02 (2)	06:44		06:59	06:08	05:30	05:17	05:34	06:04	06:36	07:09		06:47	14:36 (2)	07:16	
	16:51	31 15:33 (2)	17:30		19:03	19:38	20:09	20:31	20:25	19:49	18:57	18:06		16:29	35 15:11 (2)	16:24	
20	07:16	15:02 (2)	06:43		06:58	06:06	05:29	05:17	05:34	06:05	06:38	07:10		06:48	14:36 (2)	07:17	
	16:52	33 15:35 (2)	17:31		19:05	19:39	20:10	20:31	20:25	19:47	18:55	18:05		16:29	35 15:11 (2)	16:24	
21	07:16	15:02 (2)	06:42		06:56	06:05	05:28	05:17	05:35	06:06	06:39	07:12		06:49	14:38 (2)	07:17	
	16:53	33 15:35 (2)	17:33		19:06	19:40	20:11	20:32	20:24	19:46	18:53	18:03		16:28	33 15:11 (2)	16:24	
22	07:15	15:01 (2)	06:40		06:54	06:03	05:27	05:18	05:36	06:07	06:40	07:13		06:50	14:38 (2)	07:18	
	16:55	35 15:36 (2)	17:34		19:07	19:41	20:12	20:32	20:23	19:44	18:52	18:02		16:27	33 15:11 (2)	16:25	
23	07:14	15:02 (2)	06:39		06:53	06:02	05:26	05:18	05:37	06:08	06:41	07:14		06:52	14:39 (2)	07:18	
	16:56	35 15:37 (2)	17:35		19:08	19:42	20:13	20:32	20:22	19:42	18:50	18:00		16:27	31 15:10 (2)	16:25	
24	07:14	15:02 (2)	06:37		06:51	06:00	05:25	05:18	05:38	06:10	06:42	07:15		06:53	14:39 (2)	07:19	
	16:57	36 15:38 (2)	17:36		19:09	19:43	20:14	20:32	20:21	19:41	18:48	17:59		16:26	31 15:10 (2)	16:26	
25	07:13	15:02 (2)	06:36		06:49	05:59	05:25	05:19	05:39	06:11	06:43	07:16		06:54	14:41 (2)	07:19	
	16:58	36 15:38 (2)	17:38		19:10	19:44	20:15	20:32	20:21	19:39	18:46	17:58		16:26	29 15:10 (2)	16:27	
26	07:12	15:02 (2)	06:34		06:47	05:57	05:24	05:19	05:40	06:12	06:44	07:18		06:55	14:42 (2)	07:20	
	17:00	36 15:38 (2)	17:39		19:11	19:46	20:16	20:33	20:20	19:38	18:45	17:56		16:25	28 15:10 (2)	16:27	
27	07:11	15:02 (2)	06:33		06:46	05:56	05:23	05:19	05:41	06:13	06:45	07:19		06:56	14:43 (2)	07:20	
	17:01	36 15:38 (2)	17:40		19:12	19:47	20:17	20:33	20:19	19:36	18:43	17:55		16:24	26 15:09 (2)	16:28	
28	07:10	15:02 (2)	06:31		06:44	05:54	05:23	05:20	05:42	06:14	06:46	07:20		06:57	14:44 (2)	07:20	
	17:02	37 15:39 (2)	17:41		19:13	19:48	20:17	20:33	20:18	19:34	18:41	17:53		16:24	24 15:08 (2)	16:29	
29	07:09	15:02 (2)			06:42	05:53	05:22	05:20	05:43	06:15	06:47	07:21		06:59	14:45 (2)	07:20	
	17:03	37 15:39 (2)			19:15	19:49	20:18	20:33	20:17	19:33	18:39	17:52		16:24	23 15:08 (2)	16:29	
30	07:09	15:02 (2)			06:41	05:52	05:22	05:20	05:44	06:16	06:48	07:22		07:00	14:46 (2)	07:21	
	17:05	37 15:39 (2)			19:16	19:50	20:19	20:33	20:16	19:31	18:38	17:51		16:23	21 15:07 (2)	16:30	
31	07:08	15:03 (2)			06:39		05:21		05:45	06:17		07:24	15:46 (2)			07:21	
	17:06	36 15:39 (2)			19:17		20:20		20:15	19:30		17:49	13 15:59 (2)			16:31	
Potential sun hours	295		296		370	400	451	455	462	430	375	344		296		285	
Total, worst case	707		303									13		932		67	

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 Wind Project

Printed/Page
3/10/2011 12:49 PM / 29

Licensed user:
Vanasse Hangen Brustlin, Inc.
1001 Walnut Street
US-WATERTOWN, MA 02472
+1 (617) 924 1770
Nicole Dentamaro / ndentamaro@vhb.com

Calculated:
3/10/2011 12:04 PM/2.7.486

SHADOW - Calendar

Calculation: new cleaning limits**Shadow receptor:** AC - Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (41)

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	07:07	06:29	06:37 15:53 (2)	05:50 16:03 (2)	05:20	05:21	05:46	06:18 15:49 (2)	06:49	06:25	07:01
	16:32	17:07	17:42	19:18 66 16:59 (2)	19:51 48 16:51 (2)	20:21	20:33	20:14	19:28 72 17:01 (2)	18:36	16:48	16:23
2	07:21	07:06	06:28	06:35 15:53 (2)	05:49 16:04 (2)	05:20	05:21	05:47 16:32 (2)	06:19 15:48 (2)	06:50	06:26	07:02
	16:33	17:09	17:44	19:19 67 17:00 (2)	19:52 47 16:51 (2)	20:22	20:32	20:12 14 16:46 (2)	19:26 72 17:00 (2)	18:34	16:47	16:23
3	07:21	07:05	06:26	06:34 15:52 (2)	05:48 16:06 (2)	05:20	05:22	05:48 16:28 (2)	06:20 15:48 (2)	06:51	06:27	07:03
	16:34	17:10	17:45	19:20 68 17:00 (2)	19:53 44 16:50 (2)	20:22	20:32	20:11 21 16:49 (2)	19:25 72 17:00 (2)	18:33	16:46	16:22
4	07:21	07:04	06:25	06:32 15:51 (2)	05:46 16:07 (2)	05:19	05:23	05:49 16:26 (2)	06:21 15:47 (2)	06:52	06:28	07:04
	16:35	17:11	17:46	19:21 69 17:00 (2)	19:54 41 16:48 (2)	20:23	20:32	20:10 25 16:51 (2)	19:23 72 16:59 (2)	18:31	16:44	16:22
5	07:21	07:02	06:23	06:30 15:51 (2)	05:45 16:08 (2)	05:19	05:23	05:50 16:23 (2)	06:22 15:47 (2)	06:54	06:30	07:05
	16:36	17:12	17:47	19:22 70 17:01 (2)	19:55 39 16:47 (2)	20:24	20:32	20:09 30 16:53 (2)	19:21 71 16:58 (2)	18:29	16:43	16:22
6	07:21	07:01	06:21	06:29 15:50 (2)	05:44 16:10 (2)	05:18	05:24	05:51 16:21 (2)	06:23 15:46 (2)	06:55	06:31	07:06
	16:37	17:14	17:48	19:23 71 17:01 (2)	19:57 35 16:45 (2)	20:24	20:32	20:08 33 16:54 (2)	19:19 71 16:57 (2)	18:28	16:42	16:22
7	07:21	07:00	06:20	06:27 15:50 (2)	05:42 16:12 (2)	05:18	05:24	05:52 16:19 (2)	06:24 15:46 (2)	06:56	06:32	07:07
	16:38	17:15	17:50	19:25 71 17:01 (2)	19:58 32 16:44 (2)	20:25	20:31	20:07 37 16:56 (2)	19:18 70 16:56 (2)	18:26	16:41	16:22
8	07:21	06:59	07:18	06:25 15:50 (2)	05:41 16:14 (2)	05:18	05:25	05:53 16:17 (2)	06:25 15:46 (2)	06:57	06:33	07:08
	16:39	17:16	18:51	19:26 72 17:02 (2)	19:59 29 16:43 (2)	20:26	20:31	20:05 40 16:57 (2)	19:16 69 16:55 (2)	18:24	16:40	16:22
9	07:21	06:58	07:16	06:24 15:50 (2)	05:40 16:16 (2)	05:18	05:26	05:54 16:16 (2)	06:26 15:46 (2)	06:58	06:35	07:09
	16:40	17:18	18:52	19:27 72 17:02 (2)	20:00 24 16:40 (2)	20:26	20:31	20:04 42 16:58 (2)	19:14 68 16:54 (2)	18:22	16:39	16:22
10	07:21	06:57	07:15	06:22 15:49 (2)	05:39 16:19 (2)	05:17	05:26	05:55 16:14 (2)	06:27 15:46 (2)	06:59	06:36	07:09
	16:41	17:19	18:53	19:28 72 17:01 (2)	20:00 18 16:37 (2)	20:27	20:30	20:03 45 16:59 (2)	19:13 67 16:53 (2)	18:21	16:38	16:22
11	07:20	06:55	07:13	06:20 15:50 (2)	05:38 16:23 (2)	05:17	05:27	05:56 16:13 (2)	06:28 15:46 (2)	07:00	06:37	07:10
	16:42	17:20	18:54	19:29 72 17:02 (2)	20:01 11 16:34 (2)	20:28	20:30	20:01 46 16:59 (2)	19:11 66 16:52 (2)	18:19	16:37	16:22
12	07:20	06:54	07:11	06:19 15:49 (2)	05:37	05:17	05:28	05:57 16:11 (2)	06:29 15:47 (2)	07:01	06:38	07:11
	16:43	17:21	18:55	19:30 73 17:02 (2)	20:02	20:28	20:29	20:00 49 17:00 (2)	19:09 63 16:50 (2)	18:18	16:36	16:22
13	07:20	06:53	07:10	06:17 15:49 (2)	05:36	05:17	05:29	05:58 16:09 (2)	06:30 15:47 (2)	07:02	06:40	07:12
	16:44	17:23	18:57	19:31 72 17:01 (2)	20:03	20:29	20:29	19:57 52 17:01 (2)	19:07 62 16:49 (2)	18:16	16:35	16:22
14	07:19	06:51	07:08	06:16 15:50 (2)	05:35	05:17	05:29	05:59 16:08 (2)	06:31 15:48 (2)	07:04	06:41	07:13
	16:45	17:24	18:58	19:32 71 17:01 (2)	20:04	20:29	20:28	19:56 53 17:01 (2)	19:06 59 16:47 (2)	18:14	16:34	16:22
15	07:19	06:50	07:06	06:14 15:50 (2)	05:33	05:17	05:30	06:00 16:07 (2)	06:32 15:48 (2)	07:05	06:42	07:13
	16:46	17:25	18:59	19:33 71 17:01 (2)	20:05	20:30	20:28	19:54 55 17:02 (2)	19:04 58 16:46 (2)	18:13	16:33	16:22
16	07:19	06:49	07:05	06:12 15:51 (2)	05:32	05:17	05:31	06:01 16:05 (2)	06:33 15:49 (2)	07:06	06:43	07:14
	16:47	17:26	19:00	19:35 70 17:01 (2)	20:06	20:30	20:27	19:53 57 17:02 (2)	19:02 55 16:44 (2)	18:11	16:32	16:23
17	07:18	06:47	07:03	06:11 15:51 (2)	05:32	05:17	05:32	06:02 16:04 (2)	06:34 15:50 (2)	07:07	06:44	07:15
	16:49	17:28	19:01	19:36 69 17:00 (2)	20:07	20:30	20:27	19:52 59 17:03 (2)	19:00 52 16:42 (2)	18:10	16:31	16:23
18	07:18	06:46	07:01	06:09 15:52 (2)	05:31	05:17	05:33	06:03 16:03 (2)	06:35 15:52 (2)	07:08	06:46	07:16
	16:50	17:29	19:02	19:37 68 17:00 (2)	20:08	20:31	20:26	19:50 60 17:03 (2)	18:59 47 16:39 (2)	18:08	16:30	16:23
19	07:17	06:44	06:59	06:08 15:52 (2)	05:30	05:17	05:34	06:04 16:01 (2)	06:37 15:53 (2)	07:09	06:47	07:16
	16:51	17:30	19:03	19:38 68 17:00 (2)	20:09	20:31	20:25	19:49 62 17:03 (2)	18:57 44 16:37 (2)	18:06	16:29	16:24
20	07:16	06:43	06:58	06:06 15:53 (2)	05:29	05:17	05:34	06:05 16:00 (2)	06:38 15:55 (2)	07:10	06:48	07:17
	16:52	17:31	19:05	19:39 67 17:00 (2)	20:10	20:31	20:25	19:47 63 17:03 (2)	18:55 39 16:34 (2)	18:05	16:29	16:24
21	07:16	06:42	06:56 16:17 (2)	06:05 15:53 (2)	05:28	05:18	05:35	06:06 15:59 (2)	06:39 15:58 (2)	07:12	06:49	07:17
	16:53	17:33	19:06 22 16:39 (2)	19:40 66 16:59 (2)	20:11	20:32	20:24	19:46 64 17:03 (2)	18:53 32 16:30 (2)	18:03	16:28	16:24
22	07:15	06:40	06:54 16:13 (2)	06:03 15:54 (2)	05:27	05:18	05:36	06:07 15:58 (2)	06:40 16:01 (2)	07:13	06:50	07:18
	16:55	17:34	19:07 31 16:44 (2)	19:41 65 16:59 (2)	20:12	20:32	20:23	19:44 66 17:04 (2)	18:52 25 16:26 (2)	18:02	16:27	16:25
23	07:14	06:39	06:53 16:10 (2)	06:02 15:54 (2)	05:26	05:18	05:37	06:08 15:57 (2)	06:41 16:07 (2)	07:14	06:52	07:18
	16:56	17:35	19:08 37 16:47 (2)	19:42 64 16:58 (2)	20:13	20:32	20:22	19:42 67 17:04 (2)	18:50 12 16:19 (2)	18:00	16:27	16:26
24	07:14	06:37	06:51 16:06 (2)	06:00 15:56 (2)	05:25	05:18	05:38	06:10 15:56 (2)	06:42 07:15	06:53	07:19	
	16:57	17:36	19:09 43 16:49 (2)	19:43 61 16:57 (2)	20:14	20:32	20:21	19:41 67 17:03 (2)	18:48 17:59	16:26	16:26	
25	07:13	06:36	06:49 16:04 (2)	05:59 15:56 (2)	05:25	05:19	05:39	06:11 15:54 (2)	06:43 07:16	06:54	07:19	
	16:58	17:38	19:10 47 16:51 (2)	19:44 60 16:56 (2)	20:15	20:32	20:21	19:39 69 17:03 (2)	18:46 17:58	16:26	16:27	
26	07:12	06:34	06:47 16:02 (2)	05:57 15:57 (2)	05:24	05:19	05:40	06:12 15:53 (2)	06:44 07:18	06:55	07:20	
	17:00	17:39	19:11 51 16:53 (2)	19:46 59 16:56 (2)	20:16	20:33	20:20	19:38 70 17:03 (2)	18:45 17:56	16:25	16:27	
27	07:11	06:33	06:46 16:00 (2)	05:56 15:58 (2)	05:23	05:19	05:41	06:13 15:53 (2)	06:45 07:19	06:56	07:20	
	17:01	17:40	19:12 54 16:54 (2)	19:47 56 16:54 (2)	20:17	20:33	20:19	19:36 70 17:03 (2)	18:43 17:55	16:25	16:28	
28	07:10	06:31	06:44 15:58 (2)	05:54 15:59 (2)	05:23	05:20	05:42	06:14 15:52 (2)	06:46 07:20	06:57	07:20	
	17:02	17:41	19:13 57 16:55 (2)	19:48 55 16:54 (2)	20:17	20:33	20:18	19:35 71 17:03 (2)	18:41 17:53	16:24	16:29	
29	07:10		06:42 15:57 (2)	05:53 16:01 (2)	05:22	05:20	05:43	06:15 15:51 (2)	06:47 07:21	06:59	07:20	
	17:03		19:15 59 16:56 (2)	19:49 53 16:54 (2)	20:18	20:33	20:17	19:33 71 17:02 (2)	18:39 17:52	16:24	16:29	
30	07:09		06:41 15:56 (2)	05:52 16:01 (2)	05:22	05:20	05:44	06:16 15:50 (2)	06:48 07:22	07:00	07:21	
	17:05		19:16 62 16:58 (2)	19:50 51 16:52 (2)	20:19	20:33	20:16	19:31 72 17:02 (2)	18:38 17:51	16:23	16:30	
31	07:08		06:39 15:55 (2)	05:21		05:45	06:17 15:49 (2)		07:24		07:21	
	17:06		19:17 63 16:58 (2)	20:20		20:15	19:30 72 17:01 (2)		17:49		16:31	
Potential sun hours	295	296	370	400	451	455	462	430	375	344	296	285
Total, worst case			526	1989	368			1602	1318			

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)