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February 4, 2019 Epsilon Ref. 4965

Tara Corbett
Project Manager
Atwell, LLC
6200 S. Syracuse Way, Suite 470
Greenwood Village, CO 80111

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.

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

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.

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 [1]	Distance to Nearest Wind Turbine (ft) [1]
			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	BONSNESS, 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 [1]	Distance to Nearest Wind Turbine (ft) [1]
			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 [1]	Distance to Nearest Wind Turbine (ft) [1]
			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

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.

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Project Boundary
Proposed Wind Turbine, GE 2.72 116RD 90HH
Proposed Wind Turbine, GE 1.7 103RD 80HH
Section Boundary Line
Township Boundary Line
County Boundary Line
Occupied/Potentially Occupied Receptor, Participating Parcel
Occupied/Potentially Occupied Receptor, Non-Participating Parcel
Occupied/Potentially Occupied Receptor, Non-Participating Parcel, Participating Owner
Unoccupied Structure

Scale 1:72,000
1 inch = 6,000 feet

0 3,000 6,000 Feet

Coalfield
Keller
Fay
Vale
Foothills
Leaf Mountain
Harmonious
Border
Stoneview
Thorson
Cleary
Lucy
Divide County
Burke County

99TH ST NW
97 1/2 AVE NW
98 1/2 ST NW
97TH AVE NW
98TH AVE NW
97TH ST NW
93RD AVE NW
92ND AVE NW
90TH AVE NW
96 1/2 ST NW
86TH AVE NW
85TH AVE NW
100TH AVE NW
102ND AVE NW
94TH AVE NW
95TH ST NW
97TH AVE NW
95TH AVE NW
94 1/2 ST NW
94TH ST NW
93 1/2 ST NW
88TH AVE NW
92 1/2 ST NW
91ST AVE NW
92ND ST NW
91ST ST NW
90TH ST NW
88 1/2 AVE NW
101ST AVE NW
96TH AVE NW
93RD ST NW
89TH ST NW
105TH AVE NW
104TH AVE NW

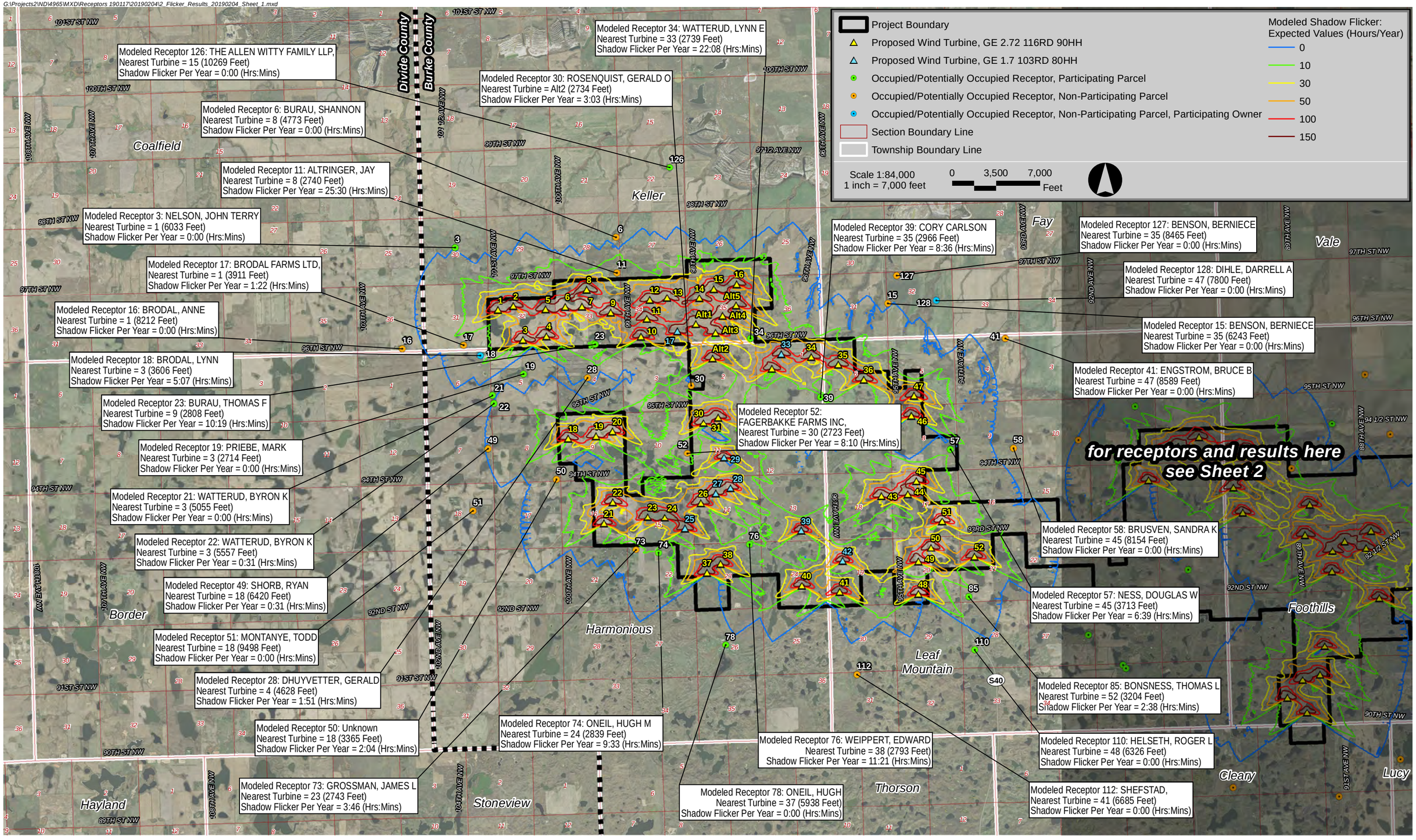
Alt1 Alt2 Alt3 Alt4 Alt5

Burke County Wind Energy Center **Burke County, North Dakota**

Epsilon Associates Inc.

Figure 1
Structures

G:\Projects2\IND\4965\MXD\Receptors 190117\20190204\2_Flicker_Results_20190204_Sheet_1.mxd



Burke County Wind Energy Center **Burke County, North Dakota**

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Figure 2, Sheet 1 of 2
Shadow Flicker Modeling Results

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Modeled Receptor 43: ULSRUD, OAKLEY BENTON
Nearest Turbine = 54 (4342 Feet)
Shadow Flicker Per Year = 7:12 (Hrs:Mins)

Modeled Receptor 131: WINZENBURG, DOUGLAS
Nearest Turbine = 58 (11077 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 64: BERG FARMS LLC,
Nearest Turbine = 62 (6660 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 67: DOWNIE, CARRIE D
Nearest Turbine = 73 (7836 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 60: RONHOLDT, Dorene
Nearest Turbine = 53 (2885 Feet)
Shadow Flicker Per Year = 11:00 (Hrs:Mins)

Modeled Receptor 111: NELSON, DAN
Nearest Turbine = 76 (14375 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 63: Unknown
Nearest Turbine = 62 (3217 Feet)
Shadow Flicker Per Year = 16:56 (Hrs:Mins)

Modeled Receptor 59: THINGVOLD, JON E
Nearest Turbine = 53 (6447 Feet)
Shadow Flicker Per Year = 0:44 (Hrs:Mins)

Modeled Receptor 69: WINZENBURG, DONALD
Nearest Turbine = 76 (8979 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

for receptors and results here see Sheet 1

Modeled Receptor 99: GRANDALL, EARL C
Nearest Turbine = 76 (10951 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 91: VELO, JOHN
Nearest Turbine = 61 (3933 Feet)
Shadow Flicker Per Year = 8:20 (Hrs:Mins)

Modeled Receptor 97: GREENFIELD, RYAN MICHAEL
Nearest Turbine = 76 (5403 Feet)
Shadow Flicker Per Year = 0:11 (Hrs:Mins)

Modeled Receptor 100: GREENFIELD, RALPH
Nearest Turbine = 76 (4995 Feet)
Shadow Flicker Per Year = 1:31 (Hrs:Mins)

Modeled Receptor 101: BEARD, HELENE
Nearest Turbine = 76 (3702 Feet)
Shadow Flicker Per Year = 6:36 (Hrs:Mins)

Modeled Receptor 123: HELSETH, ROGER L
Nearest Turbine = 52 (10966 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 104: GREENFIELD, RALPH
Nearest Turbine = 75 (6355 Feet)
Shadow Flicker Per Year = 0:23 (Hrs:Mins)

Modeled Receptor 113: HELSETH, ROGER L
Nearest Turbine = 65 (13311 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 124: HELSETH, ROGER L
Nearest Turbine = 65 (13048 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 105: ATWOOD, RAYMOND E
Nearest Turbine = 75 (9961 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 107: SMITH, INEZ B
Nearest Turbine = 75 (11570 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 108: WEINMANN, EARL W
Nearest Turbine = 64 (8291 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 133: SMITH, WILLIAM R
Nearest Turbine = 65 (8346 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 109: PETERS, RONALD L
Nearest Turbine = 64 (7137 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Modeled Receptor 92: OAS, GAYLEN K
Nearest Turbine = 61 (6286 Feet)
Shadow Flicker Per Year = 0:00 (Hrs:Mins)

Keller · Fay · Vale · Dale · Clayton · Foothills · Leaf Mountain · Harmonious · Thorson · Cleary · Lucy · Dimond

Project Boundary
Proposed Wind Turbine, GE 2.72 116RD 90HH
Proposed Wind Turbine, GE 1.7 103RD 80HH
Occupied/Potentially Occupied Receptor, Participating Parcel
Occupied/Potentially Occupied Receptor, Non-Participating Parcel
Occupied/Potentially Occupied Receptor, Non-Participating Parcel, Participating Owner
Section Boundary Line
Township Boundary Line

Modeled Shadow Flicker: Expected Values (Hours/Year)
0
10
30
50
100
150

Scale 1:84,000
1 inch = 7,000 feet
0 3,500 7,000 Feet

Burke County Wind Energy Center **Burke County, North Dakota**

Epsilon Associates Inc.

Figure 2, Sheet 2 of 2
Shadow Flicker Modeling Results