

APPENDIX F

Sound Analysis Report

WIND ENERGY INTEGRATION

SOUND STUDY

DICKINSON REFINERY WIND TURBINE PROJECT

DICKINSON, NORTH DAKOTA

AUGUST 2021

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1. INTRODUCTION

One Energy modeled sound propagation at the proposed turbine sites. The modeling was performed to confirm compliance with the North Dakota Public Service Commission's (PSC) sound avoidance area requirement.

The model used in this report was completed using the proposed turbine siting locations presented below; all results are only representative of these locations. One Energy's TAILS 3.0 software, which was developed by One Energy using both proprietary methods and industry standards, was used to complete the modeling. This Sound Study was prepared using Prudent Wind Industry Practice and One Energy's Sound Methodology version 2021.0. See Exhibit A for more information.

2. SITE OVERVIEW

Marathon Petroleum Corporation (MPC) owns a total of 345.85 acres in Dickinson, North Dakota within Stark County. The MPC property is sufficient for siting utility-scale wind turbines. The land currently owned by MPC is outlined in green in Figure 1. One Energy sited five turbines in accordance with Prudent Wind Industry Practice and represents safe siting for nearby residents, public road users, and MPC employees.



Figure 1: Satellite Image of MPC facility in Dickinson, ND

3. ZONES OF INTEREST

One Energy identified 27 "Zones of Interest" around the project area, shown in Figure 2. The Zones of Interest (Zones) are regularly inhabited structures and may also be referred to as "Receptors" within the industry. Zones are used in feasibility studies to measure the potential impact of the turbines on the surrounding community. For this study, only private residences or community buildings were included. All of the identified Zones are private residences and no community buildings were identified nearby.

In areas where there are clusters of structures, such as a neighborhood, a few of the structures have been chosen at varying positions along the edges closest to the turbines. These Zones are expected to represent



the nearby structures and are taken to be the worst-case scenario for the cluster of structures. Information on the Zones identified can be seen in Table 1.



Figure 2: Zones of Interest Satellite Image

MPC – DICKINSON: ZONES OF INTEREST INFORMATION					
Zone of Interest	Latitude	Longitude	Zone Size (Area, ft ²)	Distance from Closest Turbine (ft)	Description
R-1	46.8708	-102.9532	5,856	10,767	House
R-2	46.8718	-102.9345	9,644	6,922	House (3)
R-3	46.8531	-102.9368	3,617	6,351	House
R-4	46.8482	-102.9345	4,209	6,757	House
R-5	46.8367	-102.9249	6,458	8,331	House (3)
R-6	46.8776	-102.9236	6,157	7,031	House (4)
R-7	46.8666	-102.9174	16,878	2,737	House
R-8	46.8753	-102.9147	3,918	5,644	House (4)
R-9	46.8463	-102.9123	5,425	3,655	House
R-10	46.8478	-102.9092	2,939	2,781	House
R-11	46.8385	-102.9075	3,498	5,881	House (2)
R-12	46.8769	-102.9088	10,893	6,074	House
R-13	46.8750	-102.9076	7,136	5,421	House
R-14	46.8701	-102.9005	6,932	4,264	House
R-15	46.8466	-102.8964	16,727	3,176	House
R-16	46.8466	-102.8935	7,104	3,455	House
R-17	46.8332	-102.8937	5,167	8,067	House (3)
R-18	46.8381	-102.8750	16,770	8,582	House
R-19	46.8418	-102.8720	16,663	8,195	House (4)
R-20	46.8450	-102.8718	4,941	7,588	House (2)
R-21	46.8459	-102.8701	5,920	7,801	House (6)
R-22	46.8758	-102.8847	4,392	8,120	House (30)
R-23	46.8772	-102.8740	5,619	9,945	House (9)



R-24	46.8768	-102.8638	6,953	11,540	House (10)
R-25	46.8766	-102.8554	4,478	13,136	House (3)
R-26	46.8756	-102.8525	4,069	13,539	House (8)
R-27	46.8700	-102.8525	3,681	12,527	House (8)

Number of structures that the Zone represents is indicated in parentheses next to the description (if more than one).

Table 1: Zones of Interest Information

4. SOUND MODEL

One Energy’s Sound Study completed for the MPC Dickinson facility includes the use of One Energy’s proprietary Sound Propagation Model. The Sound Propagation Model is used to predict the sound pressure levels (SPL) as perceived at Zones of Interest due to turbine operation only (these will be referred to as “Modeled Turbine SPLs”). Modeled Turbine SPLs at each Zone and 100 feet from each Zone can be seen in Table 2.

MPC – DICKINSON: MODELED TURBINE SPLs AT ZONES OF INTEREST			
Zone of Interest	Distance to Closest Turbine (ft)	Modeled Turbine SPL (dBA)	Modeled Turbine SPL 100 ft from Zone (dBA)
R-1	10,767	13.6	13.9
R-2	6,922	23.1	23.5
R-3	6,351	24.9	25.3
R-4	6,757	24.4	24.8
R-5	8,331	21.6	21.9
R-6	7,031	23.4	23.8
R-7	2,737	37.3	37.9
R-8	5,644	27.7	28.2
R-9	3,655	34.7	35.2
R-10	2,781	37.9	38.4
R-11	5,881	27.7	28.0
R-12	6,074	26.5	26.9
R-13	5,421	28.4	28.7
R-14	4,264	32.6	32.9
R-15	3,176	37.1	37.7
R-16	3,455	35.9	36.4
R-17	8,067	22.2	22.5
R-18	8,582	20.1	20.4
R-19	8,195	20.7	21.1
R-20	7,588	22.2	22.5
R-21	7,801	21.5	21.9
R-22	8,120	22.4	22.7
R-23	9,945	17.3	17.6
R-24	11,540	13.2	13.6
R-25	13,136	9.1	9.4
R-26	13,539	8.2	8.5
R-27	12,527	10.2	10.5

Table 2: Results of the Sound Propagation Model

At all private residences the Modeled Turbine SPLs were not greater than 38 dBA and 100 feet from each private resident Zone, the Modeled Turbine SPLs were not greater than 39 dBA. These results do not exceed the required 45 dBA within 100 feet of a residence. In Figure 3, locations outside the orange boundary will not experience sound propagation of the turbines in excess of 45 dBA. All residential Zones are located outside this boundary.

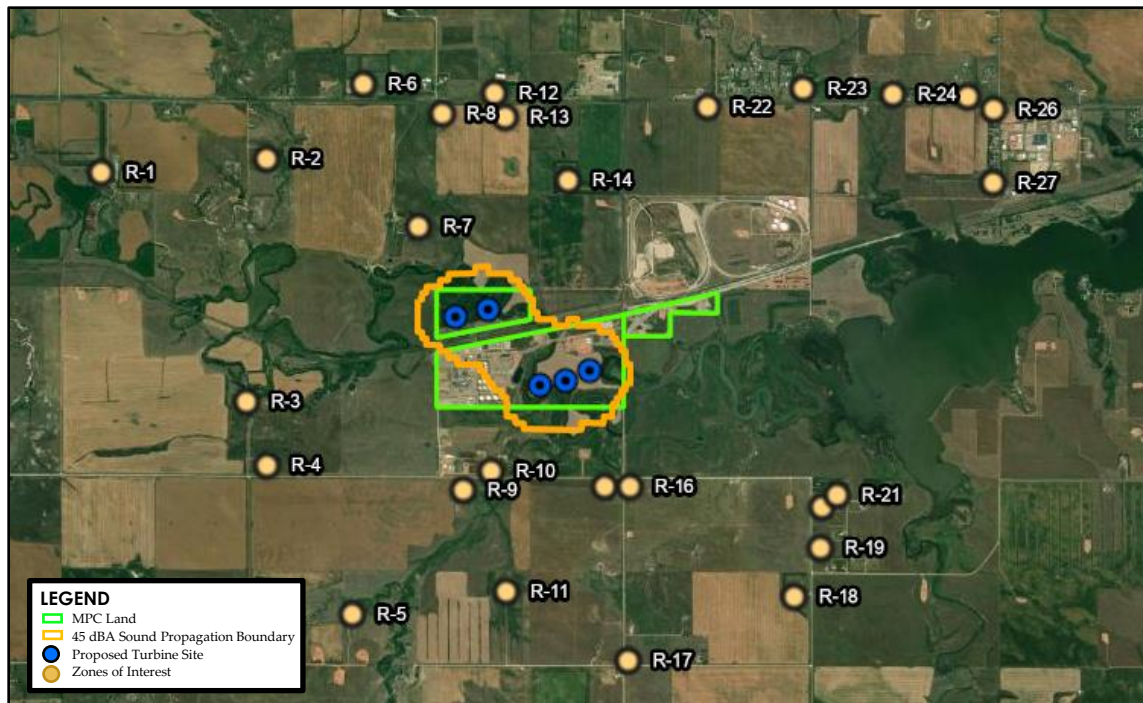


Figure 3: 45 dBA Sound Propagation Boundary Surrounding the Turbines

The siting of the turbines and their resulting sound propagation profile is not likely to alter the sound characteristics of the area. See Exhibit 3D for the Sound Model summary sheet.

5. CONCLUSIONS

One Energy believes a *Wind for Industry*® project at the MPC facility will not have a significant sound impact on the surrounding community. For this project, the North Dakota Administrative Code section 69-06-08-01 (4) states that a wind energy conversion facility operation cannot exceed sound levels of 45 dBA within 100 feet of an inhabited residence or community building. This project complies with this standard. This study has concluded that all Zones are modeled to have sound levels below 45 dBA.

NOTES:

One Energy validated the Sound Model results using an alternate software package. One Energy's Sound Methodology version 2021.0 can be seen in Exhibit B.

For purposes of the PSC reports, the ambient sound levels at observation points, as described in One Energy's methodologies, are not presented in this report. This report presents the model results as required by the PSC.

One Energy validated the Sound Model results using an alternate software package. The results of this comparison can be seen in Exhibit C.

Two third party reviews of the study were completed and can be seen in Exhibit D.

EXHIBIT A

SOUND STUDY RESULTS

Project	MPC Dickinson
Site	Dickinson, ND
Turbine	2.35 MW - 103 rotor diameter
Hub Height (m)	80
Source SPL (dBA)	105

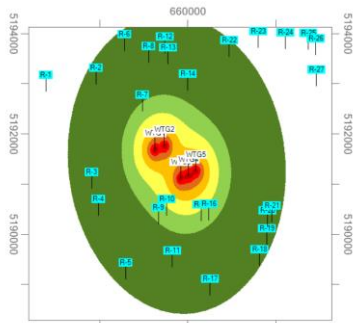
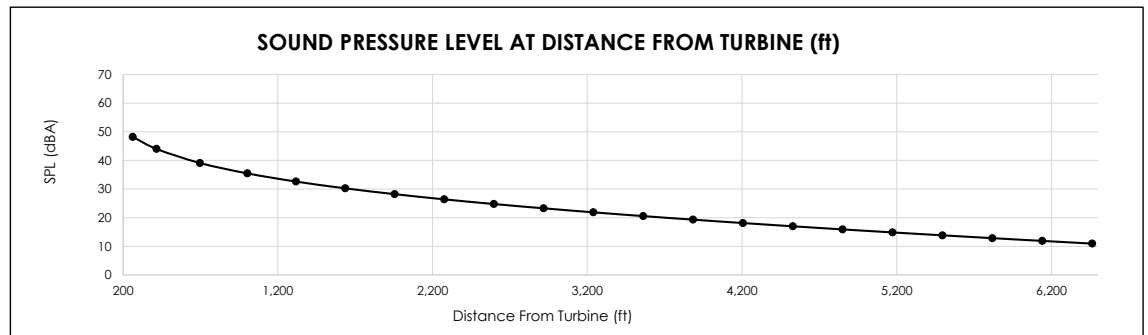
WIND TURBINE SOUND STUDY RESULTS



MODELED TURBINE SOUND PRESSURE LEVEL			
Zone of Interest	Distance to Closest Turbine (ft)	Modeled Turbine SPL (dBA)	Modeled Turbine SPL 100 ft from Zone (dBA)
R-1	10,767	13.6	13.9
R-2	6,922	23.1	23.5
R-3	6,351	24.9	25.3
R-4	6,757	24.4	24.8
R-5	8,331	21.6	21.9
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R-9	3,655	34.7	35.2
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R-20	7,588	22.2	22.5
R-21	7,801	21.5	21.9
R-22	8,120	22.4	22.7
R-23	9,945	17.3	17.6
R-24	11,540	13.2	13.6
R-25	13,136	9.1	9.4
R-26	13,539	8.2	8.5
R-27	12,527	10.2	10.5



MPC Dickinson Zones of Interest



Sound Model Results

KEY							
Range (dBA)	60+	55-60	50-55	45-50	40-45	35-40	<35
Color	Red	Orange	Yellow	Light Green	Green	Dark Green	Black

COMPARISON					
Reference	Chainsaw	Diesel Truck	Vacuum Cleaner	Average Home	Library
Sound Level (dBA)	110 dBA	90 dBA	70 dBA	50 dBA	40 dBA

CONCLUSIONS

Based on the sound model, turbine noise is not expected to exceed acceptable limits at any private residences. The residence with the highest sound level is R-10, with 37.9 dBA. All sound levels modeled are less than that of an average home.

EXHIBIT B

SOUND METHODOLOGIES



SOUND METHODOLOGIES

Publish Date: April 15, 2021



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GLOSSARY

Decibels (dB): The unit used to measure sound pressure levels. A-weighted decibels (dBA) may be used due to the relative loudness of sound as perceived by the human ear. This A-weighting weights the decibels by frequencies that can be heard by the human ear and are standard for use in measurement of environmental noise.

Long-Term: Describes a consecutive period of the most recent 30 years.

Measure-Correlate-Predict (MCP): A statistical technique that is used to create a simulated, long-term dataset by relating a concurrent short, measured target dataset to a long-term reference dataset.

Prudent Wind Industry Practices: The practices, methods, specifications and standards of safety, performance, quality, dependability, efficiency, and economy generally recognized by industry members in the US as good and proper. Other practices, methods, or acts which, in the exercise of reasonable judgment by those reasonably experienced in the industry in light of the specific projects and facts known at the time a decision is made, would be expected to accomplish the result intended at a reasonable cost and consistent with applicable laws, reliability, safety, and expedition. Prudent Wind Industry Practices are not intended to be limited to the optimum practices, methods, or acts to the exclusion of all others, but rather to be a spectrum of good and proper practices, methods, and acts.

Site MCP Dataset: A long-term MCP dataset created with the Site Dataset and the closest available reanalysis grid-point to the site.

Site-Specific Feasibility Studies: Studies of shadow flicker, ice shedding, and sound propagation at the project site. These studies indicate any impacts or lack thereof to the surrounding community.

TAILS 3.0: One Energy's proprietary software used to model turbine icing, shadow flicker, and wake loss.

Zones of Interest: Regularly inhabited structures, or clustered groups of structures, roughly within a one-mile radius of the turbine(s). Zones may include private residences, businesses, and public areas.



1. INTRODUCTION

One Energy considers many factors when siting a *Wind for Industry*® project. The safety of the surrounding community is the most important factor considered when siting wind turbines. A project will not proceed if the wind turbines cannot be safely sited within the bounds and conditions given. In addition to safety, energy production optimization is a key factor considered when siting wind turbines. Feasibility modeling is discussed in this document.

The objective of this methodology is to allow for explanation of each section within One Energy’s Sound Report. Each section states what variables and key pieces of information are presented within the Sound Report. The deliverables within the formal sound document from each section are designated in bold text throughout this document.

This Sound Methodology is version 2021.0.

2. SITE OVERVIEW

Within this section, the current landscape of the proposed project site is described, focusing on parcel information.

The following information is presented in Site Overview:

- 1) **Aerial imagery of the proposed project siting parcel(s) and project facility parcel(s)**
- 2) **Size of project parcel(s)**
- 3) **Ownership of parcel(s)**

3. ZONES OF INTEREST

In order to ensure safety and minimize potential effects from the turbines on the surrounding area, One Energy identifies “Zones of Interest” near the turbine(s). The Zones of Interest are regularly inhabited structures roughly within a one-mile radius of the turbines. Zones may include private residences, businesses, and public areas. In areas where there are clusters of structures, such as a neighborhood, a few structures are chosen at representative positions along the edges closest to the turbine(s). These Zones are expected to represent the nearby structures and are taken to be the worst-case scenario for the cluster of structures. If a Zone of Interest represents more than one structure, it is noted within the Project Siting document.

The Zones of Interest are used in the feasibility studies models (see Section 5: Feasibility Study). The impact of the turbine(s) on each Zone of Interest is calculated in each of the models. The models account for the Zone of Interest’s location relative to the turbine(s) and the wind distribution of the site. The size of each Zone of Interest is approximated using satellite imagery and is generally overestimated.

The following information is presented in Zones of Interest:

- 1) **Aerial imagery of all zones and turbine siting for reference**
- 2) **A table of the Zones of Interest including:**
 - a. **Latitude/Longitude**
 - b. **Zone size (area)**
 - c. **Distance from the closest turbine**



d. Zone description

4. FEASIBILITY STUDY

Feasibility studies are completed during the development process as part of the due diligence of a project. These studies indicate the impact of the surrounding community and logistics for project construction.

A. SOUND MODEL

One Energy's proprietary Sound Propagation Model package is used to predict the sound pressure levels at each Zone of Interest near the turbine location(s). Sound propagation through the atmosphere is dependent on conditions such as wind and temperature, atmospheric turbulence, terrain type, elevation changes, and obstructions. Wind turbines create sound when they are generating electricity due to the rotating blades, generator, and cooling fans. The sound pressure level is usually expressed in decibels (dB). Another common method of expressing sound levels is dBA. This measure quantifies the decibels using the A-weighted scale, which is intended to match human hearing.

The Sound Propagation Model uses the sound power level of the turbine provided by the turbine manufacturer to determine the sound propagation as a function of radial distance from the turbine. The results are the expected sound pressure levels at each Zone of Interest.

One Energy determines the sound pressure levels of the turbine(s) and the effects on the area's existing sound levels.

The following information is presented in the Sound Model:

- 1) **Figure of sound observation locations**
- 2) **Table of observed sound measurements including the maximum measured dBA, minimum measured dBA, average measured dBA, and the modeled dBA**
- 3) **Table including the modeled sound levels in dBA at each Zone of Interest**
- 4) **One-page summary sheet (as exhibit)**

Inputs

The main inputs for the Sound Propagation Model are: 1) Turbine location(s) (latitude and longitude); 2) Zone of Interest location; 3) Turbine-model specifics, including but not limited to, total Sound Power Level (in accordance with IEEE standards); 4) Observations at 4-8 specific points around the turbine location(s).

Methodology

A site-specific sound study is completed using turbine specifications provided by the manufacturer and field measurements. The expected sound level is modeled for each Zone of Interest. The sound pressure level (L_p) at a distance away from the turbine is calculated using the following equation:

$$L_p = L_w - 10 \log_{10}(2\pi R^2) - \alpha R \quad \text{[Equation 1]}$$

where R is the distance from the turbine in meters, α is the absorption coefficient (estimated at 0.005 dBA/m), and L_w is the sound power level of the turbine in dB(A). For multiple turbines, the total sound pressure level at a location is calculated using the following equation:



$$L_{\Sigma} = 10 \cdot \log_{10} \left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \dots + 10^{\frac{L_n}{10}} \right) \text{ dB} \quad \text{[Equation 2]}$$

Where L_n is the sound pressure level at the location due to the individual turbine n .

A model of the sound pressure levels and their propagation is created using the data from Equation 3 and Equation 4 (if necessary) to determine the sound pressure level at each Zone of Interest. The Zone of Interest locations are overlaid onto the model based on their distance from the turbine.

Four to eight sound observations are recorded using a Class 1 Sound Level Meter, such as a Casella 63-X, to determine the ambient sound levels. One Energy determines the sound observation locations based on the locations of the Zones of Interest. Each sound observation deploys the sound meter for 10 minutes and the average decibel level from those 10 minutes is determined to be the ambient sound level at that location. The measured site sound levels are then compared to the modeled sound levels produced by the turbine(s).

In addition to the 10-minute observations, a longer sound measurement campaign may be completed if deemed necessary. The sound meter is deployed for a minimum of 48 hours near the project site to determine ambient sound levels at varying times (daytime, nighttime, etc.) and the maximum sound level. Because this study requires access to the site, One Energy will need approval from the customer/landowner. If access to the site is denied, an explanation will be provided in the Project Siting document.

Model Assumptions and Limitations

- The Zones of Interest are represented by a single point on a 100-foot (30.5-meter) grid resolution.
- A total project area of 10,000 feet x 10,000 feet (3,048 meters x 3,048 meters) is modeled.
- An absorption coefficient of 0.005 dBA/meter is used in the Sound Propagation Model.
- The model is conservative in that it assumes the turbine is running at maximum wind speed and makes no attempt to account for decreased sound pressure level from the turbine at lower wind speeds.

5. CONCLUSIONS

One Energy considers many factors when siting wind turbines. The sound model is completed to measure the impact of the turbines on the surrounding community.

EXHIBIT C

MODEL VALIDATION

EXHIBIT C: SOUND PROPAGATION MODEL VALIDATION

One Energy used its proprietary internal software, to TAILS 3.0, to conduct a Sound Propagation Study for the Dickinson facility. To validate these results, One Energy utilized Continuum 3.0, an open-source software.

Table 1 and Table 2 provide the latitude and longitude for the identified Zones of Interest and the proposed turbine locations, illustrated in Figure 1. These Zones of Interest were analyzed in the Continuum 3.0 study and are the same that were analyzed in the TAILS 3.0 study. The distance from the closest turbine for each Zone is also shown.

MPC – DICKINSON: TURBINE LOCATIONS (WGS 84)		
	Latitude	Longitude
WTG01	46.859654°	-102.913217°
WTG02	46.860222°	-102.909532°
WTG03	46.854388°	-102.903689°
WTG04	46.854733°	-102.900790°
WTG05	46.855505°	-102.898077°

Table 1: Turbine Coordinates

MPC – DICKINSON: ZONES OF INTEREST INFORMATION			
Zone of Interest	Latitude	Longitude	Distance from Closest Turbine (ft)
R-1	46.8707547	-102.9532124	10,767
R-2	46.8718075	-102.9345305	6,922
R-3	46.8531083	-102.9368052	6,351
R-4	46.8481924	-102.9344951	6,757
R-5	46.836729	-102.9248599	8,331
R-6	46.8775686	-102.9236172	7,031
R-7	46.8665933	-102.9173887	2,737
R-8	46.875283	-102.9146991	5,644
R-9	46.8463008	-102.9123338	3,655
R-10	46.8477556	-102.9091822	2,781
R-11	46.8384786	-102.9074884	5,881
R-12	46.8768657	-102.9088157	6,074
R-13	46.8750226	-102.9076073	5,421
R-14	46.8701484	-102.9005029	4,264
R-15	46.8465686	-102.8963672	3,176
R-16	46.8465603	-102.8935206	3,455
R-17	46.8331528	-102.893731	8,067
R-18	46.8380784	-102.8749741	8,582
R-19	46.8418359	-102.8720146	8,195
R-20	46.8449914	-102.8718344	7,588
R-21	46.8459156	-102.8701321	7,801
R-22	46.8758109	-102.8847488	8,120
R-23	46.8772171	-102.8739695	9,945
R-24	46.876777	-102.8638329	11,540
R-25	46.8765988	-102.8553936	13,136
R-26	46.875619	-102.8524625	13,539
R-27	46.8699597	-102.8525247	12,527

Table 2: Information for Zones of Interest



Figure 1: Zones of Interest and Proposed Turbine Locations Relative to Dickinson Facility

SOUND PROPAGATION STUDY

After inputting the locations of the Zones and the turbines in Continuum 3.0 and TAILS 3.0, the models simulate the sound propagation from the turbines and model the turbine SPL at each Zone.

Table 3 shows the Modeled Turbine SPL in dBA for each Zone output by Continuum 3.0 and TAILS 3.0, as well as the difference between the output. A positive difference indicates that Continuum 3.0 predicted a lower SPL than TAILS 3.0 while a negative difference indicates that TAILS 3.0 predicted a lower SPL than Continuum 3.0.



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MPC – DICKINSON: SOUND PROPAGATION STUDY RESULTS			
Zone of Interest	Modeled Turbine SPL (dBA)		
	TAILS 3.0	Continuum 3.0	Difference
R-1	13.6	13.6	0.0
R-2	23.1	23.1	0.0
R-3	24.9	24.9	0.0
R-4	24.4	24.4	0.0
R-5	21.6	21.6	0.0
R-6	23.4	23.4	0.0
R-7	37.3	37.3	0.0
R-8	27.7	27.7	0.0
R-9	34.7	34.7	0.0
R-10	37.9	37.9	0.0
R-11	27.7	27.7	0.0
R-12	26.5	26.5	0.0
R-13	28.4	28.4	0.0
R-14	32.6	32.6	0.0
R-15	37.1	37.1	0.0
R-16	35.9	35.9	0.0
R-17	22.2	22.2	0.0
R-18	20.1	20.1	0.0
R-19	20.7	20.7	0.0
R-20	22.2	22.2	0.0
R-21	21.5	21.5	0.0
R-22	22.4	22.4	0.0
R-23	17.3	17.3	0.0
R-24	13.2	13.2	0.0
R-25	9.1	9.1	0.0
R-26	8.2	8.2	0.0
R-27	10.2	10.2	0.0

Table 3: Sound Propagation Study Results

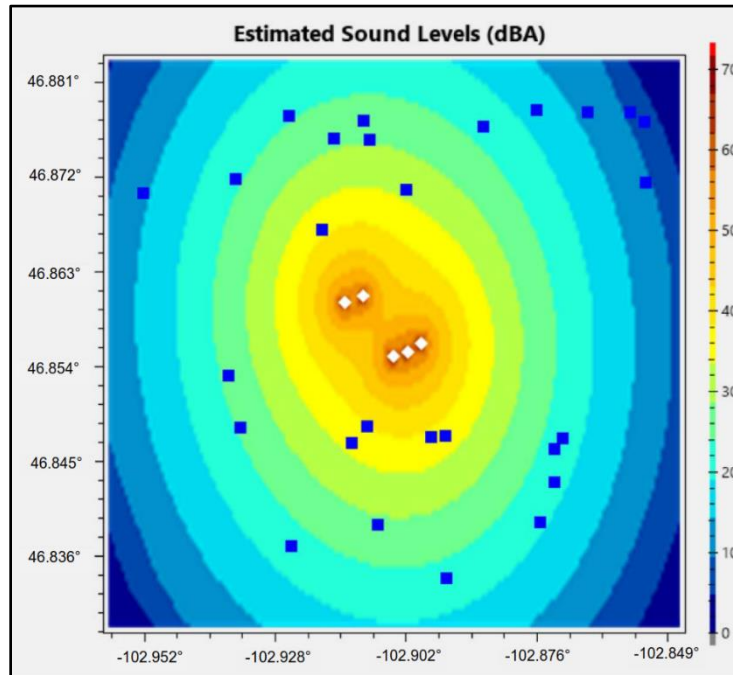


Figure 2: Continuum 3.0 - Modeled Turbine SPL

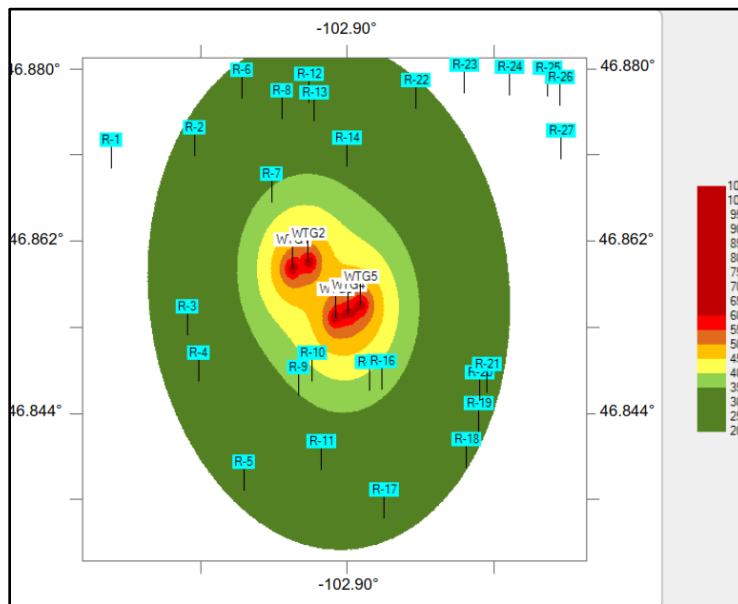


Figure 3: TAILS 3.0 - Modeled Turbine SPL

The Modeled Turbine SPL at each Zone modeled by Continuum 3.0 and TAILS 3.0 are comparable. There was no difference in the Modeled Turbine SPL for all Zones.



CONCLUSIONS

Continuum 3.0, the open-source software, was run for comparison against One Energy's in-house software. The results show the validity of the TAILS 3.0 results. The output from Continuum 3.0 and TAILS 3.0 are consistent.

EXHIBIT D

THIRD PARTY REVIEWS

Ben Mallernee

From: Liz Walls <liz.walls@arcvera.com> on behalf of Liz Walls
Sent: Tuesday, August 31, 2021 10:17 AM
To: Jessica Grosso; Ben Mallernee; Carly Good; Erin Roekle
Subject: Dickinson Shadow and Sound study review

Jessica,

I have completed my review of the updated turbine locations of the Dickinson wind project and the subsequent impact on the shadow and sound modeling studies. I updated my sound and shadow model with the updated coordinates and also ran a sound model simulation with each receptor 100 feet closer to the wind project.

I compared my results to those published in One Energy's updated reports (Sound study, dated 8/25/2021; Shadow study, dated 8/23/2021). I found consistent results with my modeled results including the simulation with the sound receptors 100 feet closer to the project.

At this point, I do not have any additional questions or requests. Both the sound and shadow studies may be deemed complete and ready for submission. Our previously-issued letter still reflects our opinion on the results of the shadow flicker and sound modeling at Dickinson so we will not be issuing a new letter.

Kind regards,
Liz

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Engineer
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16 July 2021

To whom it may concern,

ArcVera Renewables has been engaged to review One Energy Solutions sound and shadow flicker studies for Marathon Petroleum Company's Dickinson Wind Energy Project. ArcVera Renewables is not affiliated with Marathon Petroleum Company or any One Energy company or employee.

ArcVera Renewables has previously reviewed One Energy's published methodologies for sound propagation and shadow flicker studies. During those reviews, ArcVera Renewables concluded that the methodologies were based on sound scientific and engineering principles and were consistent with prudent practices. Those same methodologies were used in this case.

ArcVera Renewables has, as a result of this engagement, reviewed the site-specific reports prepared for this project. The review has concluded that One Energy substantially used its published methodologies and that the reports are free of any material defect or error.

It is ArcVera Renewables conclusion that the reports presented by One Energy Solutions for the Dickinson Wind Project are reasonable, prudent, and free of material error.

Sincerely,

John Bosche
President

1 September 2021

Letter of Review



DVDZ Consulting has been engaged to review One Energy Solutions' sound and shadow flicker studies for the Marathon Petroleum Company (MPC) Dickinson Wind Energy Project. DVDZ Consulting has previously served as an Independent Engineer for the various capital providers for One Energy's projects. DVDZ Consulting is not affiliated with any One Energy company or employee.

DVDZ Consulting has previously reviewed One Energy's published methodologies for shadow flicker and sound propagation studies. During those reviews DVDZ Consulting concluded that the methodologies were based on sound scientific and engineering principles and were consistent with standard wind energy industry practices. Prior to modeling either shadow flicker or sound propagation, One Energy conducts a detailed search for receptors that could be impacted by either phenomenon. This search can include review of satellite data, street-level imagery, or even site visits to verify the nature of a structure and determine if the structure should be included in the site-specific studies.

To assess the potential of shadow flicker, One Energy uses a proprietary model that was internally developed (TAILS 3.0). This model is similar to the software used by the wind energy industry as a whole. For example, a specific industry-standard software (WindPro) uses the same inputs and produces similar outputs as One Energy's proprietary shadow flicker software. However, TAILS 3.0 is much more conservative and produces an overestimated (or worst-case) scenario for shadow flicker. An example of the conservative nature of TAILS 3.0 can be seen in the study results. Research suggests that shadow flicker is unnoticeable at distances over 2 km from a given turbine, but One Energy includes assessments for structures up to 3 km in their study.

The sound propagation model used by One Energy to predict the turbine-generated sound pressure level at a given receptor is based on a standard model that is used in some national codes (e.g. New Zealand). This model has been reviewed in the scientific literature and has been found to adequately represent measured sound pressure levels at given distances from a point source. However, different assumptions will affect the accuracy / conservativeness of this model. While there are other methods available in the literature, this commonly used sound propagation model is accurately described by the One Energy methodology and appears to be accurately implemented.

These same previously reviewed methods were used in the assessment of shadow flicker and sound propagation for the MPC project near Dickinson, North Dakota. Considering shadow flicker, the TAILS 3.0 model suggests that no residential receptors will experience a significant amount of worst-case shadow flicker. The resulting pattern of predicted shadow flicker across the community is consistent with expectations based on research and previous projects. Importantly, all identified private residences are expected to receive less than 30 hours of *realistic* (including cloud-cover) shadow flicker a year, with most locations expected to receive no shadow flicker at all. For example, of the 27 receptors identified, 14 are not expected to experience any shadow flicker from the current turbine configuration. Of the remaining 13 receptors, 11 are greater than 2 km from the closest turbines where shadow flicker is has not been documented as noticeable. The two remaining receptors are modeled to experience less than 10 hours of flicker per year. ***These results suggest that shadow flicker generated by the turbines will have little, if any, impact on the surrounding community.***

Similarly, One Energy adhered to their published methods in assessing the impacts of modeled turbine noise on the community. Based on the modeling performed by One Energy, the noise produced by turbines associated with this project will fall below the PSC requirement of 45 dBA within 100 ft of a residence. Review of One Energy's modeling results indicated that turbine-related noise no higher than 38.4 dB will be experienced at a given receptor (R-10, in this case). One Energy also highlights these results in Figure 3 of their report where they show the maximum extent of the 45 dB sound propagation level. This level is mostly limited to the MPC property, and no residence is

within 100 ft of this level. *These results suggest that noise generated by the turbines will have little, if any, impact on the surrounding community.*



In reviewing the site-specific reports prepared for this project as well as the scientific literature supporting these various topics, DVDZ Consulting has concluded that One Energy effectively used its published methodologies and that the reports represent standard industry practices. Further, the results are consistent with output produced by commercially available software and peer-reviewed research that has been presented in the scientific literature. A full list of references consulted for this report is available upon request. It is the conclusion of DVDZ Consulting that the reports presented by One Energy Solutions for Marathon's Dickinson Wind Project are reasonable, prudent, and align with practices that have been determined by the industry to maintain the safety and well-being of the community.

About



DVDZ consulting is led by Dr. W. Scott Gunter. Gunter is currently an Assistant Professor of Meteorology at the University of Louisville. Gunter's credentials include a Bachelor of Science degree from Mississippi State University where he graduated with honors in 2008. Gunter continued his education in graduate school at Texas Tech University as a Master's student, where his research initially focused on hurricane structure and evolution using high resolution radar data. After acceptance into the Ph.D. program at Texas Tech, Gunter's research focus shifted to severe storms. Working with Dr. John Schroeder, Gunter's designed a field project to collect and analyze wind profile and turbulence data from severe thunderstorms. This project also involved a thorough comparison of different types of wind measurements, including tall tower, radar, and sodar. Dr. Gunter was an active operator of the TTUKa mobile Doppler radars and heavily involved in deployments and data collection efforts within wind farms with the National Wind Institute. Scott completed his PhD studies in 2015 after the publication of several peer-reviewed manuscripts and numerous conference presentations. Dr. Gunter is currently an Assistant Professor of Meteorology at the University of Louisville in Kentucky where he teaches courses ranging from Climate Science to Synoptic Meteorology. In addition to teaching, Dr Gunter engages in research related to the observed characteristics of the wind and comparisons of wind measurement platforms. His education and experience have led to participate in a consulting role for the wind energy industry. Gunter began consulting in 2016 and officially formed DVDZ Consulting in 2017. He has since used his expertise to evaluate numerous small scale wind projects, their associated data, and the methods used in the modeling of the wind resource and environmental conditions.