



February 4, 2019

Epsilon Ref. 4965

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**Subject: Burke Wind, LLC  
 Addendum to the Shadow Flicker Analysis Report**

Dear Ms. Corbett:

Epsilon Associates, Inc. (Epsilon) completed a shadow flicker analysis report for the Burke County Wind Energy Center dated November 6, 2018 (Case Number PU-18-344, Docket Number 17). This letter serves as an addendum to that report and includes updated modeling results. This addendum was created in order to address updates and changes to the shadow flicker modeling based upon a new receptor dataset, new land status dataset, and feedback on the format of submittals for other recent projects in North Dakota. The project layout and shadow flicker modeling parameters are identical to the ones used for the original shadow flicker analysis report.

**ASSOCIATES**

- Richard M. Lampeter, INCE
- Geoff Starsiak, LEED AP BD+C
- Marc Bergeron, PWS, CWS

Structures

Based on a review of aerial imagery within 1.5 miles of the Project Boundary, structures not previously identified were added to the receptor dataset. The new dataset provided by Atwell, LLC (Atwell) on January 18, 2019 also included minor adjustments to the coordinates of the structures to ensure that they were positioned at the center point of structures. Occupancy status of the structures in the updated dataset are categorized as occupied, unoccupied, or potentially occupied. These locations are presented in Figure 1.

Modeling Receptors

Structures identified as occupied or potentially occupied were modeled as discrete points, i.e. receptors. The shadow flicker analysis was only performed at inhabited structures, and therefore locations in the unoccupied category were not modeled. Conservatively all potentially occupied structures were assumed to be occupied and

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included in the analysis. Therefore, a total of 56 receptors were modeled and evaluated.

#### Project Area Land Status

Updates were made to the land status of the parcels within the Project Area, and include the following three categories: Participating, Non-Participating, and Non-Participating Parcel, Participating Owner. This third category applies to non-participating parcels with a landowner that has an agreement in place for other parcels in the Project Area. The updated land status information was sent to Epsilon via email by Atwell on January 18, 2019. Using the updated land status dataset, Epsilon assigned participation status to each receptor.

#### Updated Shadow Flicker Modeling Results

The November 6, 2018 shadow flicker analysis report presented expected annual durations of shadow flicker at 68 receptors. The predicted expected annual shadow flicker duration ranged from 0 hours, 0 minutes per year to 25 hours, 30 minutes per year. The maximum expected annual duration of shadow flicker at a modeling receptor was 25 hours, 30 minutes which was on a non-participating parcel.

The updated shadow flicker model presents predicted expected annual shadow flicker duration at 56 receptors. Results of the modeling range from 0 hours, 0 minutes per year to 25 hours, 30 minutes per year.

Table 1 presents expected annual shadow flicker modeling results at all structures categorized as occupied or potentially occupied that occur on participating parcels. The maximum expected annual duration of shadow flicker at a modeling receptor on a participating parcel is 22 hours, 8 minutes at Receptor #34.

Table 2 presents expected annual shadow flicker modeling results at all structures categorized as occupied or potentially occupied that occur on non-participating parcels with a participating owner. The maximum expected annual duration of shadow flicker at a modeling receptor on a non-participating parcel with a participating land owner is 5 hours, 7 minutes at Receptor #18.

Table 3 presents expected annual shadow flicker modeling results at all structures categorized as occupied or potentially occupied that occur on non-participating parcels. The maximum expected annual duration of shadow flicker at a modeling receptor on a non-participating parcel is 25 hours, 30 minutes at Receptor #11.

As part of this addendum, new figures have been created to display all results of the shadow flicker analysis. Figure 2 shows all modeling receptors (occupied and potentially occupied) and their participation status. Callouts for each modeled receptor have been added displaying the receptor ID, landowner name, predicted annual shadow flicker duration, ID of the closest wind turbine, and distance to the closest wind turbine. Flicker isolines generated from the modeling grid are also presented on this figure.

### Conclusions

Expected annual shadow flicker at all revised modeling receptor locations are below the project design goal of 30 hours per year, and therefore, the Project meets the design goal with respect to shadow flicker.

If you have any questions on the content of this letter, please feel free to call me at (978) 461-6205, or e-mail me at [RLampeter@epsilonassociates.com](mailto:RLampeter@epsilonassociates.com).

Sincerely,

EPSILON ASSOCIATES, INC.



Richard Lampeter, INCE  
Associate

**Table 1: Shadow Flicker Analysis- Participating Landowners**

Modeling ID	Landowner Name	Occupancy Status	Coordinates UTM NAD83 Zone 13N		Expected Shadow Flicker Hours per Year (HH:MM/year)	Nearest Wind Turbine ID <sup>1</sup>	Distance to Nearest Wind Turbine (ft) <sup>1</sup>
			X (m)	Y (m)			
34	WATTERUD, LYNN E	Occupied	659188.67	5408404.67	22:08	33	2739
76	WEIPPERT, EDWARD	Occupied	659170.92	5403421.29	11:21	38	2793
60	RONHOLDT, Dorene	Occupied	668093.18	5405440.18	11:00	53	2885
23	BURAU, THOMAS F	Occupied	655428.52	5408262.95	10:19	9	2808
74	ONEIL, HUGH M	Occupied	656962.13	5403207.90	9:33	24	2839
39	CORY CARLSON	Occupied	660890.33	5406975.77	8:36	35	2966
43	ULSRUD, OAKLEY BENTON	Potentially Occupied	668509.24	5406753.29	7:12	54	4342
57	NESS, DOUGLAS W	Occupied	664035.87	5405724.65	6:39	45	3713
101	BEARD, HELENE	Occupied	677174.51	5402737.69	6:36	76	3702
85	BONSNES, THOMAS L	Occupied	664483.24	5402145.91	2:38	52	3204
100	GREENFIELD, RALPH	Occupied	677459.25	5403643.33	1:31	76	4995
22	WATTERUD, BYRON K	Occupied	652977.09	5406829.78	0:31	3	5557
104	GREENFIELD, RALPH	Occupied	677384.12	5401541.64	0:23	75	6355
97	GREENFIELD, RYAN MICHAEL	Occupied	677168.21	5404237.17	0:11	76	5403
3	NELSON, JOHN TERRY	Occupied	652036.02	5410612.28	0:00	1	6033
19	PRIEBE, MARK	Occupied	653689.38	5407545.00	0:00	3	2714
21	WATTERUD, BYRON K	Occupied	652939.04	5407019.70	0:00	3	5055
64	BERG FARMS LLC,	Occupied	673276.80	5406336.35	0:00	62	6660
78	ONEIL, HUGH	Occupied	658590.40	5400978.05	0:00	37	5938
92	OAS, GAYLEN K	Occupied	669795.95	5402801.33	0:00	61	6286
110	HELSETH, ROGER L	Occupied	664627.32	5400851.83	0:00	48	6326
113	HELSETH, ROGER L	Occupied	668216.80	5400488.00	0:00	65	13311
123	HELSETH, ROGER L	Occupied	667374.23	5401221.42	0:00	52	10966
124	HELSETH, ROGER L	Occupied	668284.11	5400413.88	0:00	65	13048
126	THE ALLEN WITTY FAMILY LLP,	Potentially Occupied	657236.13	5412549.44	0:00	15	10269

1) The distances presented are calculated from the receptor (assumed building center point) to the closest wind turbine and are not intended for the evaluation of setback requirements.

**Table 2: Shadow Flicker Analysis- Non-Participating Parcels, Participating Owner**

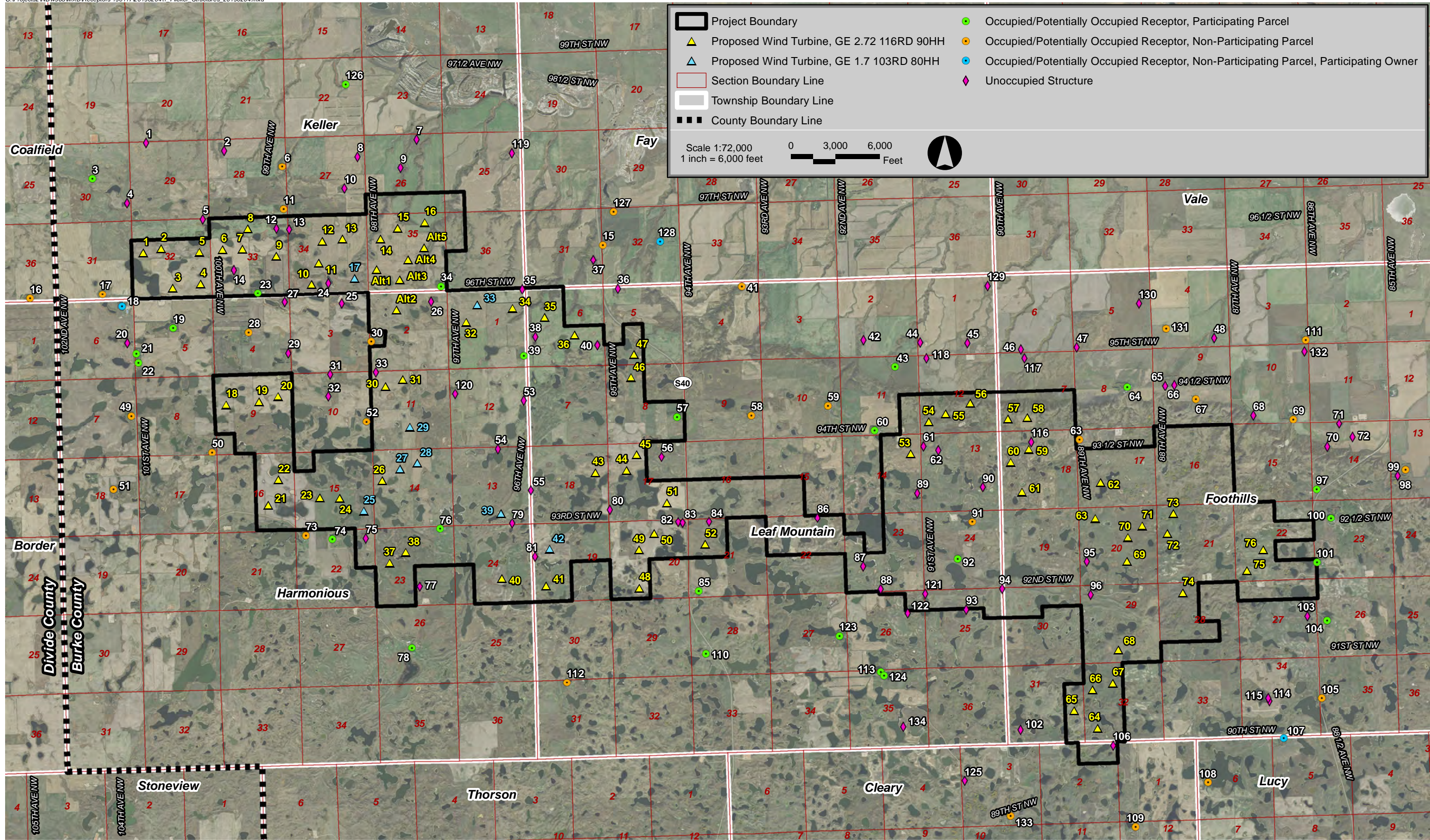
Modeling ID	Landowner Name	Occupancy Status	Coordinates UTM NAD83 Zone 13N		Expected Shadow Flicker Hours per Year (HH:MM/year)	Nearest Wind Turbine ID <sup>1</sup>	Distance to Nearest Wind Turbine (ft) <sup>1</sup>
			X (m)	Y (m)			
18	BRODAL, LYNN	Occupied	652646.19	5407990.79	5:07	3	3606
107	SMITH, INEZ B	Occupied	676490.89	5399123.05	0:00	75	11570
128	DIHLE, DARRELL A	Occupied	663691.48	5409325.01	0:00	47	7800

1) The distances presented are calculated from the receptor (assumed building center point) to the closest wind turbine and are not intended for the evaluation of setback requirements.

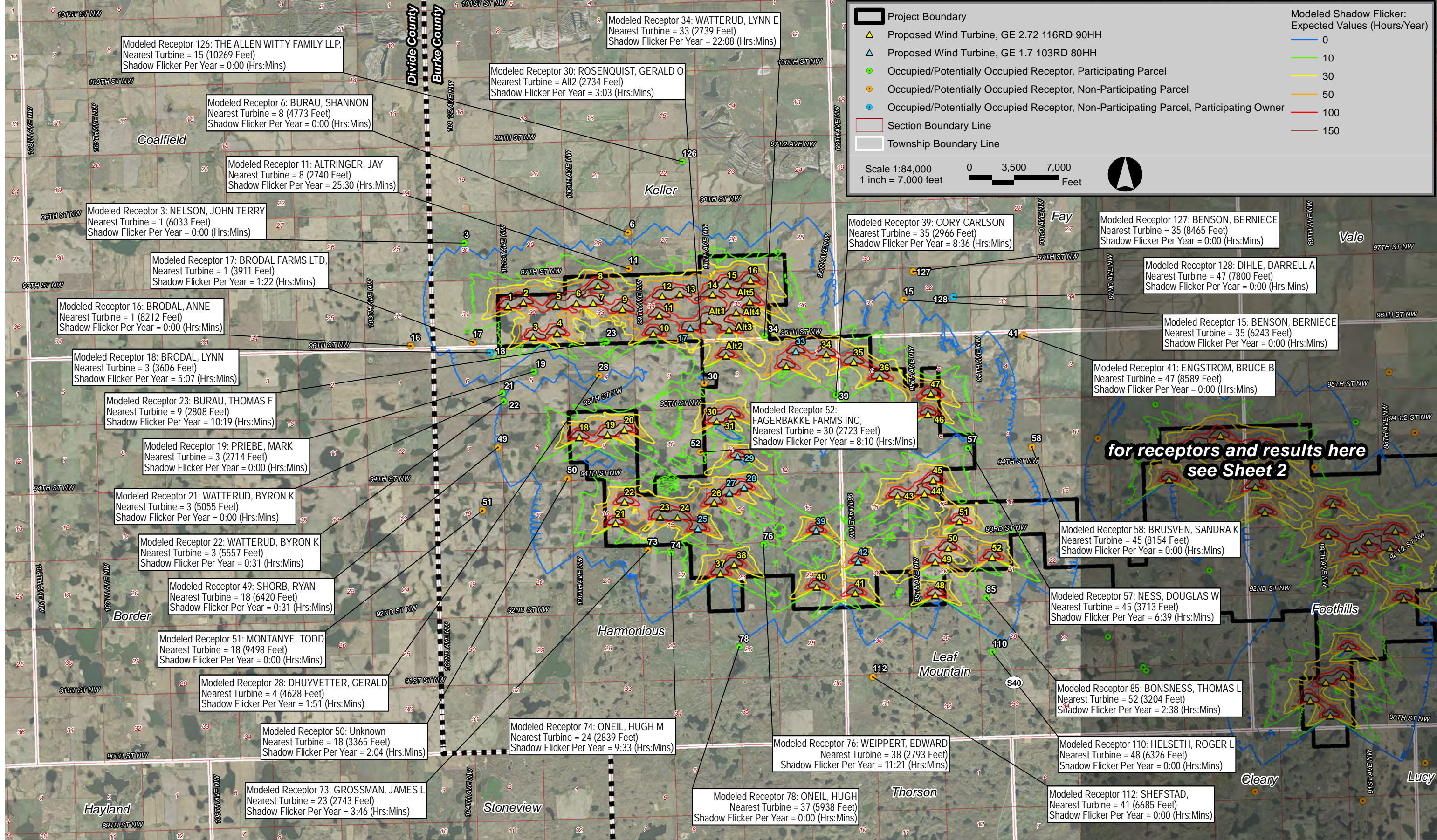
**Table 3: Shadow Flicker Analysis- Non-Participating Landowners**

Modeling ID	Landowner Name	Occupancy Status	Coordinates UTM NAD83 Zone 13N		Expected Shadow Flicker Hours per Year (HH:MM/year)	Nearest Wind Turbine ID <sup>1</sup>	Distance to Nearest Wind Turbine (ft) <sup>1</sup>
			X (m)	Y (m)			
11	ALTRINGER, JAY	Occupied	655957.70	5409991.59	25:30	8	2740
63	Unknown	Occupied	672296.53	5405256.10	16:56	62	3217
91	VELO, JOHN	Occupied	670095.61	5403562.73	8:20	61	3933
52	FAGERBAKKE FARMS INC,	Occupied	657657.97	5405623.95	8:10	30	2723
73	GROSSMAN, JAMES L	Occupied	656417.87	5403286.24	3:46	23	2743
30	ROSENQUIST, GERALD O	Occupied	657755.31	5407268.55	3:03	Alt2	2734
50	Unknown	Occupied	654491.07	5404994.62	2:04	18	3365
28	DHUYVETTER, GERALD	Potentially Occupied	655242.03	5407455.52	1:51	4	4628
17	BRODAL FARMS LTD,	Occupied	652244.06	5408242.44	1:22	1	3911
59	THINGVOLD, JON E	Occupied	667132.44	5405948.66	0:44	53	6447
49	SHORB, RYAN	Occupied	652833.25	5405740.52	0:31	18	6420
6	BURAU, SHANNON	Occupied	655932.31	5410861.93	0:00	8	4773
15	BENSON, BERNIECE	Occupied	662515.73	5409251.03	0:00	35	6243
16	BRODAL, ANNE	Occupied	650756.54	5408156.26	0:00	1	8212
41	ENGSTROM, BRUCE B	Occupied	665365.70	5408404.94	0:00	47	8589
51	MONTANYE, TODD	Potentially Occupied	652466.73	5404233.41	0:00	18	9498
58	BRUSVEN, SANDRA K	Occupied	665561.52	5405753.51	0:00	45	8154
67	DOWNIE, CARRIE D	Occupied	674689.51	5406081.13	0:00	73	7836
69	WINZENBURG, DONALD	Occupied	676689.19	5405670.55	0:00	76	8979
99	GRANDALL, EARL C	Potentially Occupied	678987.95	5404638.09	0:00	76	10951
105	ATWOOD, RAYMOND E	Occupied	677271.80	5399946.65	0:00	75	9961
108	WEINMANN, EARL W	Occupied	674937.07	5398209.93	0:00	64	8291
109	PETERS, RONALD L	Occupied	673446.33	5397301.63	0:00	64	7137
111	NELSON, DAN	Occupied	676940.80	5407298.47	0:00	76	14375
112	SHEFSTAD,	Occupied	661775.10	5400265.81	0:00	41	6685
127	BENSON, BERNIECE	Occupied	662730.77	5409931.16	0:00	35	8465
131	WINZENBURG, DOUGLAS	Potentially Occupied	674079.17	5407532.77	0:00	58	11077
133	SMITH, WILLIAM R	Occupied	670881.54	5397520.10	0:00	65	8346

<sup>1</sup>) The distances presented are calculated from the receptor (assumed building center point) to the closest wind turbine and are not intended for the evaluation of setback requirements.



Burke County Wind Energy Center Burke County, North Dakota



for receptors and results here see Sheet 2

