# Appendix G

## Noise Study and Shadow Impact Assessment

Community Wind South Repower Project
Nobles County, Minnesota

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NOISE AND SHADOW FLICKER ASSESSMENT

# Community Wind South

SEPTEMBER 28, 2021

PREPARED FOR:

Greenbacker
RENEWABLE ENERGY COMPANY

PREPARED BY:

Westwood

Westwood

# Noise and Shadow Flicker Assessment

Community Wind South

Nobles County, Minnesota


**Prepared For:**

Zephyr Wind, LLC
230 Park Avenue
Suite 1560
New York, NY
10169

**Prepared By:**

Jeff Fine
Westwood Professional Services
12701 Whitewater Drive, Suite 300
Minnetonka, MN 55343
(952) 937-5150



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## Revision History

| Rev No. | Revision Purpose | Date | Revised by |
|---|---|---|---|
| **0** | Original | June 19, 2020 | MML |
| **1** | Client Comments, Ambient Addition | June 23, 2020 | MML |
| **2** | Executive Summary Addition | June 24, 2020 | MML |
| **3** | Vestas V110-2.0 to 2.2 Model Range Inclusion | July 17, 2020 | MML |
| **4** | New Site Maps | August 27, 2020 | MML |
| **5** | Add't Shadow Modeling with Obstacles | October 29, 2020 | MML |
| **6** | Finalized Hub Height | February 4, 2021 | MML |
| **7** | Added cumulative impact from Nobles turbines | September 24, 2021 | JF |

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Westwood

# Executive Summary

Westwood Professional Services (Westwood) was contracted by Zephyr Wind, LLC (the User) to support the repowering of the Community Wind South Project by completing a noise and shadow flicker assessment. It is our understanding that the User intends to repower 15 wind turbines during the 2021 calendar year to improve efficiency and reliability. Community Wind South has a proposed nameplate capacity of 33 megawatts (MW) and is located in southwestern Minnesota in Nobles County.

The noise assessment consisted of 64 participating and non-participating residential dwellings identified within 2 miles of a proposed Community Wind South turbine. These locations were modeled using a point-type sound receptor to ensure the highest sound pressure level at the structure perimeter was calculated. Moderate ground attenuation was assumed.

The shadow flicker assessment consisted of 64 participating and non-participating residential dwellings. These locations were modeled using a greenhouse simulation consisting of a 1-meter x 1 meter window located 1 meter above ground level. Reductions based on turbine operational time, operational direction, and site-specific meteorological data were used to calculate probable yearly shadow flicker hours. Obstacles such as trees and farm outbuildings were included at two receptor locations to reduce shadow flicker impacts, all other receptors were modeled without additional obstacles.

The noise assessment has been completed in accordance with Minn. Stat. § 116.07 and Minnesota Rules, Chapter 7030 with all identified participating and non-participating dwellings treated as Noise Classification Area 1 (NAC 1) with daytime L50 noise allowances of 60 decibels (dBA) and nighttime L50 noise allowances of 50 dBA. NAC 1 Areas generally consists of residential dwellings, hotels, medical service facilities, educational facilities, camping areas, and religious or cultural gathering areas. Noise levels from the model shows all 64 receptors to experience a turbine noise contribution of 47 dB or less. The total noise, which includes the addition of the ambient noise level to the turbine noise to be below 50 dBA during all hours of the day and are therefore in compliance with Minn. Stat. § 116.07 and Minnesota Rules, Chapter 7030.

Based on the provided turbine array, 62 of the receptors were modeled to experience no more than 26 hours and 6 minutes of shadow flickering per year and are therefore within accordance with the generally accepted industry-standard limit of 30 cumulative hours per year per residence. The remaining 2 receptors modeled are expected to experience 35 hours and 14 minutes and 31 hours and 51 minutes of shadow flicker respectively. Both receptors are owned by participating landowners. Please refer to Section 8.0 for a further discussion on the receptors that measure over 30 cumulative hours per year per residence. It should be noted that Minnesota has no state standard limit on shadow flicker.

# 1.0 Introduction

Westwood Professional Services (Westwood) was contracted by Zephyr Wind, LLC (the User) to support the repowering of the Community Wind South Project by completing a noise and shadow flicker assessment. The proposed site consists of 15 turbines with a nameplate capacity of 33 megawatts (MW). The existing turbines will be repowered with Vestas V110 turbines with a nameplate capacity of 2.2 MW, a hub height of 105.05 meters and a rotor diameter of 110 meters. Turbine locations were provided to Westwood by the User.

The User provided a KMZ of the participating and non-participating noise and shadow flicker receptors within 2 miles of a wind turbine. Receptors consist of 64 occupied and unoccupied residential dwellings.

The Project Area is located in Nobles County in southwestern Minnesota near the town of Reading. The Subject Property is located at an approximate elevation of 1,650 to 1,750 feet above mean sea level (amsl) and is relatively flat. The Project Area is located within an agricultural and residential area.

# 2.0 Sound Background

In order to verify that the turbine array existing at Community Wind South is within compliance with the Minn. Stat. § 116.07 and Minnesota Rules, Chapter 7030 sound allowance levels, Westwood analyzed the site specifics through a model built in windPRO. The model assumed the turbines were operating at a maximum noise level of 107.7 dB(A) at a hub height of 105.05m using a standard non-serrated trailing edge blade. Noise impacts from surrounding existing turbines at the Nobles Wind Repower and three single-turbine projects (Arnold Wind, Wilmont Hills, Don Sneve) are also included.

Nobles Repower plans to utilize various noise reduced operating modes (NRO). At the time of this report the final configuration of the Nobles layout was not available. However, data obtained by Westwood from Xcel Energy and from public information filed in Nobles Repower noise analysis report submitted to the Minnesota PUC made it possible to model the Repower project. Not all NRO modes specified are known to exist for the GE 1.6-97 / GE1.6-91 turbines. In instances where said NRO mode doesn't exist the next loudest operational model was used as a measure of introducing conservativeness. Furthermore, the three single-turbine projects are older turbines for which reliable noise data was not available. 1/1 octave band data was presented in public information given to MN PUC, however for the sake of conservativeness these three (Vestas V82, NEG Micon MM54, MM72) were modeled with the same noise emission levels as the Community Wind South turbines which are louder than the actual turbine emission levels.

According to the Vestas V110-2.2 noise emission documentation reviewed by Westwood, the loudest normal operational sound pressure level emission from a standard blade edge is 107.7 dBA at 10 m/s at 105.05 m above ground level. To model the noise within windPRO an uncertainty margin of 2 dBA was added to the noise 1/3 octave band noise emission levels and turbines were assumed to be operating at the loudest hub height emission level.

Details of turbine coordinates and associated NRO modes assumed for external wind turbines can be found in Exhibit 1.

***Table 1: Turbines Included in windPRO Noise Model***

| Project | Manufacturer | Turbine Assumed in windPRO | Quantity | Hub Height (m) | Rotor Diameter (m) | Max. Sound Pressure Level (dBA) |
|---|---|---|---|---|---|---|
| Community Wind South Repower | Vestas | V110-2.2 | 15 | 105.05 | 110 | 107.7 |
| Nobles Repower | GE | 1.6-91 | 22 | 80 | 91 | Various NRO |
| Nobles Repower | GE | 1.6-97 | 111 | 80 | 97 | Various NRO |
| Nobles Repower | Vestas | V136-3.6 | 1 | 82 | 136 | 105.5 |
| Arnold Wind Farm | Vestas | V110-2.2 | 1 | 70 | 110 | 107.7 |
| Wilmont Hills | Vestas | V110-2.2 | 1 | 70 | 110 | 107.7 |
| Don Sneve | Vestas | V110-2.2 | 1 | 70 | 110 | 107.7 |

# 3.0 Sound Methodology

The sound assessment was performed in windPRO utilizing the program's ability to calculate detailed sound maps and environments throughout the Project Area and at point-source sound receptors.

The windPRO sound assessment calculation included the following data: turbine coordinates, turbine manufacturer specifications, sound receptor coordinates, USGS Digital Elevation Model (DEM) (height contour data), uncertainty factor, Project Area specific meteorological conditions, and ground attenuation.

The assessment was completed using the ISO 9613-2 General model with a ground attenuation factor of 0.5, representative of environments with mixed vegetation and crop cover. Sound pressure levels were calculated at 4 m above ground level at all sound receptors. Minnesota Rule, Chapter 7030 utilizes an L50 noise metric to demonstrate compliance to allowable noise levels at residences, therefore a conversion from modeled Leq values to L50 must be made. This can be accomplished by modifying the ground attenuation factor or by simply making a reduction to output values via spreadsheet. This analysis assumed a standard 0.5 ground attenuation coefficient and a 0.7 dB(A) reduction to the calculated Leq at each residence.

Ambient noise conditions were taken from field measurements completed at the Three Waters Wind project approximately 20 miles southeast of the Community Wind South project area. Characteristics at this site are substantially similar to the Community Wind South site and have also previously been used as the basis for determining ambient conditions for the wind farm that surrounds the turbine locations at Community Wind South.

As indicated in the report the average daytime L50 across all onsite monitoring locations was 38 dB(A) and nighttime average was 33 dB(A). Certain single-hour measurements tended to be far off from the mean values due to the presence of vehicle traffic, aircraft flyovers, farm equipment operating etc.

These spikes in sound level are not representative of typical ambient and it is recommended to use a mean value rather than a single-hour maximum to characterize the ambient condition.

As a measure of conservativeness, it is recommended to use the loudest maximum day / night averages across all measurements taken. Sensor "Offsite E" has an average nighttime L50 of 37 dB(A) and is also located fairly close to Interstate 90, thereby representing a louder ambient condition than would be expected at the project site. Sensor "Onsite D" has an average daytime L50 of 41 dB(A). Results using 37 dB(A) at night and 41 dB(A) during daytime to add to project turbine noise contribution to obtain total noise at the receptor locations are presented in Table 3 and Table 4 below.

Data from Three Waters Wind PUC Docket #19-576 are summarized below in Table 2.

***Table 2: A-Weighted Sound Level Results from Three Waters Wind***

| **Location** | **Overall** | | | | **Day** | | | | **Night** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Leq** | **L90** | **L50** | **L10** | **Leq** | **L90** | **L50** | **L10** | **Leq** | **L90** | **L50** | **L10** |
| Onsite A | 42 | 26 | 34 | 44 | 43 | 30 | 37 | 45 | 42 | 25 | 31 | 43 |
| Onsite B | 41 | 27 | 32 | 41 | 41 | 29 | 34 | 42 | 39 | 25 | 29 | 38 |
| Onsite C | 41 | 30 | 36 | 43 | 41 | 31 | 37 | 44 | 40 | 29 | 35 | 42 |
| Onsite D | 44 | 29 | 40 | 47 | 45 | 36 | 41 | 47 | 43 | 27 | 34 | 46 |
| Onsite I | 43 | 26 | 38 | 46 | 44 | 31 | 40 | 46 | 43 | 23 | 33 | 46 |
| **Average** | **43** | **28** | **37** | **45** | **43** | **32** | **38** | **45** | **41** | **26** | **33** | **44** |
| Offsite E | 46 | 29 | 38 | 46 | 46 | 31 | 39 | 46 | 45 | 28 | 37 | 46 |
| Offsite F | 39 | 27 | 32 | 38 | 41 | 28 | 33 | 40 | 36 | 26 | 31 | 37 |

# 4.0 Sound Data Analysis

The sound assessment determined that no occupied or unoccupied residential dwellings will be impacted by total sound levels exceeding 60 dBA during the daytime or 50 dBA during the nighttime. Therefore, the Community Wind South repower is within compliance with the Minn. Stat. §116.07 and Minnesota Rules, Chapter 7030.

See below for a table depicting the sound pressure level distributions for the Project Area. Please see Appendix A for the full sound pressure level analysis results.

*Table 3: Distribution of L50 Total Noise (Turbine + Ambient) (dBA)*

| Realistic Sound (dBA) | Number of Sound Receptors (Daytime Ambient) | Number of Sound Receptors (Nighttime Ambient) |
|---|---|---|
| 0 to 35 | 0 | 0 |
| 35 to 40 | 0 | 7 |
| 40 to 45 | 19 | 22 |
| 45 to 50 | 45 | 35 |

*Table 4: L50 Total Noise (Turbine + Ambient) (dBA)*

| Receptors | L50 From Turbine (dBA) | L50 Total Noise Daytime Ambient (Turbine + 41 dBA) | L50 Total Noise Nighttime Ambient (Turbine + 37 dBA) |
|---|---|---|---|
| NSA-1-NP | 35 | 42 | 39 |
| NSA-2-NP | 34 | 42 | 39 |
| NSA-3-NP | 43 | 45 | 44 |
| NSA-4-NP | 38 | 43 | 40 |
| NSA-5-NP | 39 | 43 | 41 |
| NSA-6-NP | 46 | 47 | 46 |
| NSA-7-NP | 40 | 44 | 42 |
| NSA-8-NP | 38 | 43 | 40 |
| NSA-9-NP | 43 | 45 | 44 |
| NSA-10-NP | 41 | 44 | 43 |
| NSA-11-NP | 44 | 46 | 45 |
| NSA-12-P | 46 | 47 | 47 |
| NSA-13-NP | 47 | 48 | 48 |
| NSA-14-NP | 46 | 47 | 47 |
| NSA-15-NP | 40 | 43 | 42 |
| NSA-16-NP | 47 | 48 | 47 |
| NSA-17-P | 47 | 48 | 48 |
| NSA-18-NP | 42 | 45 | 43 |
| NSA-19-NP | 44 | 46 | 45 |
| NSA-20-NP | 43 | 45 | 44 |
| NSA-21-NP | 44 | 46 | 44 |
| NSA-22-NP | 45 | 46 | 45 |
| NSA-23-NP | 47 | 48 | 47 |
| NSA-24-NP | 47 | 48 | 47 |
| NSA-25-NP | 47 | 48 | 47 |
| NSA-26-NP | 46 | 47 | 46 |

| Receptors | L50 From Turbine (dBA) | L50 Total Noise Daytime Ambient (Turbine + 41 dBA) | L50 Total Noise Nighttime Ambient (Turbine + 37 dBA) |
|---|---|---|---|
| NSA-27-NP | 47 | 48 | 47 |
| NSA-28-NP | 47 | 48 | 47 |
| NSA-29-NP | 47 | 48 | 47 |
| NSA-30-NP | 47 | 48 | 48 |
| NSA-31-NP | 47 | 48 | 48 |
| NSA-32-NP | 47 | 48 | 48 |
| NSA-33-P | 47 | 48 | 47 |
| NSA-34-NP | 43 | 45 | 44 |
| NSA-35-NP | 44 | 46 | 44 |
| NSA-36-P | 46 | 47 | 47 |
| NSA-37-NP | 47 | 48 | 47 |
| NSA-38-P | 44 | 46 | 45 |
| NSA-39-P | 45 | 46 | 45 |
| NSA-40-NP | 46 | 47 | 47 |
| NSA-41-NP | 43 | 45 | 44 |
| NSA-42-NP | 43 | 45 | 44 |
| NSA-43-NP | 46 | 47 | 46 |
| NSA-44-NP | 46 | 47 | 47 |
| NSA-45-NP | 45 | 47 | 46 |
| NSA-46-P | 41 | 44 | 42 |
| NSA-47-NP | 47 | 48 | 47 |
| NSA-48-NP | 41 | 44 | 43 |
| NSA-49-NP | 42 | 44 | 43 |
| NSA-50-NP | 45 | 47 | 46 |
| NSA-51-NP | 42 | 44 | 43 |
| NSA-52-NP | 44 | 46 | 45 |
| NSA-53-NP | 47 | 48 | 47 |
| NSA-54-NP | 46 | 48 | 47 |
| NSA-55-NP | 45 | 46 | 45 |
| NSA-56-NP | 43 | 45 | 44 |
| NSA-57-NP | 46 | 47 | 46 |
| NSA-58-NP | 45 | 47 | 46 |
| NSA-59-NP | 46 | 47 | 47 |
| NSA-60-NP | 36 | 42 | 40 |
| NSA-61-NP | 34 | 42 | 39 |
| NSA-62-NP | 34 | 42 | 39 |

| Receptors | L50 From Turbine (dBA) | L50 Total Noise Daytime Ambient (Turbine + 41 dBA) | L50 Total Noise Nighttime Ambient (Turbine + 37 dBA) |
|---|---|---|---|
| NSA-63-NP | 33 | 42 | 38 |
| NSA-64-NP | 32 | 42 | 38 |

*Receptor locations are identified as either Participating (P) or Non-Participating (NP).

# 5.0 Shadow Flicker Background

Shadow flicker is a flickering effect caused by the rotation of wind turbine blades casting periodic shadows on an observer. This is generally observed in areas within 1-2 km of a wind turbine and decreases with distance as the shadow effect diffuses. Additionally, shadow flicker effects are greatest in the winter months and during sunrise and sunset due to the lowered angle of the sun casting longer shadows.

Of the 64 receptors modeled 62 are expected to experience less than 30 hours/year of shadow flicker. For the two receptors that are modeled above 30 hours/year blocking obstacles such as farm outbuildings and tree stands were added in, which has the effect of reducing the number of flicker hours calculated.

Shadow flicker time of day is another important consideration; residential dwellings would be less impacted by mid-day shadow flicker effects while residents are at school or work whereas a commercial property would be less impacted by shadow flicker effects occurring before or after business hours.

Historical meteorological and climate data was also taken into consideration during this shadow flicker assessment to account for overcast and cloudy conditions in the Project Area that would produce no shadows to account for.

# 6.0 Shadow Flicker Methodology

The shadow flicker assessment was performed in windPRO utilizing the program's ability to calculate detailed shadow maps and environments throughout the Project Area and at point-source shadow receptors.

Shadow flicker maps are generated by windPRO to indicate where shadows will be cast and for how long those shadows will be in an area. Fine resolution was used during the shadow flicker assessment and consisted of a calculation every three minutes of every day over the period of one year with a 20 meter by 20 meter resolution.

Additionally, a record of the shadow flicker that occurs as the sun moves from sunrise to sunset is simulated through one year and the amount of time a shadow flicker occurs at a receptor is determined. This calculation is completed every minute of every day for one year. The shadow receptors used in this analysis were configured as greenhouse-mode receptors representing a 1-meter x 1-meter window located 1-meter above ground level.

This produces a "worst case" scenario with conservative results due to the assumption that all windows are always in direct line of sight with the turbines and sun.

The windPRO program must determine which turbines are visible to which receptors and is not blocked by local topography or distance. This is completed by performing a preliminary Zones of Visual Influence (ZVI) calculation using 10 meter elevation grid sampling. Therefore, if there

is visible line of sight between the turbine tip height and the receptor height; and the distance between them is less than the maximum shadow distance determined by the software then flicker is calculated at that receptor. ZVI is considered in this report but topographic blocking between the sun and receptor is not considered as the terrain is moderately flat and the results are more conservatively biased.

The windPRO shadow flicker assessment calculation included the following data: turbine coordinates, turbine manufacturer specifications, shadow receptor coordinates, monthly sunshine probabilities, joint wind speed and direction frequency distribution, and USGS DEM (height contour data).

***Table 5: Sunshine Probability from Sioux Falls, SD***

| Sioux Falls, SD Monthly Sunshine Probabilities (2006-2009) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Sunshine %** | 53 | 59 | 46 | 54 | 55 | 58 | 71 | 61 | 59 | 57 | 49 | 55 |

retrieved from: http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos15.dat

The potential shadow flicker calculation at a given shadow receptor is completed by simulating the environment near the wind turbines and shadow receptors. The position of the sun relative to the turbine rotor disk and the resulting shadow is calculated in time steps of one minute throughout one year. If the shadow of the rotor disk, which is assumed solid, at any time casts a shadow on a receptor, the step will be registered as one minute of shadow flicker. The calculation requires the sun to be at least 3.0° above the horizon in order to register a shadow flicker. When the sun is below 3.0°, the shadow will diffuse too quickly to be distinguishable.

The sun's path with respect to each wind turbine is calculated by windPRO to determine the path of cast shadows for every minute of every day for one year. The wind farm operational runtime and nacelle direction are calculated from the Project Area's long-term wind speed and direction distribution supplied by the client. The long-term wind data consists of 5+ years of park averaged nacelle anemometer data from the existing 98.5m AGL turbines on site. The nacelle anemometer data was vertically sheared to 105.05m AGL for this calculation. Along with the expected runtime, the projected annual shadow flicker analysis also considers historical cloud cover and monthly sunshine probability.

# 7.0 Shadow Flicker Analysis

Westwood uses the term realistic in reference to turbine operational hours and direction as well as local sunshine probabilities that have been factored in, but generally no blocking or shading effects from trees or structures are considered leading to realistic estimates that are inherently conservative values. This also assumes an availability factor of 100% while actual availability factors are more likely to be 95-98%; however, a conservative approach to estimating shadow flicker totals ensures the realistic estimates are not discounted. It should be noted that the initial model without the use of obstacle data resulted in 2 dwellings expected to experience more than 30 hours/year of shadow flicker. Therefore, a more granular approach to modeling these 2 locations by adding blocking effects from trees and other structures was used. Given that all 62 of the other dwellings were modeled at less than 30 hours/year of shadow flicker obstacle data was not considered at the remainder of the dwellings.

A total of 64 participating and non-participating residential dwellings within 2 miles of a wind turbine were identified and analyzed. Fine resolution shadow flicker maps were generated for the turbine array. The 64 shadow receptors were modeled as greenhouse-mode receptors during the estimated shadow flicker calculation for the Community Wind South array. With one exception, no shadow receptors are expected to experience more than 26 hours and 6 minutes of shadow flicker per year. The remaining receptor is expected to experience 35 hours and 14 minutes of shadow flicker per year. This receptor is owned by a participating landowner.

Of the 64 shadow receptors, 29 (45.3%) registered no shadow flicker hours. See below for a table depicting the realistic shadow flicker distribution for the 64 identified receptors.

***Table 6: Distribution of Shadow Flicker Hours Impact***

| Realistic Shadow Flicker (hrs/year) | Number of Receptors |
|---|---|
| 0 | 29 |
| 0 to 5 | 23 |
| 5 to 10 | 8 |
| 10 to 15 | 0 |
| 15 to 20 | 1 |
| 20 to 25 | 1 |
| 25 to 30 | 1 |
| 30+ | 1 |

***Table 7: Shadow Flicker Hours Impact per Receptor***

| Receptors | V110-2.05 Shadow Impacts |
|---|---|
| NSA-1-NP | 00:00 |
| NSA-2-NP | 00:00 |
| NSA-3-NP | 00:00 |
| NSA-4-NP | 00:00 |
| NSA-5-NP | 00:00 |
| NSA-6-NP | 00:00 |
| NSA-7-NP | 00:13 |
| NSA-8-NP | 00:00 |

| Receptors | V110-2.05 Shadow Impacts |
|---|---|
| NSA-9-NP | 00:55 |
| NSA-10-NP | 01:15 |
| NSA-11-NP | 05:18 |
| NSA-12-P | 35:14 |
| NSA-13-NP | 06:21 |
| NSA-14-NP | 06:32 |
| NSA-15-NP | 00:00 |
| NSA-16-NP | 05:21 |
| NSA-17-P | 09:57 |
| NSA-18-NP | 00:00 |
| NSA-19-NP | 00:00 |
| NSA-20-NP | 02:56 |
| NSA-21-NP | 02:55 |
| NSA-22-NP | 01:29 |
| NSA-23-NP | 04:47 |
| NSA-24-NP | 04:15 |
| NSA-25-NP | 06:29 |
| NSA-26-NP | 15:41 |
| NSA-27-NP | 02:03 |
| NSA-28-NP | 00:00 |
| NSA-29-NP | 03:39 |
| NSA-30-NP | 00:22 |
| NSA-31-NP | 00:22 |
| NSA-32-NP | 23:47 |
| NSA-33-P | 26:06 |
| NSA-34-NP | 00:17 |
| NSA-35-NP | 00:22 |
| NSA-36-P | 01:53 |
| NSA-37-NP | 00:22 |
| NSA-38-P | 05:09 |
| NSA-39-P | 04:41 |
| NSA-40-NP | 00:21 |
| NSA-41-NP | 03:42 |
| NSA-42-NP | 02:40 |
| NSA-43-NP | 00:00 |
| NSA-44-NP | 05:37 |
| NSA-45-NP | 00:36 |
| NSA-46-P | 00:52 |
| NSA-47-NP | 00:54 |
| NSA-48-NP | 00:00 |
| NSA-49-NP | 00:00 |
| NSA-50-NP | 00:00 |
| NSA-51-NP | 00:00 |
| NSA-52-NP | 00:00 |
| NSA-53-NP | 00:00 |
| NSA-54-NP | 00:00 |
| NSA-55-NP | 00:00 |
| NSA-56-NP | 00:00 |
| NSA-57-NP | 00:00 |
| NSA-58-NP | 00:00 |
| NSA-59-NP | 00:00 |
| NSA-60-NP | 00:00 |

| Receptors | V110-2.05 Shadow Impacts |
|---|---|
| NSA-61-NP | 00:00 |
| NSA-62-NP | 00:00 |
| NSA-63-NP | 00:00 |
| NSA-64-NP | 00:00 |

*Receptor locations are identified as either Participating (P) or Non-Participating (NP).

# 8.0 Additional Shadow Flicker Modeling

The results presented in Table 7 above include additional modeling to incorporate the blocking effects from physical obstacles at two receptor locations. These sites were field screened to determine the height and classification of the existing blocking or shading effects from trees or structures at the identified farmsteads to evaluate realistic shadow flicker. When modeled with the blocking and shading effects accounted for at the identified sites, the maximum shadow flicker expected at receptor NSA-12-P was not significantly reduced and is expected to have a shadow flicker of 35 hours and 14 minutes per year. The maximum shadow flicker expected at receptor NSA-36-P was reduced by 29 hours and 58 minutes to a total expected shadow flicker of 1 hour and 53 minutes per year. However, this model also assumes an availability factor of 100% while actual availability factors are more likely to be 95-98%, and this is still a conservative approach to estimating shadow flicker totals.

***Table 8: Obstacle Porosity Classifications within windPRO***

| | |
|---|---|
| **0.0** | Massive (wall, buildings, etc.) |
| **0.1** | Close groups of trees or several rows of hedges |
| **0.2** | Close hedges (evergreen) |
| **0.3** | |
| **0.4** | Normal hedges |
| **0.5** | Row of buildings |
| **0.6** | |
| **0.7** | Open (scattered hedges) |
| **0.8** | |
| **0.9** | |

***Table 9: Obstacles Modeled at Receptor NSA-12-P***

| Receptors | V110-2.05 Shadow Impacts | Obstacle | Classifications |
|---|---|---|---|
| NSA-12-P | 35:14 | 1. Barn / Shed | 0.0 / 6.1 meters |
| | | 2. Barn / Shed | 0.0 / 7.6 meters |
| | | 3. Barn / Shed | 0.0 / 6.1 meters |
| | | 4. Barn / Shed | 0.0 / 12.2 meters |

***Table 10: Obstacles Modeled at Receptor NSA-36-P***

| Receptors | V110-2.05 Shadow Impacts | Obstacle | Classifications |
|---|---|---|---|
| NSA-36-P | 1:53 | 1. Tree Stand | 0.1 / 15.2 meters |


**Figure 1: Obstacles modeled at Receptor NSA-12-P**


**Figure 2: Obstacles modeled at Receptor NSA-36-P**

# 9.0 Conclusions

The results of the noise assessment are that all 64 receptors are expected to experience a total noise L50 below 60 dB(A) during daytime hours and 50 dB(A) during nighttime hours and are therefore in compliance with Minn. Stat. § 116.07 and Minnesota Rules, Chapter 7030. The following assumptions were used during the noise assessment:

- All turbine locations were using the Vestas V110-2.2 model with 105.05 meter hub height.
- All turbines were assumed to be operating simultaneously at the maximum noise emission level.
- All turbines were assumed to be downwind of all receptors.
- Atmospheric conditions were assumed to be favorable for noise propagation.
- An additional 2 dBA was added to the noise emission levels.
- Cumulative effects from the Nobles Wind Repower project and 3 additional existing turbines in the near vicinity to the Community Wind South project area.

Due to the above conservative assumptions, the realistic noise levels observed will likely be less than those predicted by this assessment.

The shadow flicker impact assessment for the identified receptors was calculated with reductions to account for expected operational uptime and long-term sunshine probabilities. Of the residential dwellings modeled, 63 of the residential dwellings modeled are expected to experience no more than 26 hours and 6 minutes of shadow flickering per year; therefore, these receptors are within the generally accepted industry standard of less than 30 hours of shadow per receptor per year. Please see Section 8.0 for details on blocking obstacle considerations used in the model.

A Shadow flicker impact of 35 hours and 14 minutes was modeled for one site which has been modeled with obstacle blocking considerations.

The following assumptions were used during the shadow flicker assessment:

- All turbine locations were using the Vestas V110-2.2 model with 105.05 meter hub height.
- Effects from physical obstacles such as buildings and trees are accounted for on two receptor locations, all others did not utilize obstacle data.
- Receptors were greenhouse/worst-case scenarios rather than modeling specific facades of receptors.
- The assessment assumes 100% turbine availability.

Due to the above conservative assumptions, the realistic shadow flicker observed will likely be less than those predicted by this assessment.

**Exhibit 1:**

**Receptors and Turbines Used in Model**

# Receptor Locations

| Receptors | Easting (UTM NAD 83 Z15) | Northing (UTM NAD 83 Z15) |
|---|---|---|
| NSA-1-NP | 274,748.00 | 4,847,490.00 |
| NSA-2-NP | 277,629.00 | 4,847,163.00 |
| NSA-3-NP | 271,544.00 | 4,846,905.00 |
| NSA-4-NP | 275,125.00 | 4,846,812.00 |
| NSA-5-NP | 272,216.00 | 4,846,599.00 |
| NSA-6-NP | 270,238.00 | 4,846,489.00 |
| NSA-7-NP | 276,718.00 | 4,846,400.00 |
| NSA-8-NP | 277,910.00 | 4,846,111.00 |
| NSA-9-NP | 276,246.00 | 4,846,089.00 |
| NSA-10-NP | 273,035.00 | 4,846,037.00 |
| NSA-11-NP | 271,653.00 | 4,845,931.00 |
| NSA-12-P | 274,264.00 | 4,845,880.00 |
| NSA-13-NP | 276,255.00 | 4,845,830.00 |
| NSA-14-NP | 271,916.00 | 4,845,562.00 |
| NSA-15-NP | 278,218.00 | 4,845,358.00 |
| NSA-16-NP | 271,948.00 | 4,845,121.00 |
| NSA-17-P | 274,960.00 | 4,845,076.00 |
| NSA-18-NP | 270,182.00 | 4,844,883.00 |
| NSA-19-NP | 278,101.00 | 4,844,852.00 |
| NSA-20-NP | 271,184.00 | 4,844,529.00 |
| NSA-21-NP | 271,178.00 | 4,844,498.00 |
| NSA-22-NP | 270,908.00 | 4,844,370.00 |
| NSA-23-NP | 277,051.00 | 4,844,304.00 |
| NSA-24-NP | 277,060.00 | 4,844,274.00 |
| NSA-25-NP | 271,895.00 | 4,844,267.00 |
| NSA-26-NP | 275,855.00 | 4,844,236.00 |
| NSA-27-NP | 276,650.00 | 4,844,217.00 |
| NSA-28-NP | 278,176.00 | 4,843,883.00 |
| NSA-29-NP | 271,694.00 | 4,843,882.00 |
| NSA-30-NP | 270,132.00 | 4,843,735.00 |
| NSA-31-NP | 270,132.00 | 4,843,722.00 |
| NSA-32-NP | 273,325.00 | 4,843,613.00 |
| NSA-33-P | 271,788.00 | 4,843,087.00 |
| NSA-34-NP | 269,788.00 | 4,842,866.00 |
| NSA-35-NP | 269,885.00 | 4,842,765.00 |
| NSA-36-P | 274,148.00 | 4,842,760.00 |
| NSA-37-NP | 277,523.00 | 4,842,730.00 |
| NSA-38-P | 274,662.00 | 4,842,725.00 |
| NSA-39-P | 275,477.00 | 4,842,716.00 |
| NSA-40-NP | 277,537.00 | 4,842,709.00 |
| NSA-41-NP | 275,898.00 | 4,842,624.00 |
| NSA-42-NP | 274,957.00 | 4,842,622.00 |
| NSA-43-NP | 278,500.00 | 4,842,490.00 |
| NSA-44-NP | 276,857.00 | 4,842,485.00 |

| Receptors | Easting (UTM NAD 83 Z15) | Northing (UTM NAD 83 Z15) |
| --- | --- | --- |
| NSA-45-NP | 273,361.00 | 4,842,100.00 |
| NSA-46-P | 274,736.00 | 4,842,093.00 |
| NSA-47-NP | 271,747.00 | 4,842,088.00 |
| NSA-48-NP | 277,915.00 | 4,841,534.00 |
| NSA-49-NP | 269,566.00 | 4,841,438.00 |
| NSA-50-NP | 270,931.00 | 4,841,250.00 |
| NSA-51-NP | 274,924.00 | 4,841,201.00 |
| NSA-52-NP | 271,332.00 | 4,841,088.00 |
| NSA-53-NP | 271,821.00 | 4,841,084.00 |
| NSA-54-NP | 273,075.00 | 4,841,006.00 |
| NSA-55-NP | 274,025.00 | 4,840,941.00 |
| NSA-56-NP | 274,823.00 | 4,840,846.00 |
| NSA-57-NP | 276,428.00 | 4,840,482.00 |
| NSA-58-NP | 274,960.00 | 4,840,430.00 |
| NSA-59-NP | 271,672.00 | 4,840,081.00 |
| NSA-60-NP | 273,147.00 | 4,847,218.00 |
| NSA-61-NP | 276,802.00 | 4,847,606.00 |
| NSA-62-NP | 273,501.00 | 4,848,094.00 |
| NSA-63-NP | 275,154.00 | 4,848,087.00 |
| NSA-64-NP | 275,321.00 | 4,848,351.00 |

# Turbines Used in Model

*(UTM NAD 83 Z15)*

| Project | Easting (m) | Northing (m) | Elevation (m) | Turbine Model | Hub Height (m) | LwA,ref (dBA) |
|---|---|---|---|---|---|---|
| CWS T1 | 275,302 | 4,844,096 | 515.4 | V110-2.2 | 105.05 | 109.7 |
| CWS T2 | 275,528 | 4,843,225 | 511.4 | V110-2.2 | 105.05 | 109.7 |
| CWS T3 | 275,360 | 4,845,287 | 512.6 | V110-2.2 | 105.05 | 109.7 |
| CWS T4 | 272,201 | 4,843,086 | 529.3 | V110-2.2 | 105.05 | 109.7 |
| CWS T5 | 273,176 | 4,843,083 | 521.9 | V110-2.2 | 105.05 | 109.7 |
| CWS T6 | 273,634 | 4,842,910 | 524.4 | V110-2.2 | 105.05 | 109.7 |
| CWS T7 | 274,388 | 4,843,380 | 518.5 | V110-2.2 | 105.05 | 109.7 |
| CWS T8 | 274,699 | 4,843,529 | 515.7 | V110-2.2 | 105.05 | 109.7 |
| CWS T9 | 274,394 | 4,844,483 | 521.5 | V110-2.2 | 105.05 | 109.7 |
| CWS T10 | 273,949 | 4,843,850 | 527.9 | V110-2.2 | 105.05 | 109.7 |
| CWS T11 | 272,897 | 4,844,033 | 522.1 | V110-2.2 | 105.05 | 109.7 |
| CWS T12 | 273,235 | 4,844,964 | 527.4 | V110-2.2 | 105.05 | 109.7 |
| CWS T13 | 272,818 | 4,844,977 | 531.5 | V110-2.2 | 105.05 | 109.7 |
| CWS T14 | 274,494 | 4,845,539 | 523.4 | V110-2.2 | 105.05 | 109.7 |
| CWS T15 | 274,096 | 4,844,940 | 522.7 | V110-2.2 | 105.05 | 109.7 |
| Nobles Repower T1 | 269,096 | 4,846,508 | 514.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T2 | 269,575 | 4,846,480 | 515.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T3 | 269,296 | 4,845,948 | 513.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T4 | 269,893 | 4,845,630 | 520.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T5 | 270,645 | 4,846,424 | 528.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T6 | 271,139 | 4,846,553 | 527.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T7 | 271,510 | 4,845,545 | 527.9 | 1.6-97 | 80 | 106 |
| Nobles Repower T8 | 272,263 | 4,845,367 | 532.7 | 1.6-97 | 80 | 106 |
| Nobles Repower T9 | 272,260 | 4,844,875 | 530.1 | 1.6-97 | 80 | 106 |
| Nobles Repower T10 | 272,242 | 4,844,457 | 529.3 | 1.6-97 | 80 | 106 |
| Nobles Repower T11 | 269,069 | 4,843,971 | 510.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T12 | 269,453 | 4,844,237 | 509.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T13 | 269,766 | 4,843,891 | 522.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T14 | 270,512 | 4,844,008 | 528.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T15 | 270,593 | 4,843,375 | 516.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T16 | 271,254 | 4,843,883 | 530.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T17 | 272,096 | 4,843,887 | 528 | 1.6-97 | 80 | 106 |
| Nobles Repower T18 | 270,329 | 4,842,075 | 521.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T19 | 270,407 | 4,842,544 | 520.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T20 | 270,871 | 4,842,417 | 524.2 | 1.6-97 | 80 | 106 |
| Nobles Repower T21 | 271,355 | 4,842,386 | 525.2 | 1.6-91 | 80 | 105 |
| Nobles Repower T22 | 271,054 | 4,841,642 | 516.5 | 1.6-97 | 80 | 106 |
| Nobles Repower T23 | 271,489 | 4,841,801 | 521.8 | 1.6-91 | 80 | 103 |

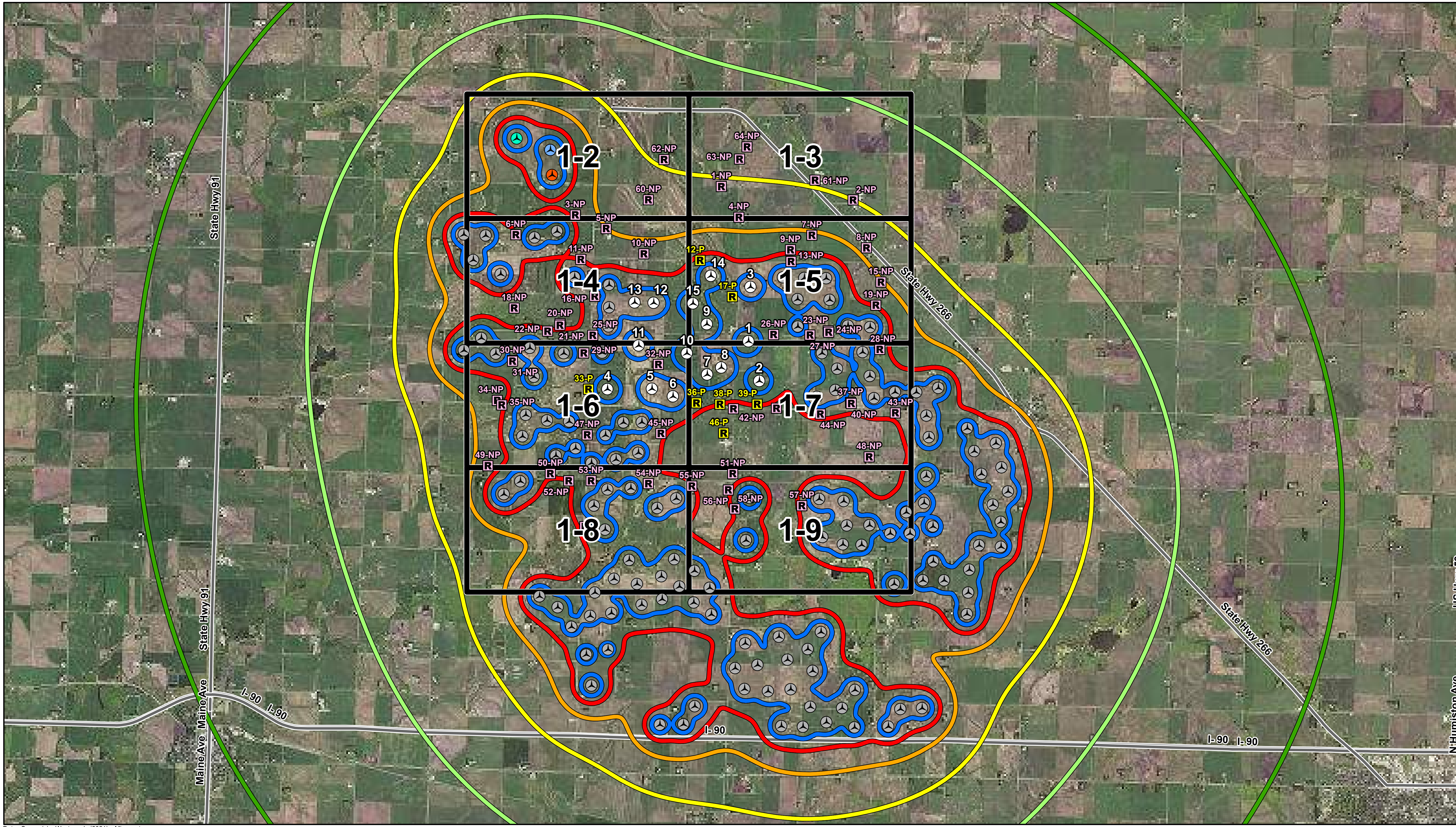
| Project | Easting (m) | Northing (m) | Elevation (m) | Turbine Model | Hub Height (m) | LwA,ref (dBA) |
|---|---|---|---|---|---|---|
| Nobles Repower T24 | 272,146 | 4,842,080 | 519.7 | 1.6-91 | 80 | 103 |
| Nobles Repower T25 | 272,542 | 4,842,353 | 510.3 | 1.6-97 | 80 | 106 |
| Nobles Repower T26 | 272,945 | 4,842,353 | 517.3 | 1.6-97 | 80 | 106 |
| Nobles Repower T27 | 271,832 | 4,841,472 | 521.7 | 1.6-91 | 80 | 105 |
| Nobles Repower T28 | 272,371 | 4,841,545 | 510.7 | 1.6-97 | 80 | 106 |
| Nobles Repower T29 | 272,862 | 4,841,685 | 511.1 | 1.6-97 | 80 | 106 |
| Nobles Repower T30 | 269,906 | 4,840,813 | 499.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T31 | 270,271 | 4,841,090 | 503.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T32 | 272,176 | 4,840,889 | 512.2 | 1.6-91 | 80 | 105 |
| Nobles Repower T33 | 272,687 | 4,840,913 | 508.1 | 1.6-97 | 80 | 106 |
| Nobles Repower T34 | 271,876 | 4,840,539 | 506.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T35 | 272,115 | 4,840,011 | 500.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T36 | 273,262 | 4,840,471 | 507 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T37 | 273,680 | 4,840,676 | 508.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T38 | 270,660 | 4,838,567 | 491.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T39 | 271,056 | 4,838,324 | 501.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T40 | 271,874 | 4,838,637 | 498.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T41 | 272,298 | 4,838,933 | 500.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T42 | 272,633 | 4,839,341 | 498.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T43 | 272,798 | 4,838,814 | 508.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T44 | 271,766 | 4,838,126 | 504.8 | 1.6-91 | 80 | 105 |
| Nobles Repower T45 | 272,230 | 4,838,183 | 505.8 | 1.6-91 | 80 | 105 |
| Nobles Repower T46 | 272,895 | 4,838,358 | 508.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T47 | 273,333 | 4,838,975 | 512.3 | V136-3.6 | 82 | 107.5 |
| Nobles Repower T48 | 273,621 | 4,839,347 | 507.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T49 | 273,727 | 4,838,746 | 515.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T50 | 274,060 | 4,839,087 | 511.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T51 | 274,389 | 4,838,711 | 513.5 | 1.6-91 | 80 | 105 |
| Nobles Repower T52 | 273,344 | 4,838,475 | 516.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T53 | 274,035 | 4,838,392 | 515.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T54 | 274,418 | 4,838,128 | 513.8 | 1.6-91 | 80 | 105 |
| Nobles Repower T55 | 271,353 | 4,837,892 | 504.1 | 1.6-91 | 80 | 105 |
| Nobles Repower T56 | 271,669 | 4,837,280 | 506.5 | 1.6-97 | 80 | 106 |
| Nobles Repower T57 | 272,146 | 4,837,387 | 504.7 | 1.6-91 | 80 | 103 |
| Nobles Repower T58 | 273,262 | 4,835,726 | 512.5 | 1.6-97 | 80 | 106 |
| Nobles Repower T59 | 273,779 | 4,835,729 | 510.9 | 1.6-97 | 80 | 106 |
| Nobles Repower T60 | 274,031 | 4,836,122 | 514.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T61 | 275,152 | 4,837,487 | 511.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T62 | 275,892 | 4,837,622 | 503.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T63 | 274,925 | 4,836,946 | 512.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T64 | 275,417 | 4,837,010 | 511.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T65 | 276,073 | 4,837,117 | 509.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T66 | 275,125 | 4,836,487 | 512.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T67 | 275,639 | 4,836,433 | 508.4 | 1.6-97 | 80 | 108.5 |

| Project | Easting (m) | Northing (m) | Elevation (m) | Turbine Model | Hub Height (m) | LwA,ref (dBA) |
|---|---|---|---|---|---|---|
| Nobles Repower T68 | 276,136 | 4,836,469 | 517.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T69 | 276,814 | 4,837,714 | 502.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T70 | 276,521 | 4,837,344 | 504 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T71 | 276,622 | 4,836,866 | 500.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T72 | 277,543 | 4,836,438 | 507.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T73 | 276,562 | 4,836,080 | 506.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T74 | 277,257 | 4,836,044 | 505.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T75 | 275,922 | 4,835,665 | 512.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T76 | 276,395 | 4,835,645 | 508.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T77 | 276,910 | 4,835,739 | 503.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T78 | 277,523 | 4,835,617 | 502.4 | 1.6-91 | 80 | 105 |
| Nobles Repower T79 | 278,264 | 4,835,627 | 506.2 | 1.6-97 | 80 | 106 |
| Nobles Repower T80 | 278,533 | 4,836,007 | 508.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T81 | 279,007 | 4,836,022 | 510.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T82 | 276,073 | 4,845,488 | 511.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T83 | 276,540 | 4,845,469 | 517.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T84 | 276,387 | 4,845,006 | 512.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T85 | 276,385 | 4,844,406 | 512.9 | 1.6-91 | 80 | 105 |
| Nobles Repower T86 | 277,019 | 4,845,456 | 514.8 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T87 | 277,089 | 4,844,983 | 516.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T88 | 277,483 | 4,844,413 | 512.6 | 1.6-97 | 80 | 106 |
| Nobles Repower T89 | 277,967 | 4,844,376 | 512.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T90 | 276,908 | 4,843,818 | 516.3 | 1.6-97 | 80 | 106 |
| Nobles Repower T91 | 277,236 | 4,843,473 | 514.9 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T92 | 277,797 | 4,843,830 | 514.9 | 1.6-97 | 80 | 106 |
| Nobles Repower T93 | 276,785 | 4,842,866 | 507.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T94 | 277,191 | 4,843,008 | 512.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T95 | 277,948 | 4,843,305 | 515.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T96 | 278,036 | 4,842,819 | 515.6 | 1.6-97 | 80 | 106 |
| Nobles Repower T97 | 278,496 | 4,842,948 | 511.6 | 1.6-91 | 80 | 105 |
| Nobles Repower T98 | 278,963 | 4,842,939 | 511.9 | 1.6-91 | 80 | 105 |
| Nobles Repower T99 | 279,445 | 4,843,027 | 514.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T100 | 279,179 | 4,842,424 | 512.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T101 | 279,227 | 4,841,952 | 515.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T102 | 280,069 | 4,842,136 | 515.3 | 1.6-91 | 80 | 105 |
| Nobles Repower T103 | 280,217 | 4,841,634 | 518.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T104 | 280,692 | 4,841,803 | 517.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T105 | 279,161 | 4,841,102 | 513.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T106 | 280,366 | 4,841,135 | 515.4 | 1.6-97 | 80 | 106 |
| Nobles Repower T107 | 280,809 | 4,841,271 | 521.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T108 | 275,291 | 4,840,667 | 517.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T109 | 271,775 | 4,836,601 | 508.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T110 | 275,196 | 4,839,742 | 516.6 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T111 | 276,809 | 4,840,628 | 512.4 | 1.6-97 | 80 | 108.5 |

| Project | Easting (m) | Northing (m) | Elevation (m) | Turbine Model | Hub Height (m) | LwA,ref (dBA) |
|---|---|---|---|---|---|---|
| Nobles Repower T112 | 277,345 | 4,840,574 | 517.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T113 | 276,871 | 4,839,792 | 509.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T114 | 277,407 | 4,840,040 | 509.2 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T115 | 277,904 | 4,840,040 | 509 | 1.6-97 | 80 | 106 |
| Nobles Repower T116 | 277,316 | 4,839,627 | 511.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T117 | 277,725 | 4,839,611 | 509.1 | 1.6-91 | 80 | 105 |
| Nobles Repower T118 | 278,713 | 4,840,314 | 512.4 | 1.6-91 | 80 | 105 |
| Nobles Repower T119 | 279,104 | 4,840,512 | 511.6 | 1.6-97 | 80 | 106 |
| Nobles Repower T120 | 278,355 | 4,839,855 | 513.8 | 1.6-91 | 80 | 103 |
| Nobles Repower T121 | 278,787 | 4,839,848 | 511 | 1.6-91 | 80 | 103 |
| Nobles Repower T122 | 279,292 | 4,839,996 | 512 | 1.6-91 | 80 | 105 |
| Nobles Repower T123 | 280,609 | 4,840,458 | 511.3 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T124 | 280,945 | 4,840,742 | 512.7 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T125 | 280,778 | 4,840,079 | 514.9 | 1.6-97 | 80 | 106 |
| Nobles Repower T126 | 280,298 | 4,839,571 | 514.5 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T127 | 280,776 | 4,839,533 | 517.5 | 1.6-97 | 80 | 106 |
| Nobles Repower T128 | 278,428 | 4,838,749 | 509 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T129 | 279,290 | 4,839,231 | 510.2 | 1.6-91 | 80 | 105 |
| Nobles Repower T130 | 279,058 | 4,838,821 | 510.8 | 1.6-97 | 80 | 106 |
| Nobles Repower T131 | 279,523 | 4,838,814 | 512.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T132 | 280,077 | 4,839,041 | 517.1 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T133 | 280,048 | 4,838,540 | 515.4 | 1.6-97 | 80 | 108.5 |
| Nobles Repower T134 | 280,014 | 4,838,069 | 518.6 | 1.6-97 | 80 | 108.5 |
| Arnold | 271,012 | 4,848,338 | 536.7 | V110-2.2 | 70 | 109.7 |
| Don Sneve | 271,044 | 4,847,787 | 536.5 | V110-2.2 | 70 | 109.7 |
| Wilmont Hills | 270,279 | 4,848,596 | 536.7 | V110-2.2 | 70 | 109.7 |

# Appendix A

# Noise Results




Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); Census Bureau (2019).

**Legend**

- R Participating Residence
- R Non-Participating Residence
- Map Book Grid
- Major Road
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1.25 Miles

Westwood

Toll Free (888) 937-5150 westwoodps.com

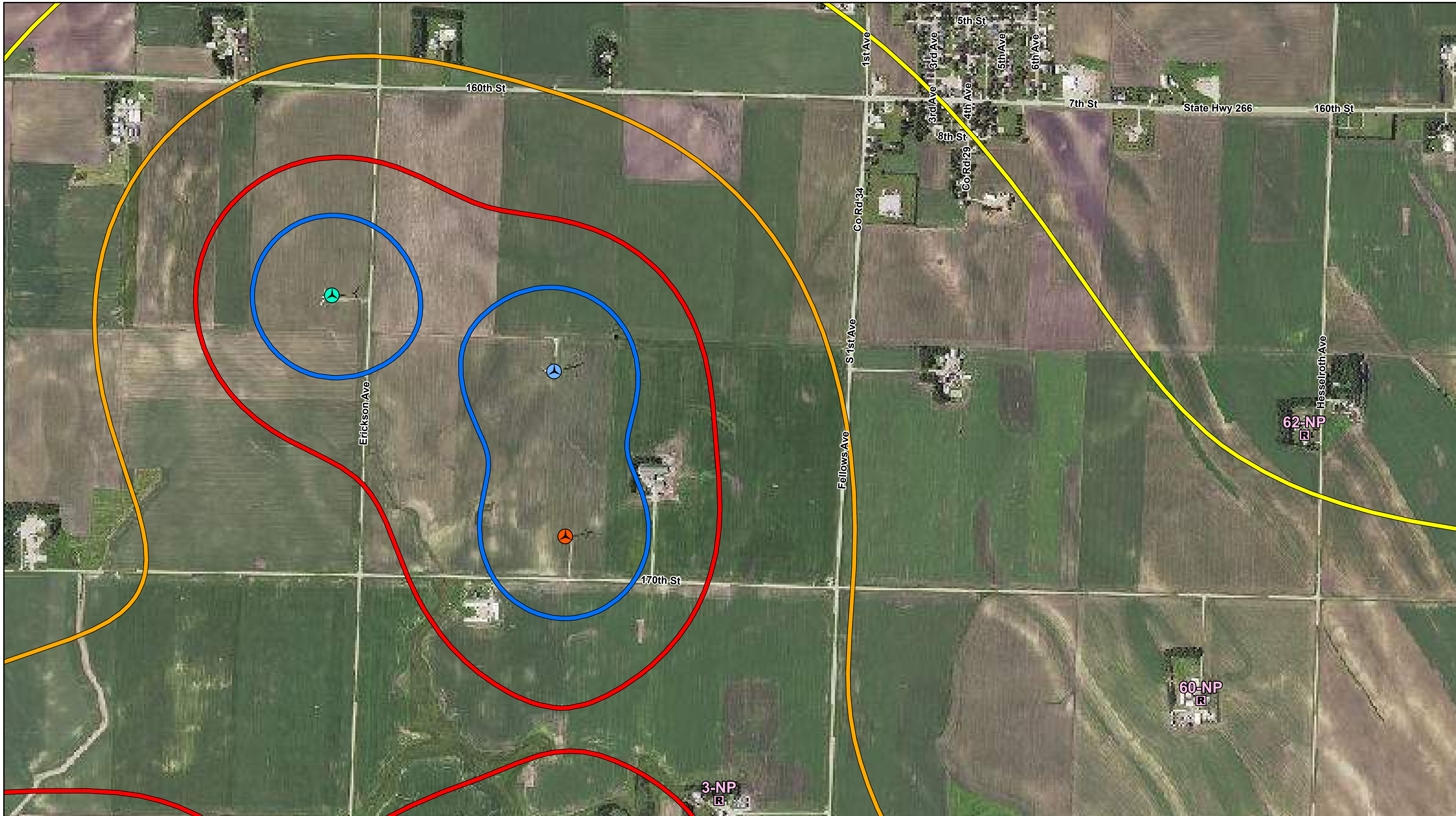
Westwood Professional Services, Inc.

# Community Wind South Project

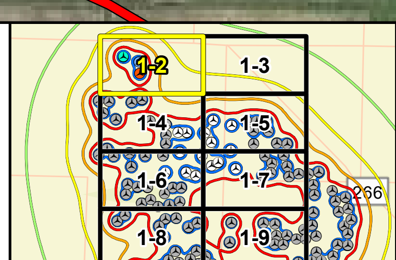
Nobles County, Minnesota

## Wind Noise Impacts Overview Map

EXHIBIT 1 - 1




Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); ESRI WMS World Streets Basemap (Accessed 2020); Census Bureau (2019).




**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

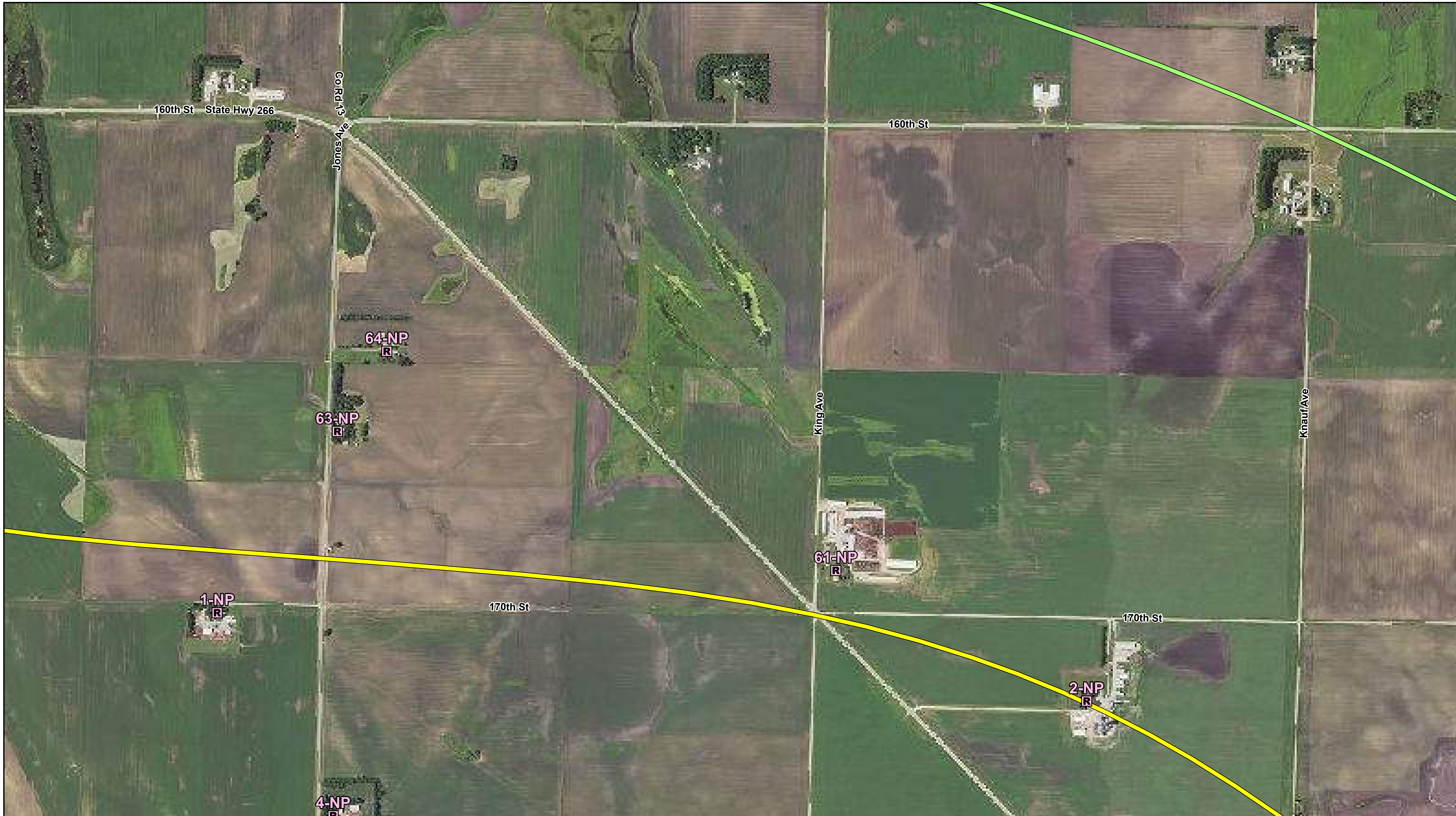
# Community Wind South Project

Nobles County, Minnesota

Wind Noise Impacts Map Book

EXHIBIT 1 - 2

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

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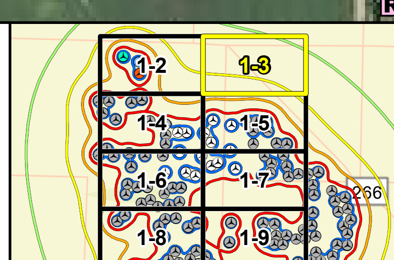



**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

Wind Noise Impacts Map Book

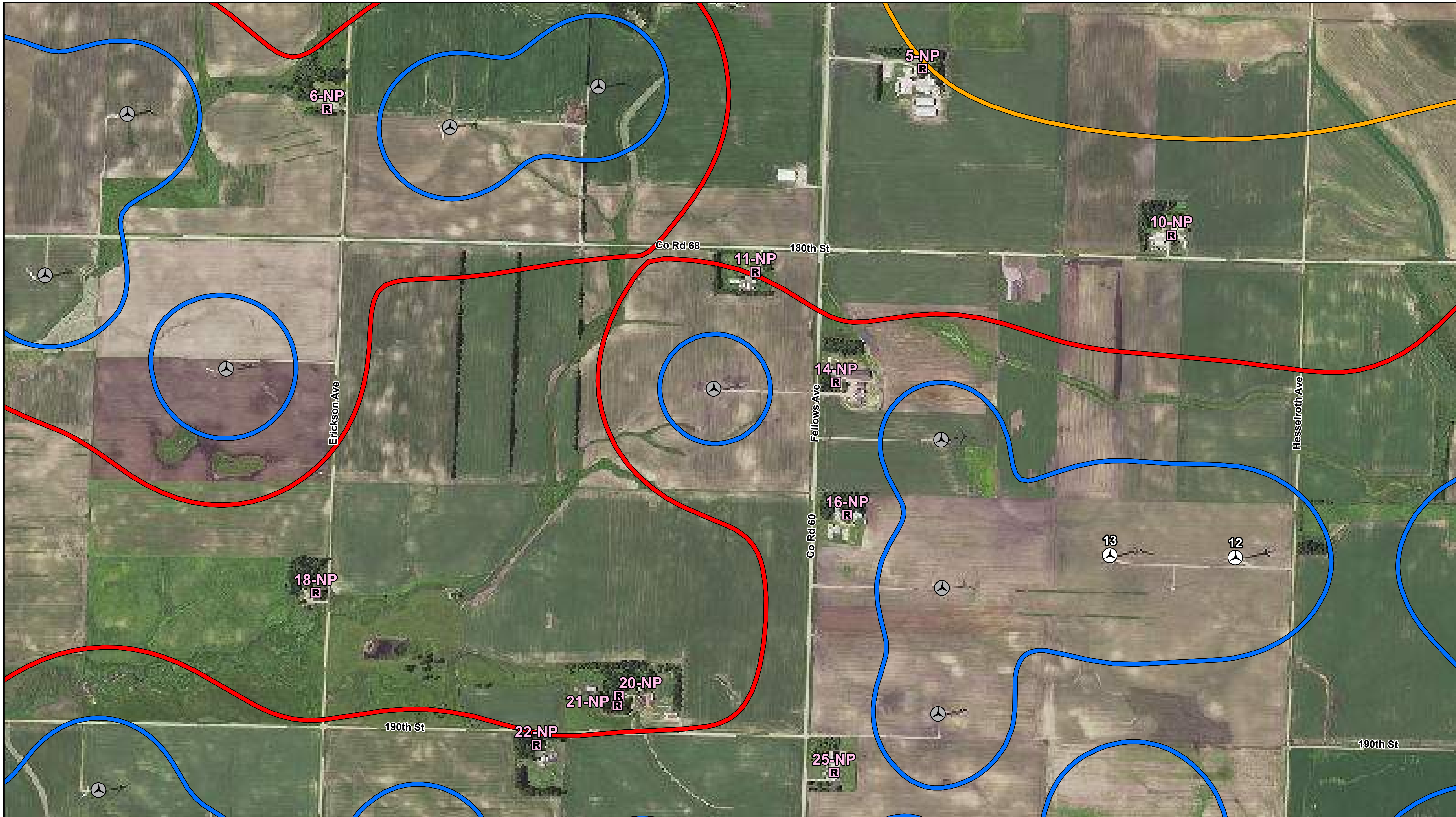
EXHIBIT 1 - 3

Westwood

Toll Free (888) 937-5150 westwoodps.com

Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook 210924 9/24/2021 6:50 PM radevito

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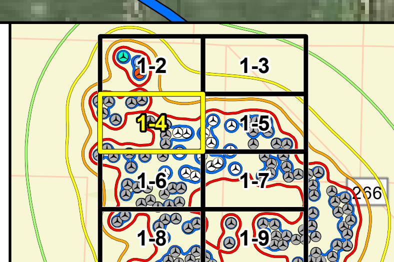


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

Wind Noise Impacts Map Book

EXHIBIT 1 - 4

Westwood

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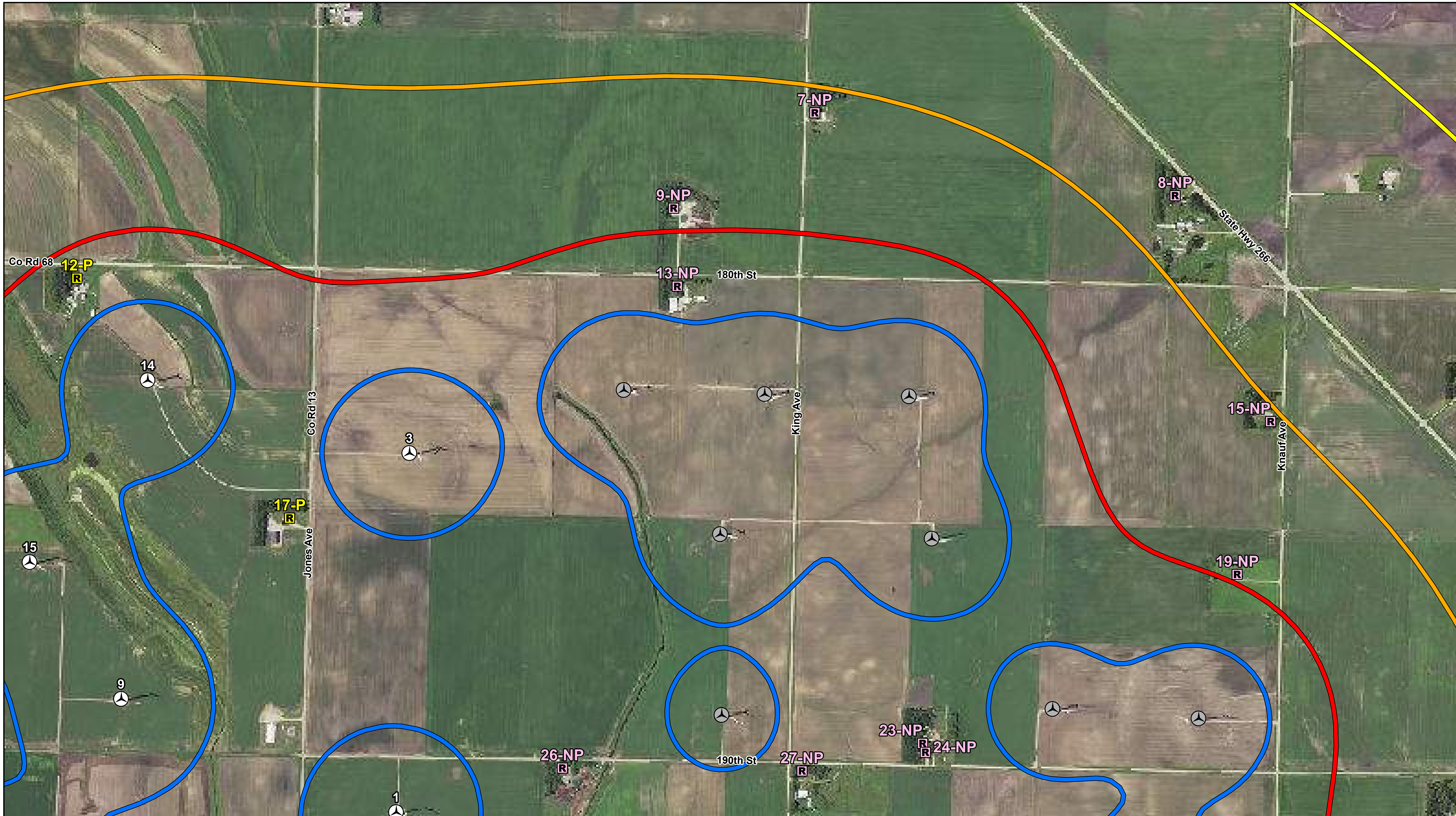
Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook_210924 9/24/2021 6:50 PM radevito

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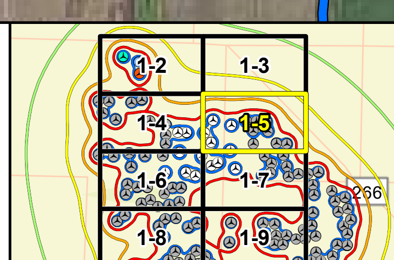


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Wind Noise Impacts Map Book

EXHIBIT 1 - 5

Westwood
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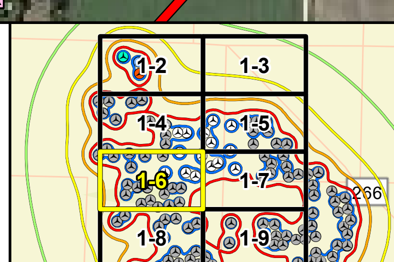
Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook_210924 9/24/2021 6:50 PM radevito


Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); ESRI WMS World Streets Basemap (Accessed 2020); Census Bureau (2019).




**Legend**

- Participating Residence
- Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Wind Noise Impacts Map Book

EXHIBIT 1 - 6

Westwood

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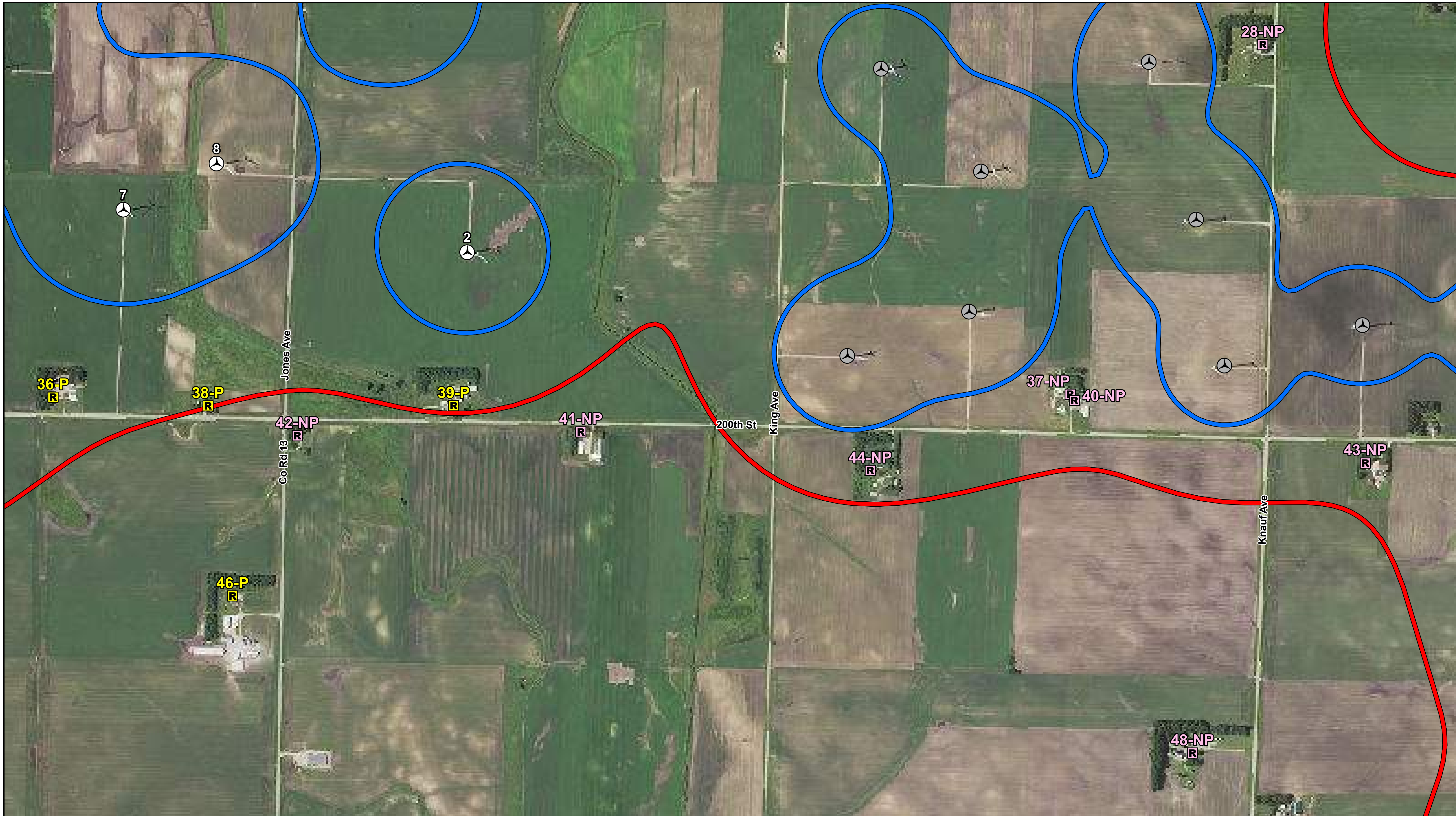
Map Document: N:\0026682.00\GIS\Pro\Community Wind South\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook_210924 9/24/2021 6:50 PM radevito

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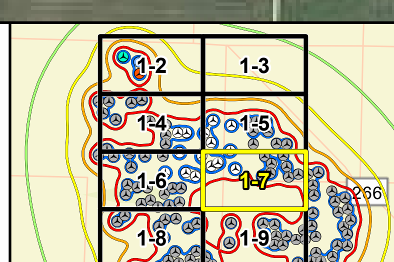


**Legend**

- Participating Residence
- Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

## Wind Noise Impacts Map Book

EXHIBIT 1 - 7

Westwood

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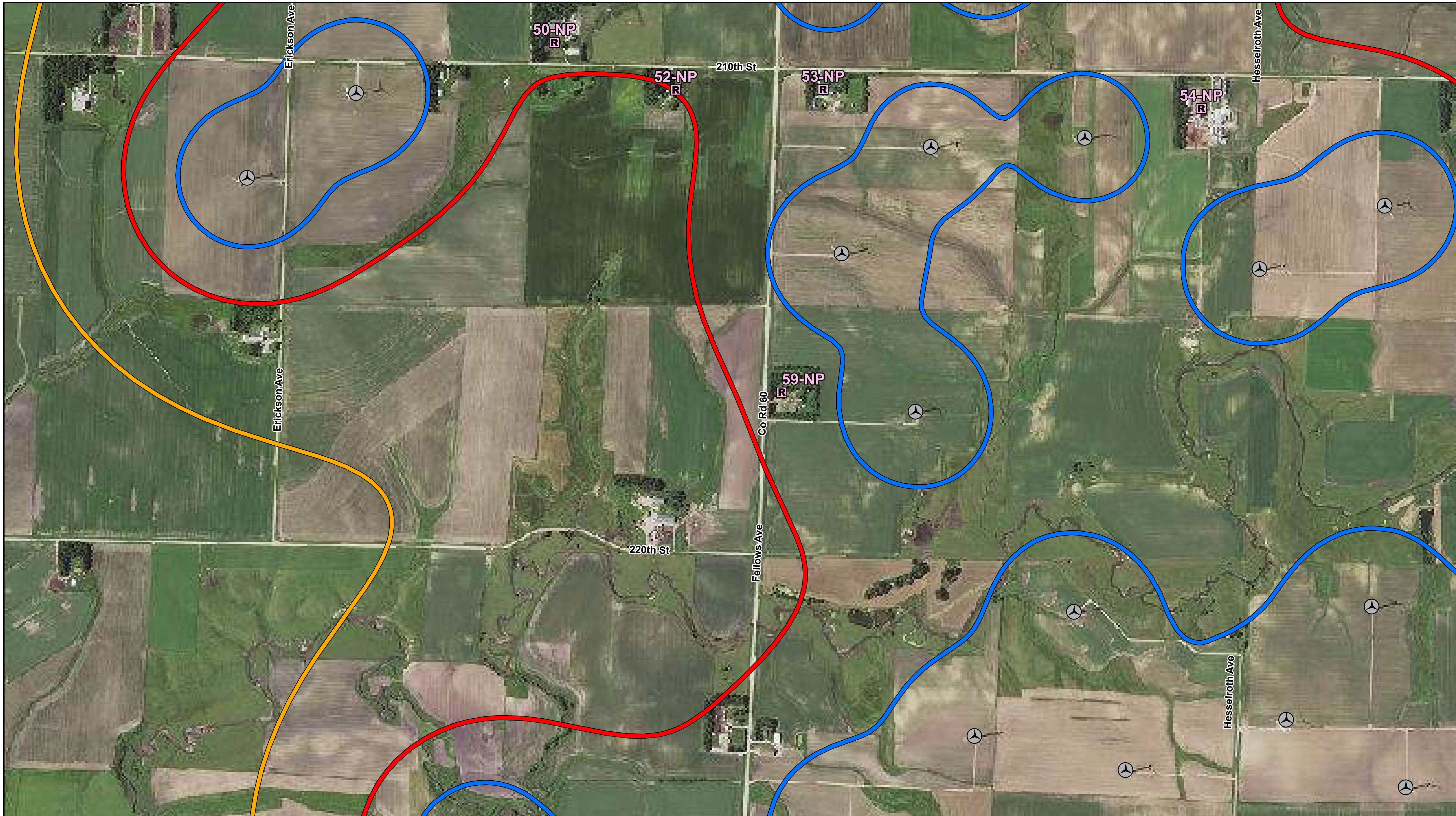


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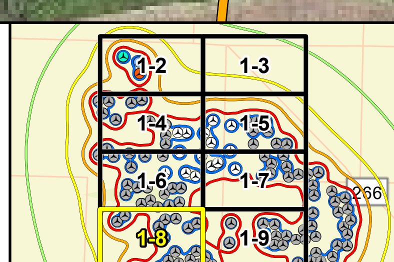


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Wind Noise Impacts Map Book

EXHIBIT 1 - 8

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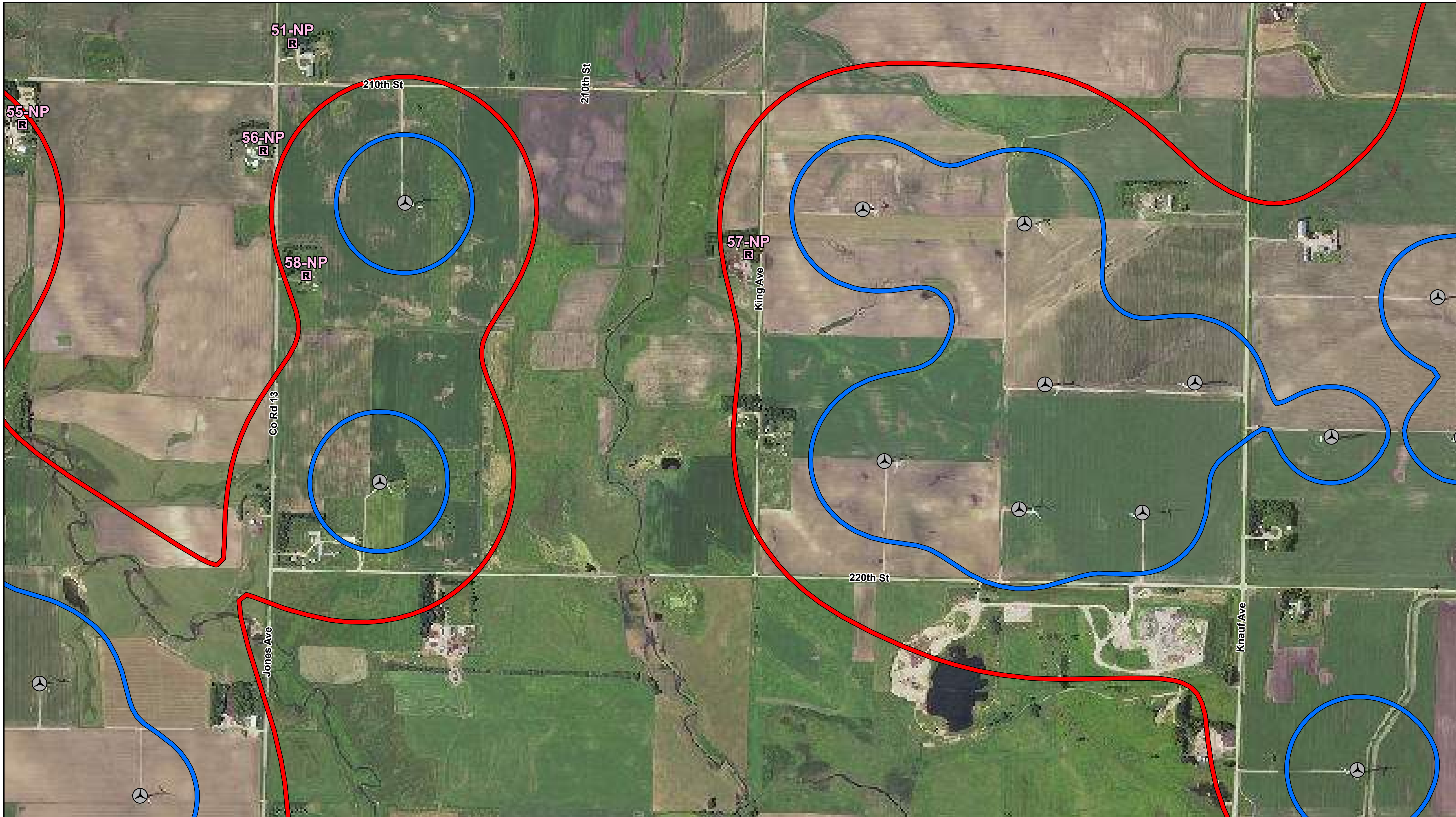
Map Document: N:\0026682.00\GIS\Pro\Community Wind South\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook_210924 9/24/2021 6:50 PM radevito

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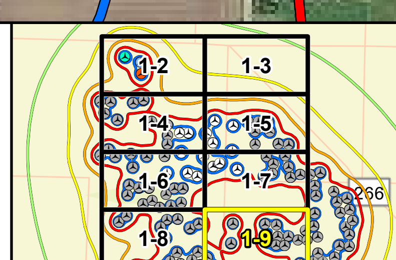


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Noise Impact in Decibels**

- 25 dB(A)
- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Wind Noise Impacts Map Book

EXHIBIT 1 - 9

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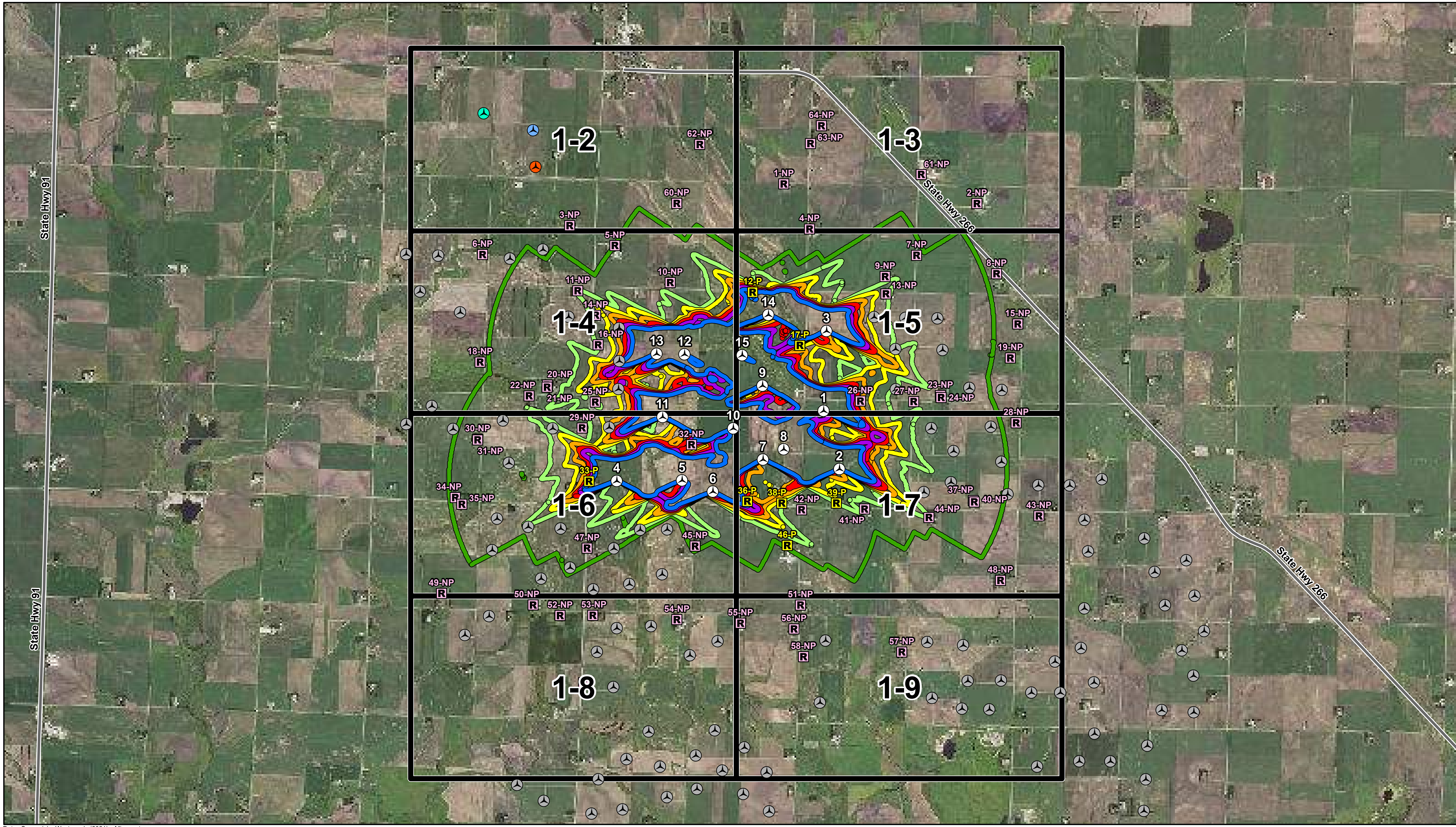
Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_NoiseImpactsMapBook_210924 9/24/2021 6:50 PM radevito

# Appendix B

# Shadow Flicker Results

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**Legend**

- R Participating Residence
- R Non-Participating Residence
- Map Book Grid
- Major Road
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

Feet
0 4,500

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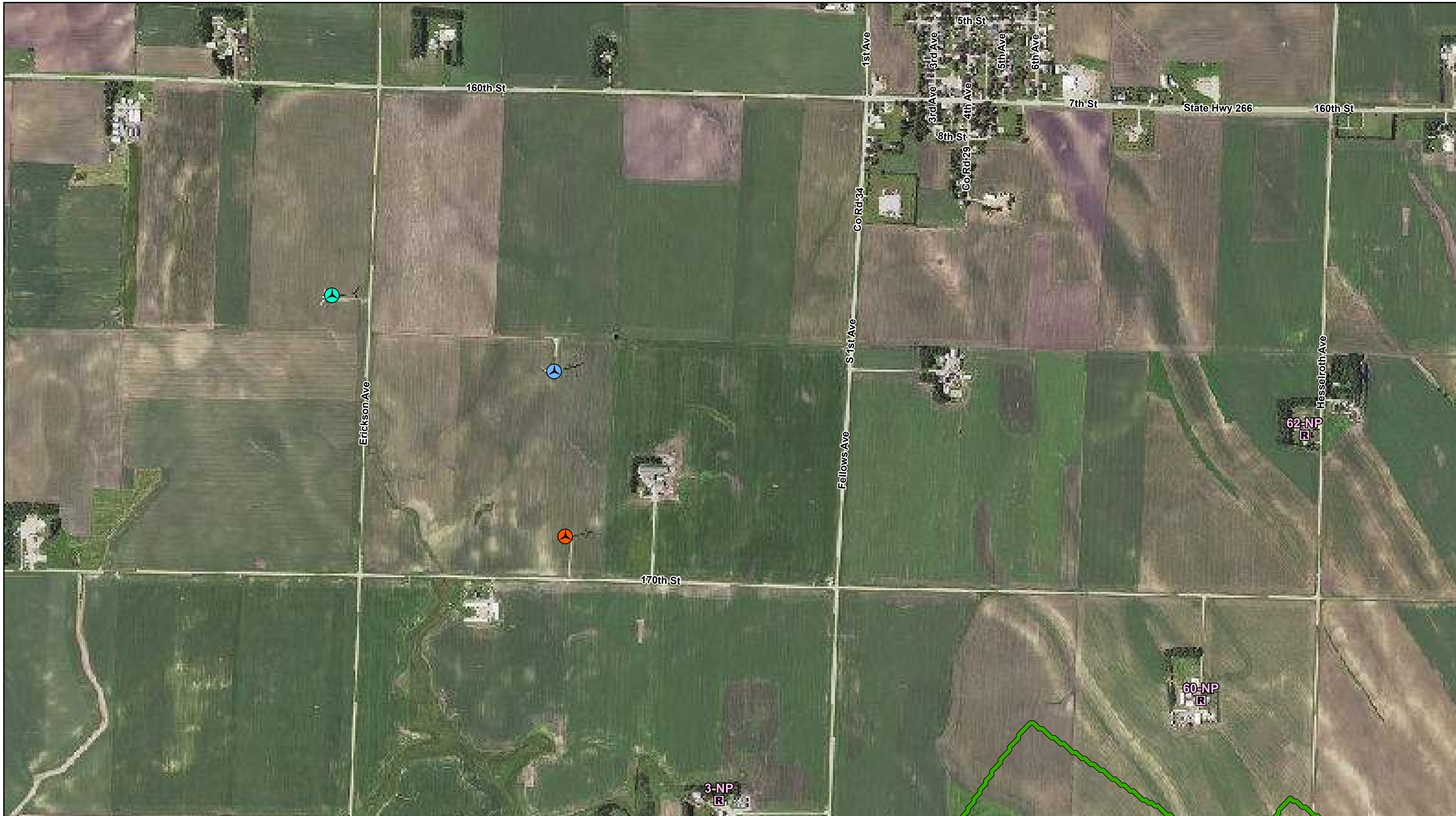
# Community Wind South Project

Nobles County, Minnesota

## Shadow Flicker Overview Map

EXHIBIT 2 - 1

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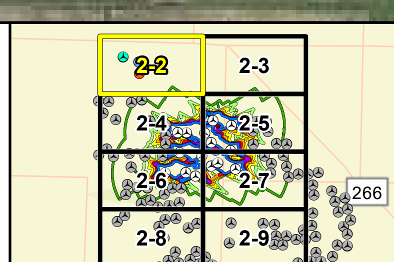


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 2

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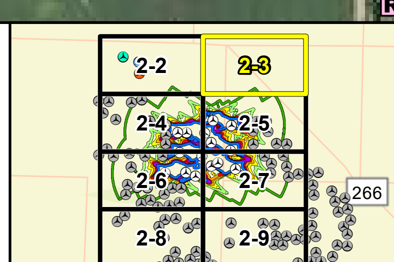
Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook_210924 9/24/2021 6:53 PM radevito


Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); ESRI WMS World Streets Basemap (Accessed 2020); Census Bureau (2019).




**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 3

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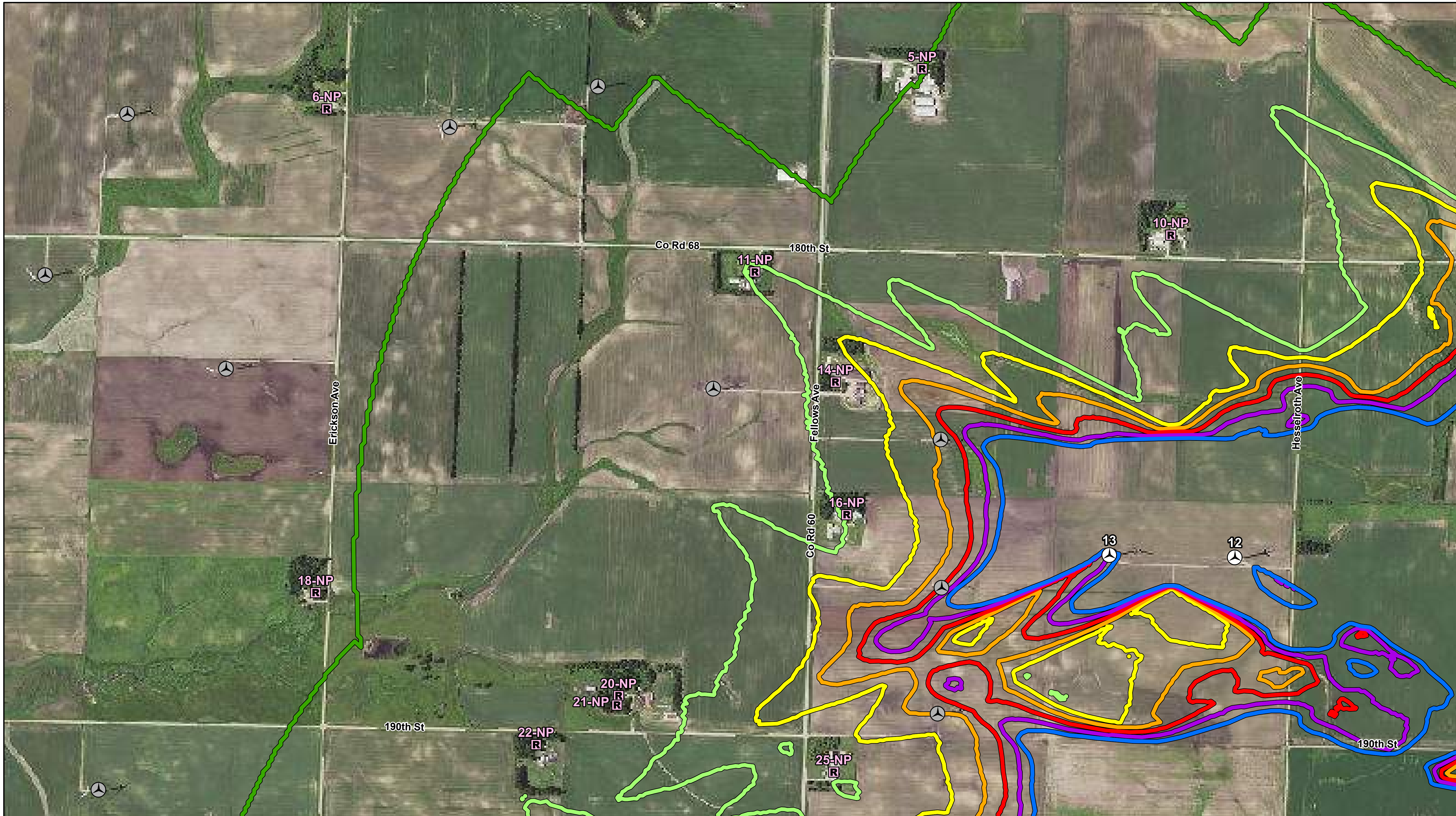
Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook 210924 9/24/2021 6:53 PM radevito

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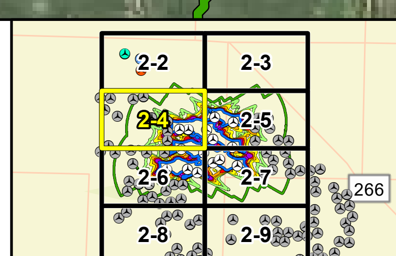


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 4

Westwood
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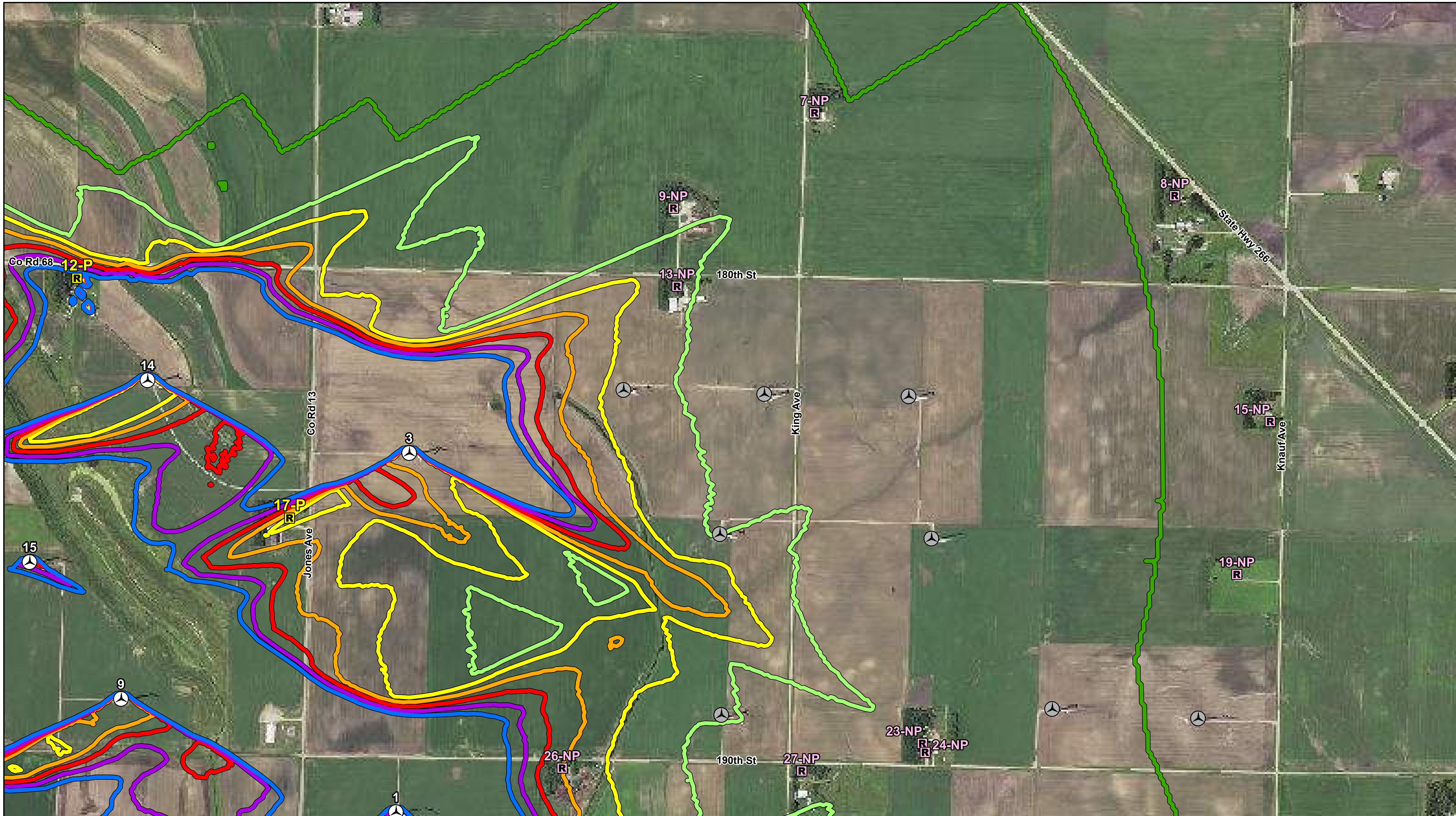
Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook_210924 9/24/2021 6:53 PM radevito

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Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); ESRI WMS World Streets Basemap (Accessed 2020); Census Bureau (2019).

Westwood

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2-2 2-3 2-4 2-5 2-6 2-7 2-8 2-9 266

**Legend**

- Participating Residence
- Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

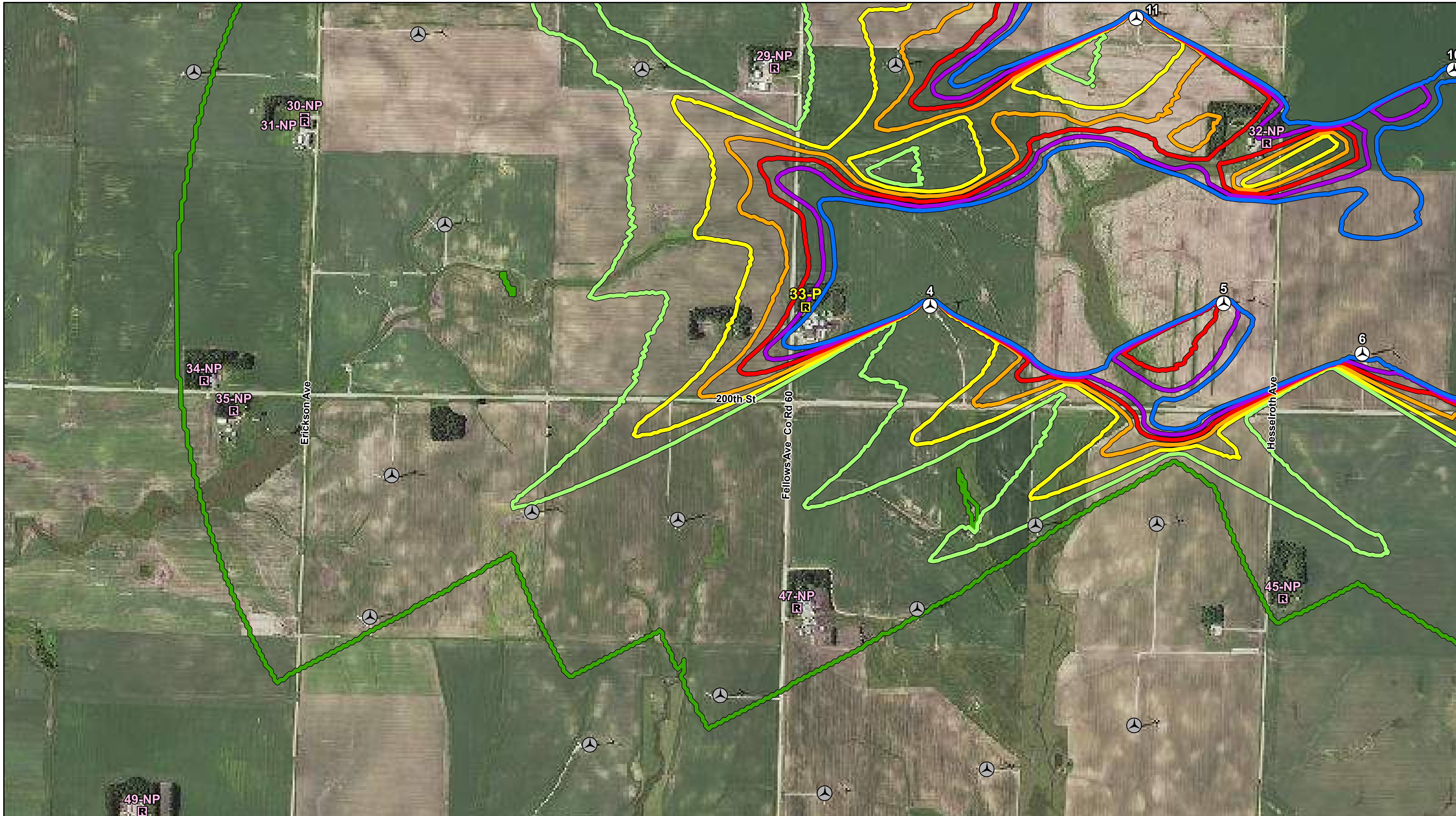
Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 5

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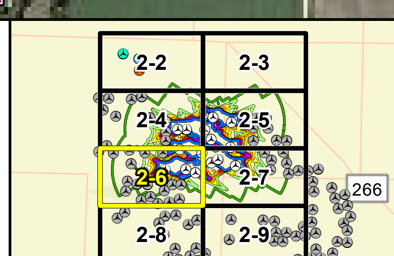


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 6

Westwood

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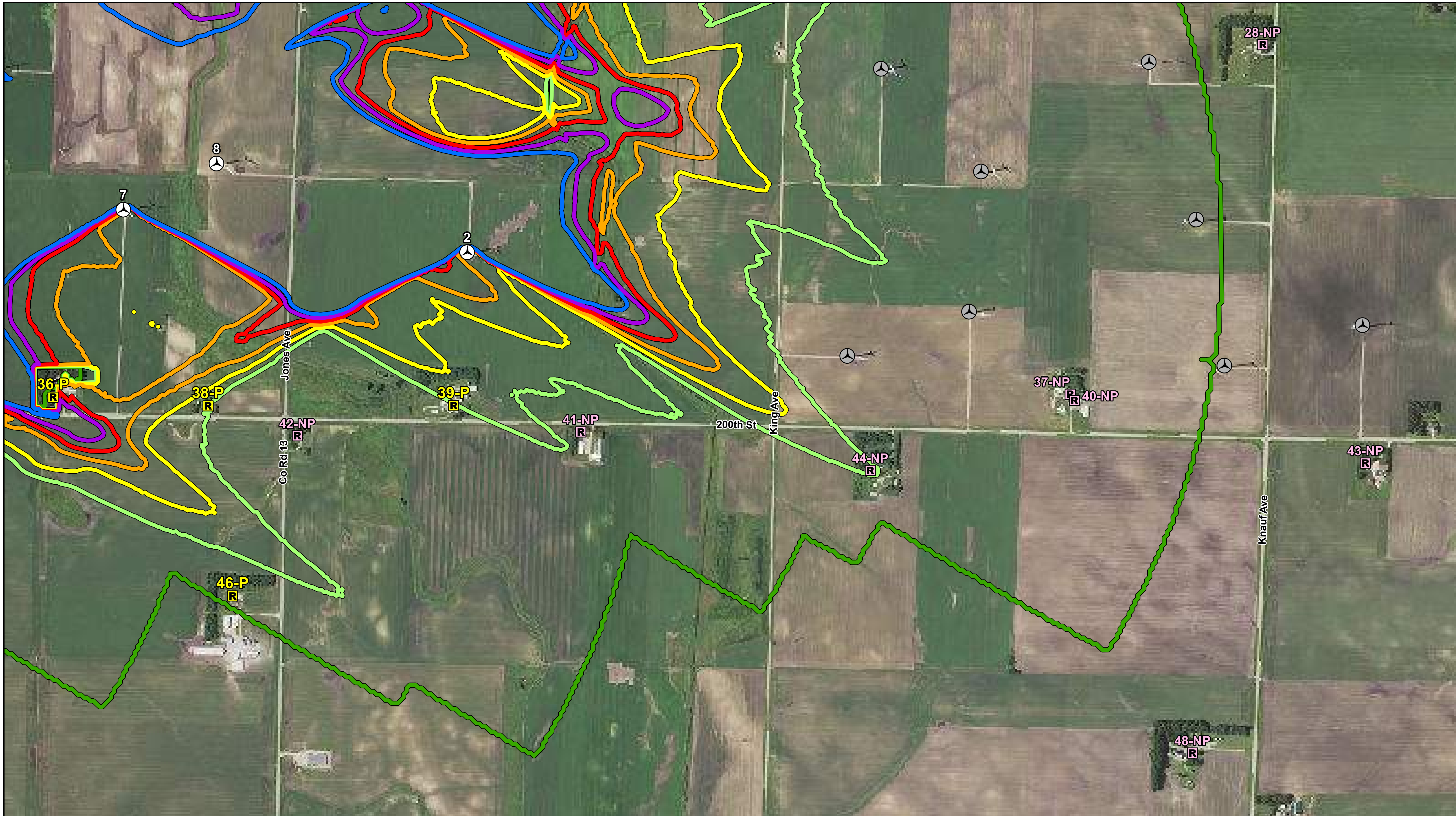
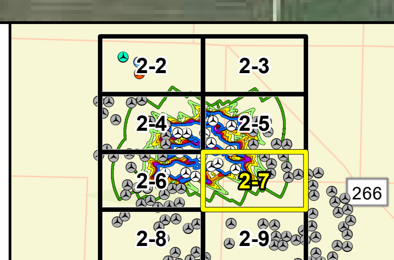
Westwood Professional Services, Inc.

Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook_210924 9/24/2021 6:53 PM radevito




Data Source(s): Westwood (2021); Minnesota NAIP Imagery (2019); ESRI WMS World Streets Basemap (Accessed 2020); Census Bureau (2019).




**Legend**

- Participating Residence
- Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 7

Westwood
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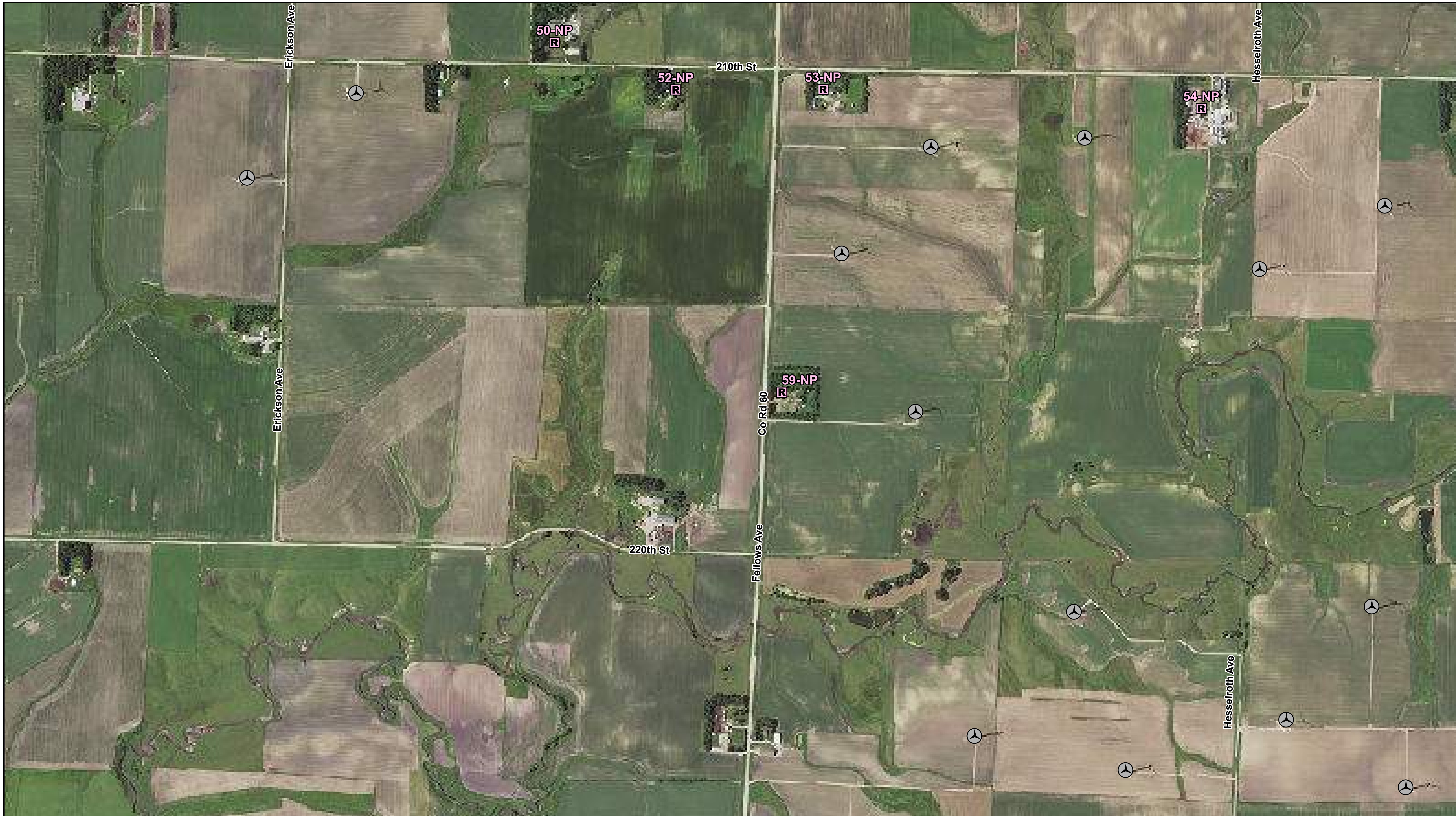
Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook_210924 9/24/2021 6:53 PM radevito

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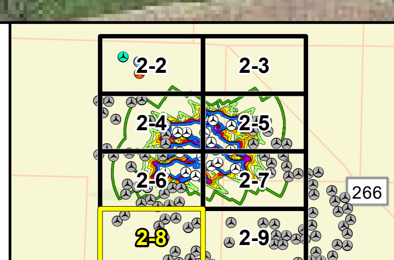


**Legend**

- R Participating Residence
- R Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

Feet
0 1,000

# Community Wind South Project

Nobles County, Minnesota

Turbine Shadow Flicker Map Book

EXHIBIT 2 - 8

Westwood
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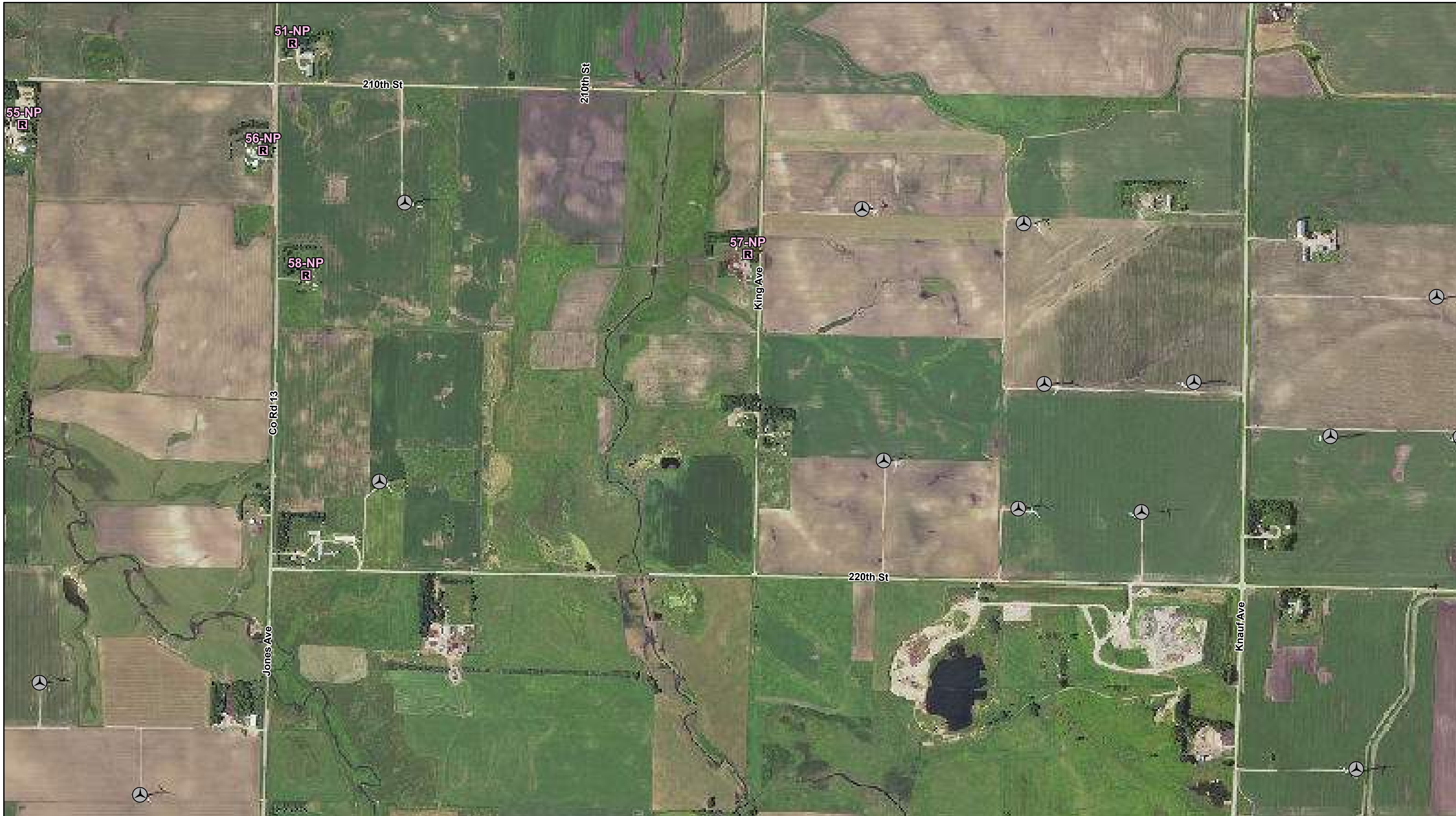
Map Document: N:\0026682.00\GIS\Pro\Community Wind South Noise & Shadow Exhibits\Community Wind South Noise & Shadow Exhibits.aprx CWS_ShadowFlickerMapBook 210924 9/24/2021 6:53 PM radevito

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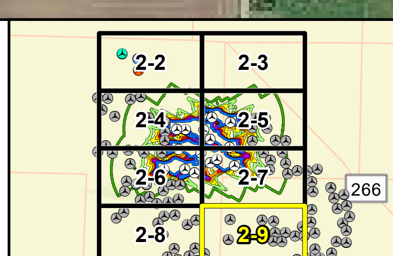


**Legend**

- Participating Residence
- Non-Participating Residence
- Community Wind South Turbine
- Arnold Turbine
- Don Sneve Turbine
- Nobles Turbine
- Wilmont Hills Turbine

**Turbine Shadow Flicker in Hours Per Year**

- 0 Hrs/Yr
- 5 Hrs/Yr
- 10 Hrs/Yr
- 15 Hrs/Yr
- 20 Hrs/Yr
- 25 Hrs/Yr
- 30 Hrs/Yr

N

0 1,000 Feet

# Community Wind South Project

Nobles County, Minnesota

## Turbine Shadow Flicker Map Book

EXHIBIT 2 - 9

Westwood

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