Section 13.0 Shadow Flicker Study

Shadow flicker is the term for the moving shadows caused when a moving object, in this case a wind turbine, cast a shadow on a receptor surface on properties. With regard to wind farms, the shadow flicker effect is caused by the rotating blades casting a moving shadow over a residence during periods of sunshine. For shadow flicker to occur at a typical receptor the following conditions are required;

- A sensitive receptor (i.e. residual home, camp ground or scenic overlook) has to be located in area where the wind turbine generators are located between the sun and the receptor.
- A sufficient level of sunlight is required. If it is nighttime or if there is a significant level of clouds or fog then the shadow flicker is not observed.
- The line of sight between the receiver and the turbine must be clear. Obstructions such as topography, vegetation or buildings will prevent the flicker affect being observed.
- For shadow flicker to be experienced within a home there must be a window or glass door that is oriented such that shadow flicker passes over it.
- The turbine must be operating with the rotor orientated at a angle towards the receptor. If the rotor is facing perpendicular to the line between the sun and the receiver, very little flicker will be observed, while if the rotor is facing a residence such that the blades have the sun behind them, some flicker may be observed. Therefore wind direction and the angle of the blade orientation will influence the level of flicker experienced.
- Shadow flicker intensity decreases as the distance between receptors and turbines increases. At distances beyond 10 rotor diameters or approximately 3,740 feet based on a the largest wind turbine being considered by the project, shadow flicker effects are generally considered negligible.
- The sun must be in the correct position. The sun needs to be a minimum elevation of 3 degrees over the horizon to cause flicker. The sun's position changes throughout the day and across the year, and is a key variable in the determination of the number of shadow flicker hours experienced.

Shadow flicker is not considered a health-related issue, as blade pass frequencies for modern commercial-scale wind turbines are so low they are considered harmless. According to the British Epilepsy Association (2013), approximately three percent of individuals with epilepsy have sensitivity to light, and most people with photosensitive epilepsy are sensitive to flickering around 16-25 Hz (Hertz or Hz = 1 flash per second), although some people may be sensitive to rates as low as 3 Hz and as high as 60 Hz. Modern wind turbines are usually built to operate at a frequency of 1 Hz or less. There is no evidence that wind turbines operating at this frequency can trigger seizures (British Epilepsy Association, 2013). Therefore, the primary concern with shadow flicker is the annoyance it could cause for adjacent receptors.

The nearest non-participating party near the project area is the Alvear Property. The location is approximately 6,336 feet east of the nearest turbine. The residence is approximately 155 feet higher in elevation than the nearest wind turbine location. The residence is also east of the project and between the rising sun and the wind turbines. Other residences in the Project Area are participating parties to the development and have granted an easement which allows for impacts such as flicker and noise. The historical Bowler Flat town site is not occupied and was not considered sensitive receptor in the area. The dominate wind direction at the project is along a Southwest to Northwest direction with very little East-West wind. In order to cause flicker shadows, the blades have to be oriented with the sun behind the blades and the blades have to be oriented obliquely to the sun.

Shadow flicker can be predicted using computer modeling programs and input data regarding turbine characteristic and weather conditions. The model considers the movement of the sun throughout the day and year. The location of houses (receptors) and turbines are input as well as a digital model of the topography. By identifying where the site is on the earth, the suns trajectory (elevation and azimuth) can be modeled, enabling the calculation of the amount of time during which the sun, turbines and receptor are correctly aligned in order to result in shadow flicker. A worst case shadow flicker scenario can be predicted based on assumptions of no weather or other obstructions between the receptor and turbine, the turbine is in continuous operations, and the turbine rotor is continuously perpendicular to the sun and the turbine rotor is position between the receptor and the sun.

The Alvear residence is over 1.2 miles east from the nearest wind turbine location and the residence is approximately 155 feet higher in elevation which makes an angle of incidence such that shadows during the sunset hours will fall on the intervening topography between the house and the nearest wind turbine. The distance between the house and the nearest wind turbine exceeds the maximum distance considered for human perception of shadow flicker.