GR-2 Public Health

Several commenters expressed concern that implementation of the Campo Wind Project with Boulder Brush Facilities (Project) would result in potential negative health impacts. Many of the comments provided a general statement regarding health impacts, stating that their health would be affected or damaged by the installation and operation of the Project's turbines on the Campo Band of Diegueño Mission Indians Reservation (Reservation). A number of comments refer to specific health-related issues, including anxiety, sleep deprivation, ringing in ears, irregular heartbeat, stomach issues, cancer, vertigo, bronchial asthma, loss of energy, illnesses and symptoms, damage to bones, and damage to human efficiency.

Topic areas analyzed under the California Environmental Quality Act and included in the Draft Environmental Impact Report (EIR) that include analysis for public health related issues include air quality, hazards and hazardous materials, noise, and greenhouse gas emissions. These topics are analyzed in Chapters 2.2, 2.5, 2.6, and 3.1.4 of the Draft EIR, respectively.

In addition, Section 2.5.3.5 of Chapter 2.5, Hazards and Hazardous Materials, of the Draft EIR includes an overview of public concerns of health effects. This section includes a discussion regarding public concerns of health effects related to infrasound, low-frequency noise, electromagnetic fields (EMFs), and shadow flicker. The discussion of these health concerns is based on the County of San Diego (County) Public Health 2019 Position Statement regarding potential health effects of wind turbines, which is discussed below.

As part of the analysis of the Project under the National Environmental Policy Act (NEPA), the Final Environmental Impact Statement (EIS) prepared for the Project by the Bureau of Indian Affairs (BIA) studied the potential impacts of turbines on public health and safety and discussed these impacts in the Final EIS[1] prepared for the Project, concluding that there would be no significant adverse impact on human health from noise (Final EIS, RTC-41, RTC-48), EMF exposure (Final EIS, pp. 61–62 and 136–137), or shadow flicker (Final EIS, pp. 62–63 and 137–140). The Final EIS also contains discussion of these topics in the following sections in Appendix T, Common Responses to Recurring Comments: 2.15, Public Health and Safety: EMF/EMR; 2.18, Visual Resources: Shadow Flicker; 2.23, Noise: Turbine Proximity to Homes; and 2.24, Noise: Low Frequency.

County of San Diego Public Health 2019 Position Statement

As discussed in Chapter 2.5, Section 2.5.3.5, of the Draft EIR, the County Health and Human Services Agency prepared a Public Health Position Statement (County Public Health 2019 Position

[1] The Final EIS can be found at http://campowind.com/.

Statement),[2] which was a follow-up to a previous statement dated July 10, 2012 and which summarizes current peer-reviewed literature and scientific publications with respect to these issues. The 2012 statement was a result of the County having conducted a similar review in 2012 with similar results at the time that it adopted the existing County Wind Energy Ordinance. The County Public Health 2019 Position Statement was presented to the County's Planning Commission at a public hearing in March 2019 and again in April 2019, where the Planning Commission voted to accept the County Public Health 2019 Position Statement. The County Public Health 2019 Position Statement is summarized in the Draft EIR and is cited as a reference document. The County has reviewed available peer-reviewed literature and scientific publications on the topic of health effects from wind turbines and determined that there are no epidemiological evidence-based studies to support a causal connection between wind turbines and pathological effects.[3,4,5]

The County Public Health 2019 Position Statement concluded the following:

> Since 2012, numerous comprehensive journal reviews and studies have been conducted around the world to examine potential adverse health effects of wind turbines. In addition to the vast majority of credible, scientific, peer-reviewed journals, evidence from numerous federal, state and local governments has been examined. Based on these findings and the scientific merit of the research conducted to date:
>
> - An imbalance was found between the availability of primary bibliographical sources (i.e., original scientific experiments and studies) and secondary sources (i.e., scientific literature reviews). This included focus on noise, low frequency noise and infrasound, EMF, and shadow flicker.
> - The majority of evidence shows that, while noise from wind turbines is not causally related to adverse health effects, wind turbines may be a source of annoyance for a small minority of community residents. That annoyance may cause stress for these individuals, and that stress may be associated with certain reported health effects.
> - The weight of evidence suggests that, when sited properly, wind turbines are not related to adverse health effects.

[2] County of San Diego Health and Human Services Agency. 2019. *Public Health Position Statement: Human Health Effects of Wind Turbines.* February 25, 2019. https://www.sandiegocounty.gov/content/dam/sdc/pds/advance/2019%20Public%20Health%20Position%20Statement%20on%20Human%20Health%20Effects%20of%20Wind%20Turbines.pdf.

[3] County of San Diego Public Health Services. 2012. *Position Statement on Health Effects of Wind Turbines.* July 10, 2012.

[4] County of San Diego. 2013. *Final Environmental Impact Report, Wind Energy Ordinance Amendment POD 10-007.* https://www.sandiegocounty.gov/content/dam/sdc/pds/advance/POD10-007/FEIR/00_COVER_TOC_ACRONYMS.pdf.

[5] County of San Diego Health and Human Services Agency 2019.

> Numerous literature reviews were found, however, limited number of primary sources (i.e., research articles) available. Additional research, such as cohort or case-controlled studies, would be needed to association between wind turbines and adverse health effects.

The County Public Health 2019 Position Statement acknowledges that noise and shadow flicker from wind turbines may cause annoyance. Studies relied upon by the County Public Health 2019 Position Statement state there is a convincing body of evidence to show that annoyance is strongly related to visual cues and attitude, as well as the wind turbine noise itself. In particular, this was highlighted by the fact that people who benefit economically from wind turbines (e.g., those who have leased their property to wind farm developers) reported significantly lower levels of annoyance than those who received no economic benefit, despite increased proximity to the turbines and exposure to similar (or louder) sound levels. The body of evidence regarding annoyance referenced by the County Public Health 2019 Position Statement includes studies by the Minnesota Department of Public Health, Maschke, Havas, Niemann, the World Health Organization, and the National Research Council.

Further, Dr. Kenneth Mundt, an epidemiologist with over 30 years of experience, reviewed and supported the County Public Health 2019 Position Statement. Dr. Mundt submitted a letter, dated March 20, 2019, to the County Planning Commission regarding the County Public Health 2019 Position Statement; his letter is considered a part of the record of proceedings for the review of this Project. In his March 20, 2019, letter, Dr. Mundt agrees that mere correlation does not equate to causation, and that the types of medical studies needed to establish a direct connection between disease and contributing factors are carefully designed and conducted to control introduction of bias and other compromises to the value of the results. He observed that there is much research and understanding on types of noise (and at what levels) that do cause direct health effects, "but not at levels consistent with those emitted from wind turbines." He also refers to the large Health Canada Community Noise and Health Study[6,7] as an example of peer-reviewed, published studies indicating "that wind turbine noise emissions do not cause human disease or any serious harm to human health." Dr. Mundt also refers to studies by Crichton[8,9,10]

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6 Health Canada. 2002. *Recreational and Community Health. Environmental and Workplace Health: Health Canada*. http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/commun/index-eng.php.

7 Health Canada. 2005. *Community Noise Annoyance. Environmental and Workplace Health: Health Canada*. http://www.hc-sc.gc.ca/hl-vs/alt_formats/pacrb-dgapcr/pdf/iyh-vsv/life-vie/community-urbain-eng.pdf.

8 Crichton, F., G. Dodd, G. Schmid, G. Gamble, T. Cundy, and K.J. Petrie. 2014a. "The power of positive and negative expectations to influence reported symptoms and mood during exposure to wind farm sound." *Health Psychology* 33(12):1588–1592. https://puc.sd.gov/commission/dockets/electric/2019/EL19-027/testimony/staff/DHExh3.pdf.

9 Crichton, F., G. Dodd, G. Schmid, G. Gamble, and K.J. Petrie. 2014b. "Can Expectations Produce Symptoms from Infrasound Associated with Wind Turbines?" *Health Psychology* 33(4):360–364. http://docs.wind-watch.org/Crichton-Can-Expectations-Produce-Symptoms-From-Infrasound.pdf.

10 Crichton, F., G. Dodd, G. Schmid, and K.J. Petrie. 2015. "Framing Sound: Using Expectations to Reduce Environmental Noise Annoyance." *Environmental Research* 142:609–614. https://www.fmhs.auckland.ac.nz/assets/fmhs/som/psychmed/petrie/docs/2015%20Framing%20sound.pdf.

that support the influence of receptor expectations on potential annoyance with wind turbines, and that such expectations can be preconditioned positively or negatively.

In addition, the County Public Health 2019 Position Statement is consistent with the determination of the County, when, in January 2013, the County prepared an EIR for the preparation of its Wind Energy Ordinance.[11] This EIR examined public health effects in relation to identified significant unavoidable noise impacts in the County's Final EIR (page 2.8-4) for the Wind Energy Ordinance:

> Concerns have been raised about adverse health effects caused by wind turbine noise. Some claims have been made linking low frequency noise to physiological impacts such as rapid heartbeat, nausea, and blurred vision. Several reviews of currently available scientific data, as mentioned previously, have determined that there is no direct causal relationship between wind turbine low frequency sound and health effects. For example, the Wind Turbine Sound and Health Effects An Expert Panel Review by the American Wind Energy Association (AWEA 2010) and The Potential Health Impact of Wind Turbines from the Chief Medical Officer of Health (CMOH 2010), are based on literature reviews of scientific and medical databases; they both cite current scientific and peer reviewed literature of wind turbine generated sound and low frequency sound. The cited reports all support the conclusion that there is no relationship between wind turbine sound and adverse health. While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

Potential Noise Health Effects

Comments received relating to noise annoyance and health effect concerns can generally be split into four categories: (1) A-weighted sound levels, which refer to audible community noise and for which the County assesses annoyance vis-à-vis Section 36.404 et al. from its Noise Ordinance; (2) low-frequency noise, which can be audible and resides in the 20 hertz (Hz) to 200 Hz range of the sound spectrum; (3) infrasound, which is considered inaudible to human hearing; and (4) amplitude modulation.

A-Weighted Sound Levels

As explained in the Draft EIR and in the Final EIS for the Project, spill-over noise from the aggregate operation of the Project wind turbines to Off-Reservation receptors may, in a few locations, exceed the noise limits for this zone as defined in Section 36.404 of the County's Noise Ordinance (45 A-weighted decibels [dBA] nighttime and 50 dBA daytime). However, the acoustical analysis for the Project also shows that it would comply at all locations with County's

[11] County of San Diego 2013.

General Plan Guidelines 4.1.A.i (60 dBA community noise equivalent [CNEL]) at the nearest sensitive receptor located off of the Reservation. Compliance with this 60 dBA CNEL standard is sufficient to safeguard human health, and supports a determination that the turbines are properly sited for purposes of protection of human health. Additional responses concerning noise are contained in Global Response GR-4, Noise.

A study published in 2014 by Knopper et al. supports the conclusion that the County's A-weighted noise requirements are compatible with industry guidance for protection of public health. The study summarizes six "best practices," the last of which reads as follows:[12]

> 6. When ambient noise is taken into account, wind turbine noise can be >45 dB(A), but a combined wind turbine-ambient noise should not exceed >55 dB(A) for non-participating and participating receptors. Our suggested upper limit is based on WHO [World Health Organization] (100) conclusions that noise above 55 dB(A) is "considered increasingly dangerous for public health," is when "adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed" and "cardiovascular effects become the major public health concern, which are likely to be less dependent on the nature of the noise."

The WHO reference that Knopper cites above is its Night Noise Guidelines for Europe,[13] which defines the 55 dBA limit with respect to an 8-hour "$L_{night,\ outside}$" sound equivalent level (L_{eq}) from 11:00 p.m. to 7:00 a.m. This suggested guidance limit of 55 dBA is comparable with the County's 60 dBA CNEL threshold, as described below. Importantly, this best practice sets a standard that focuses on protecting human health.

To be able to translate the threshold of 55 dBA into a CNEL value, it is first reasonably assumed that the 55 dBA 8-hour L_{eq} during the nighttime period is attributed to operating wind turbines under strong wind resource conditions that yield maximum power generation and noise emission level. It is then reasonable to extrapolate that the same conditions could occur during the other 16 hours (i.e., 7:00 a.m. to 11:00 p.m.) of a typical day/night cycle and therefore assume that the entire 24-hour period would be 55 dBA as well.

Because the CNEL descriptor applies a 5 dB upward adjustment to hourly noise levels during three "evening" hours (7:00 p.m. to 10:00 p.m.) and a 10 dB upward adjustment during nine "nighttime" hours (10:00 p.m. to 7:00 a.m.), a 24-hour L_{eq} of 55 dBA translates into a value of 61.7 dBA CNEL, which is higher than the County's 60 dBA CNEL significance threshold. The more stringent

[12] Knopper, L.D., C.A. Ollson, L.C. McCallum, M.L. Whitfield Aslund, R.G. Berger, K. Souweine, and M. McDaniel. 2014. "Wind Turbines and Human Health." *Frontiers in Public Health* 2. https://www.frontiersin.org/articles/10.3389/fpubh.2014.00063/full.

[13] WHO (World Health Organization). 2009. *Night Noise Guidelines for Europe.* https://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf.

County threshold of 60 dBA CNEL requires wind turbine operation noise to not exceed a 24-hour L_{eq} of 53.3 dBA, which is less than the Knopper-recommended 55 dBA L_{eq} value.

Figure GR-2-A shows how the Knopper best practice "for wind turbine development in the context of human health" at 55 dBA compares with the County's lower 53.3 dBA level associated with the County's 60 dBA CNEL threshold. The dark blue solid line shows 55 dBA L_{eq} values representing eight consecutive hours of operations, with the dashed blue line showing the extrapolation for other hours.

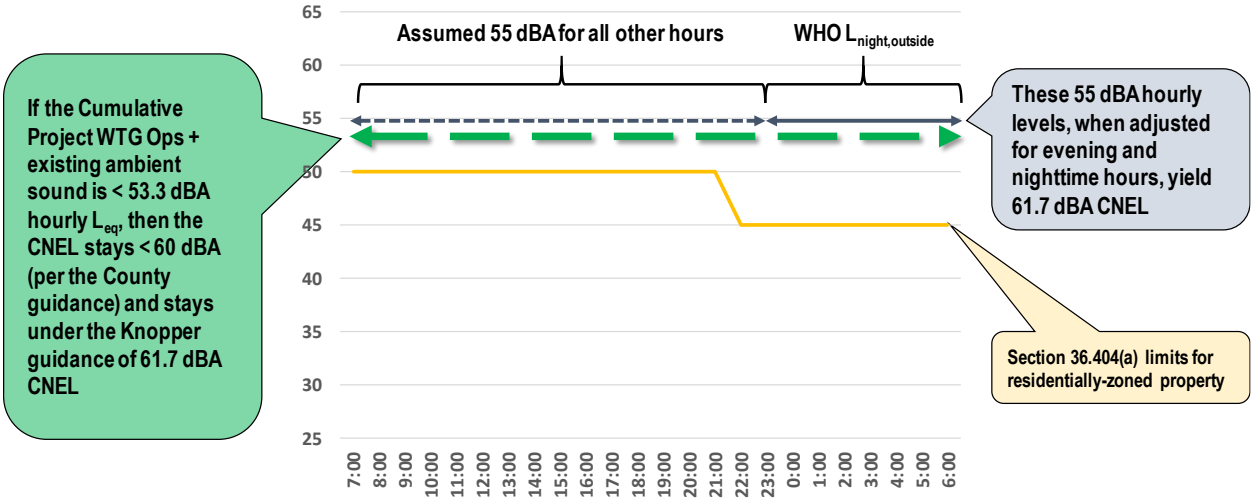

Figure GR-2-A. Comparison of the County's noise significance guidance with Knopper best practice, plotted as hourly L_{eq} values versus consecutive hours of a typical day/night cycle

The thicker dashed green line at 53.3 dBA in Figure GR-2-A shows the constant hourly L_{eq} that must be met to comply with the County's 60 dBA CNEL value. Because the County's CNEL threshold of 60 is lower than the WHO guidance, the County concludes that its noise significance standard is adequately protecting human health. This is also true for the hourly L_{eq} thresholds prescribed by Section 36.404(a) of the County's Noise Ordinance for single-family residential properties, represented by the gold line in Figure MR-4-G, reflecting 50 dBA hourly L_{eq} during the day and 45 dBA hourly L_{eq} at night. These thresholds are also below the WHO guidance.

In summary, projects that meet the County's 60 CNEL standard can be reasonably assumed to be protective of human health. Nonetheless, if noise exceeds the levels shown by the gold line in Figure GR-2-A, nearby residents could still be annoyed. If a project's operational noise levels exceed the County's hourly L_{eq} standards and/or the 20 dB difference between predicted C-weighted wind turbine generator operation noise and the A-weighted Residual Background Sound Criterion, potential annoyance could result.

A factor influencing annoyance is how often noise is expected to exceed the County's hourly L_{eq} standards, including those in County Noise Ordinance 36.404[a]) or the 20 dB differential (i.e., County Ordinance Section 6952.f.1). For example, Figure GR-4-F from Global Response GR-4 illustrates—with quantified days per year—the frequency of hourly A-weighted daytime and nighttime exceedances for two representative studied Off-Reservation locations as follows:

- Daytime exceedances are predicted to occur fourteen (14) days per year at LT-10 when average hub height wind speeds are greater than 10 mps; fourteen (14) days per year at LT-1 when average hub height wind speeds are greater than 10 mps; and, fifteen (15) days per year at LT-1 when average hub height wind speeds are within 9 to 10 mps.
- Nighttime exceedances are predicted to occur fourteen (14) days per year at LT-10 when average hub height wind speeds are greater than 10 mps, fifteen (15) days per year when average hub height wind speeds are within 9 to 10 mps, and twelve (12) days per year when average hub height wind speeds are within 8 to 9 mps.
- At LT-1, nighttime exceedances are predicted to occur fourteen (14) days per year when average hub height wind speeds are greater than 10 mps, fifteen (15) days per year when average hub height wind speeds are within 9 to 10 mps, twelve (12) days per year when average hub height wind speeds are within 8 to 9 mps, and twenty-five (25) days per year when average hub height wind speeds are within 7 to 8 mps.

The full year of studied meteorological data suggests that for at least 153 days (42% of the year's 365 days), based on anticipated average hub height wind speed not having sufficient magnitude, there would be no exceedances at any location.

Low-Frequency Noise

Low-frequency noise is defined as noise within the range of 20 Hz to 200 Hz. A young, non-pathological ear can perceive sounds ranging from 20 Hz to 20,000 Hz. Natural sources of low-frequency noise include rolling thunderclaps, waterfalls, and "roar" from aerodynamic turbulence due to high-speed wind flows interacting with ground terrain features. Human-made sources of low-frequency noise are abundant and include internal combustion engines, ground and airborne transportation, and operation of electromechanical equipment such as pumps, fans, compressors, and generators featuring high-speed rotating or reciprocating componentry.

It is anticipated that Project turbines, the gen-tie line, and the high-voltage substation and switchyard would generate low-frequency noise. In addition, the transformer within the Boulder Brush Facilities that would be installed in the high-voltage substation area is anticipated to be a continuous producer of low-frequency noise during Project operations. This is due to transformers handling electrical current that alternates at 60 cycles per second, yielding a usual harmonic at 120 Hz. However, as analyzed in Chapter 2.6, Noise, of the Draft EIR, the expected sound pressure

level from continuous operation of the high-voltage substation transformers at this distance would be less than 20 dBA L_{eq} and therefore would be expected to result in a less-than-significant effect.

As discussed in the County Public Health 2019 Position Statement, based on literature reviews assessing impacts associated with exposure to low-frequency noise, available peer-reviewed literature provides no clear evidence that the operation of wind turbines and associated infrastructure contributes to health concerns as a result of low-frequency noise. Studies upon which the County Public Health 2019 Position Statement rely include the aforementioned Knopper et al. 2014 paper, which also reviewed multiple studies, including examples (and researcher remarks) as follows:[14]

> Bolin et al. (38)[15] – The authors concluded that empirical support was lacking for claims that LFN and infrasound cause serious health effects in the form of "vibroacoustic disease," "wind turbine syndrome," or harmful effects on the inner ear.

Additional studies have discussed low-frequency sound from wind turbines with respect to potential annoyance and health effects, such as the following two excerpts.

- The Minnesota Department of Health and Environmental Health Division reported the following (2009): "The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on the quality of life. Sleeplessness and headache are the most common health complaints and are highly correlated (but not perfectly correlated) with annoyance complaints. Complaints are more likely when turbines are visible or when shadow flicker occurs. Most available evidence suggests that reported health effects are related to audible low-frequency noise. Complaints appear to rise with increasing outside noise levels above 35 dBA [A weighted decibels]. It has been hypothesized that direct activation of the vestibular and autonomic nervous system may be response for less common complaints, but evidence is scant."[16]
- A report by the Chief Medical Officer of Health of Ontario, Canada (2010), reviewed the potential health impact of wind turbines and summarized: "The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying."[17]

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14 Knopper et al. 2014.

15 Bolin, K., G. Bluhm, G. Eriksson, and M.E. Nilsson. 2011. "Infrasound and Low Frequency Noise from Wind Turbines: Exposure and Health Effects." *Environmental Research* 6: 106. doi:10.1088/1748-9326/6/3/035103.

16 Minnesota Department of Health. 2009. *Public Health Impacts of Wind Turbines.* St. Paul, Minnesota. www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf.

17 CMOH (Chief Medical Officer of Health). 2010. *Chief Medical Officer of Health (CMOH) Report*. May 2010. http://www.health.gov.on.ca/en/common/ministry/publications/reports/wind_turbine/wind_turbine.pdf.

Low-frequency noise can be problematic if it occurs at very high levels or levels higher than what occurs from wind turbines. Mechanics who work on military aircraft and others in proximity to military and aerospace applications are one example of the subset of the general population who might be routinely exposed to very high levels of low-frequency noise. For instance, F-18 fighter jet afterburner noise at approximately 40 feet exceeds 110 dB in audible low frequencies between 20 Hz and 200 Hz.[18] Excessive exposure to low-frequency noise has been associated with a condition termed "vibro-acoustic disease," a thickening of cardiovascular structures, such as cardiac muscle and blood vessels. Such military and aerospace situations where these high levels of low-frequency noise can occur bear no connection to the sound produced by wind turbines. On the contrary, there is clear, consistent, and objective evidence that modern wind turbines emit very low levels of low-frequency noise.

In the Draft EIR, a Project-specific C-weighted analysis was completed that evaluates low-frequency noise generated by Project wind turbines on the Reservation that could potentially impact lands under the County's jurisdiction (Appendix G of the Final EIR). Refer to EIR Chapter 2.6, Noise, for a detailed discussion. The County's applicable threshold as described in Section 6952.f.1 of the Zoning Ordinance is represented as the decibel difference between the predicted C-weighted wind turbine generator noise and the Residual Background Sound Criterion (i.e., A-weighted L_{90} + 5 dB) not to exceed 20 dB. While the Acoustical Analysis Report (Appendix G of the Final EIR) did identify conditions where and when this threshold might be exceeded, it is an annoyance/nuisance-based threshold, not a health-based threshold. The County's selection of 20 dB as a nuisance criterion is supported by the Kamperman and James paper, which is also referenced in Section 2.8 of the Wind Energy Ordinance Final EIR:[19]

> Why should the dBC immission limit not be permitted to be more than 20 dB above the background measured LA90+5 dB?
>
> The World Health Organization and others have determined that if a noise has a measured difference between dBC and dBA more than 20 dB, the noise is highly likely to create an annoyance because of the low frequency component.

This annoyance-based threshold is subject to waiver in certain instances, allowing the County to approve C-weighted wind turbine noise levels despite their potential to exceed A-weighted Residual Background Sound Criterion by more than a 20 dB difference in magnitudes and thus regardless of what L_{90} value may be measured (or by whom) at an assessment location. Although no waiver is sought

[18] McKinley, Richard. 2000. "Military Noise Environments and Hearing Protection/Conservation". Human Effectiveness Directorate. November 17, 2000. https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/cami/library/online_libraries/aerospace_medicine/sd/media/McKinley.pdf

[19] Kamperman, G., and R. James. 2008. "The 'How To' Guide to Siting Wind Turbines to Prevent Health Risks from Sound." October 28, 2008. http://www.windturbinesyndrome.com/wp-content/uploads/2008/11/kamperman-james-10-28-08.pdf.

here, the availability of a waiver under the County's code indicates that low-frequency noise above the County's 20 dB level is not anticipated to result in adverse public health impacts.

Studied health effects of low-frequency sounds include vibro-acoustic disease, which has been linked to prolonged exposure to high-intensity, low-frequency noise (in excess of 110 dB), not low-intensity, low-frequency noise below 90 dB. Low-frequency noise associated with the Project turbines would be well below 90 dB at the assessed locations. The 20 dB difference context could result in subjective annoyance, but there is no evidence of an effect on health.

Infrasound

Infrasound is defined as acoustic oscillations that occur at frequencies below 20 Hz, which is generally considered below the range of human hearing. Natural sources of infrasound include wind or weather patterns causing air oscillations, ocean waves, and turbulence. Seismic activity, given its subsurface nature and very large vibrational wavelengths, is another common source of infrasound. A frequency-weighting characteristic, designated "G," is generally used for the determination of weighted sound pressure levels of sound whose spectrum lies partly or wholly within the frequency band from 1 Hz to 20 Hz, resulting in G-weighted levels that are referred to as "dBG."

The Project components that would be anticipated to be the primary sources of infrasound are the proposed wind turbines on the Reservation and not the gen-tie line, the switch yard, or the substation, which are the project components located off the Reservation. The health concerns associated with infrasound include effects to the vestibular (sensory) system, which aids in the control of positioning and movement of the head and body.

As discussed in the County Public Health 2019 Position Statement, available peer-reviewed literature provides no clear evidence that the operation of wind turbines and associated infrastructure contributes to health concerns as a result of infrasound. Studies upon which the County Public Health 2019 Position Statement rely include the following:[20]

> Turnbull et al. (41)[21] – The authors reported that the measured level of infrasound within the wind farms was well below the audibility threshold and was similar to that of urban and coastal environments and near other engineering noise sources. Indeed, the level of infrasound from wind farms at 360 and 85 m [61 and 72 dB(G), respectively] was comparable to that observed at a distance of 25 m from ocean waves [75 dB(G)].

[20] Knopper et al. 2014.

[21] Turnbull C., J. Turner, and D. Walsh. 2012. "Measurement and Level of Infrasound from Wind Farms and other Sources." *Acoustics Australia* 40: 45–50.

The evidence also shows that infrasound emissions from wind turbines are below the internationally recognized threshold for perception of infrasound. Furthermore, the Chief Medical Officer of Health from Ontario, Canada, stated in a 2010 report, "There is no evidence of adverse health effects from infrasound below the sound pressure level of 90 dB."[22]

Based on the County's review of available peer-reviewed scientific literature, the County Public Health 2019 Position Statement states that no conclusive evidence has been provided that confirms wind-turbine-related infrasound directly causes health effects such as mental health problems, headaches, pain, stiffness, or diseases such as diabetes, cardiovascular disease, tinnitus, or hearing damage. Additionally, no epidemiological studies have concluded that generation of infrasound from wind turbines results in direct health effects.

Comments were received on the Draft EIR expressing concerns regarding the potential adverse health effects of infrasound and low-frequency noise impacts from the wind turbines. Several comments refer to the March 18, 2019, Wilson-Ihrig noise report that was prepared for Backcountry Against Dumps and is included as an attachment to Comment Letter O5. The 2019 Wilson-Ihrig noise report includes a prior February 28, 2014 Wilson-Ihrig report as an appendix. The report documents noise recordings in the Jacumba and Boulevard areas. The report states the intent of the recordings was to document existing infrasound and low-frequency noise (ILFN)[23] generated by existing wind turbines in the area, to document C-weighted noise levels in the vicinity of the Project's proposed wind turbines, and to suggest that there are adverse health consequences from such exposure. The report presents measurements of unweighted infrasound levels at a number of residential properties in the Project vicinity. These studies state that infrasound and low-frequency noise from existing operating wind turbines up to many miles away are measurable at these residences and further suggest that exposure to infrasound and low-frequency noise could result in adverse health impacts.

Both the February 28, 2014 and March 18, 2019 Wilson-Ihrig reports also discuss research that they claim "seem[s] to provide strong evidence of a cause and effect relationship" between infrasound and low-frequency noise and eventual adverse human health responses. In particular, and although infrasound is below the range of human hearing, the Wilson Ihrig reports refer to stimulation of the outer hair cells of the auditory portion of the ear (cochlea) at very low frequencies. Specifically, the Wilson-Ihrig reports quote a Salt and Kaltenbach study that 60 dBG "will stimulate the OHC [outer hair cells] of the human ear." The "dBG" descriptor here means that the sound level referred to by Salt and Kaltenbach is G-weighted, which is different from an unweighted dB level or an A-weighted or C-weighted value. Figure GR-2-B, appearing in both of the Wilson-Ihrig reports (i.e., from page 25 of

[22] As cited in Iberdrola Renewables 2011.

[23] ILFN is considered to include infrasound (i.e., sound waves with a frequency below the lower limit of audibility [generally 20 Hz]) and low frequency sound (20 Hz and above, up to 200 Hz).

the March 18, 2019, report, and page 29 of the February 28, 2014, report) graphically displays the difference in these three sound level weighting scales.

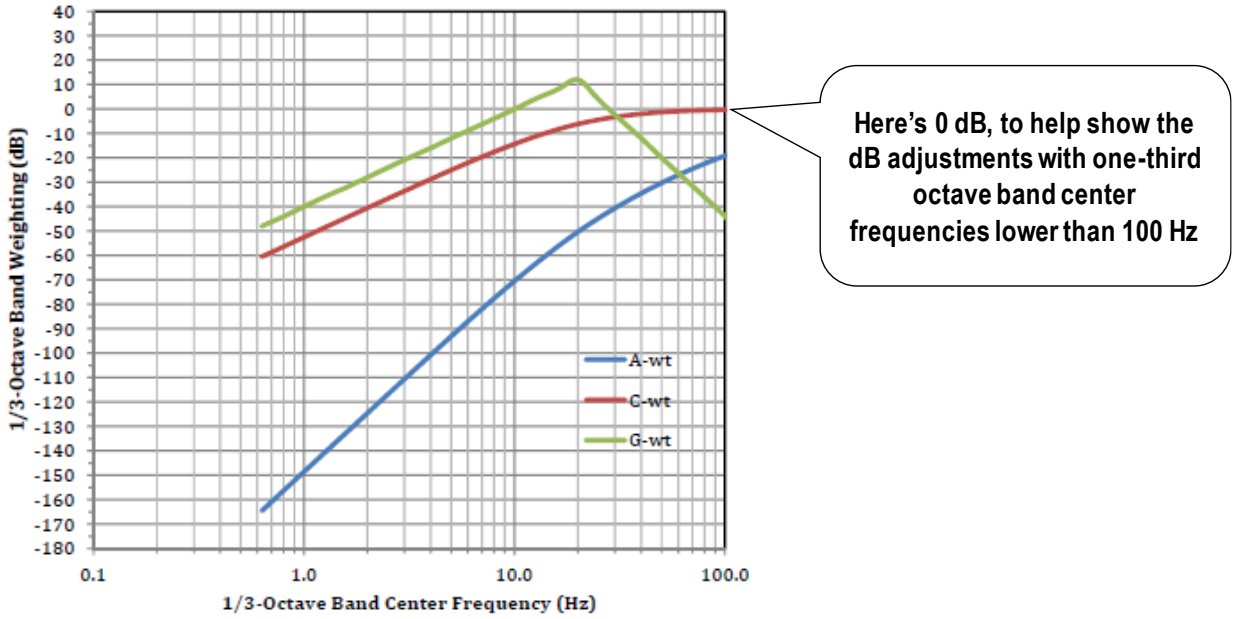

Figure GR-2-B. Comparison of A, C, and G-weighting decibel (dB) adjustment curves below 100 Hz

The three sound level weighting curves shown in Figure GR-2-B are decibel value adjustments applied to an unweighted sound level. The A-weighting curve, shown in blue, mimics the typical sensitivity of average healthy human hearing and therefore emphasizes sound in the usual speech range of audible sound frequencies (500 Hz to 4,000 Hz) not displayed in Figure GR-2-B. Average healthy human hearing is less sensitive with decreasing frequency, and the blue A-weighting curve reflects this by showing dB adjustments of approximately -20 at 100 Hz and -50 at 20 Hz, the latter of which is the understood limit of audible sound.

The C-weighting curve, shown in red on Figure GR-2-B, applies lesser decibel discounts with decreasing frequency; for instance, the discount is less than 10 dB at the lowest end of the audible spectrum (20 Hz) and hence a much smaller dB adjustment than the A-weighting curve would apply at this same sound frequency. For this reason, the C-weighting curve is often applied in the music industry to assess sound that has audible low-frequency content (bass frequencies) and for which A-weighting would not be appropriate. The G-weighting curve, shown in green in Figure GR-2-B, has an angular shape. G-weighting is used to evaluate inaudible sound below 20 Hz.

The executive summaries of both Wilson-Ihrig reports state "the studies cited above, and more recent studies demonstrate that wind turbines (specifically wind turbine-generated infrasound and low-frequency noise) have the potential to not only annoy humans, but harm them physiologically." The reports reference the G-weighted sound level of 60 dBG that Salt and Kaltenbach indicate could cause stimulation of the outer ear cells. For clarification, the County

notes that the Wilson-Ihrig reported measurements at the representative residences are unweighted and, when adjusted to the G-weighting curve, do not exceed the G-weighted sound level of 60 dBG. Specifically, as illustrated in Figure GR-2-B, the G-weighting adjustment at 1 Hz is approximately −40 dB, which when applied to an unweighted level of 63 dB at 1 Hz would convert it to 23 dBG. A measurement of 23 dBG is substantially lower than 60 dBG.

Figure GR-2-C below illustrates the application of G-weighting decibel adjustments to a sample of Wilson Irhig's noise data. Please refer to Figure C-4 of the Wilson-Ihrig March 14, 2019, report for the noise data. The solid blue plot across the 0 to 40 Hz frequency range represents the unweighted sound pressure level (dB) measured by Wilson-Ihrig at the Skains residence (described to be "1.65 miles from nearest WT [wind turbine]," with the 63 dB peak at 1 Hz described as due to Ocotillo Wind Turbine operation at a distance of 11 miles) on November 13, 2018. The dashed orange plot shows Wilson Ihrig's unweighted values after adjusting for the G-weighted scale. When the G-weighting dB adjustment is made, the dBG values displayed by the dotted orange line in Figure GR-2-C are well below 60 dBG. As such, stimulation of the human ear outer hair cells would not occur. Therefore, the "potentially numerous consequences" suggested to occur by the 2011 Salt and Kaltenbach study at values above 60 dBG would not be occurring in the Project Vicinity, where the existing measurements are below 60 dBG.

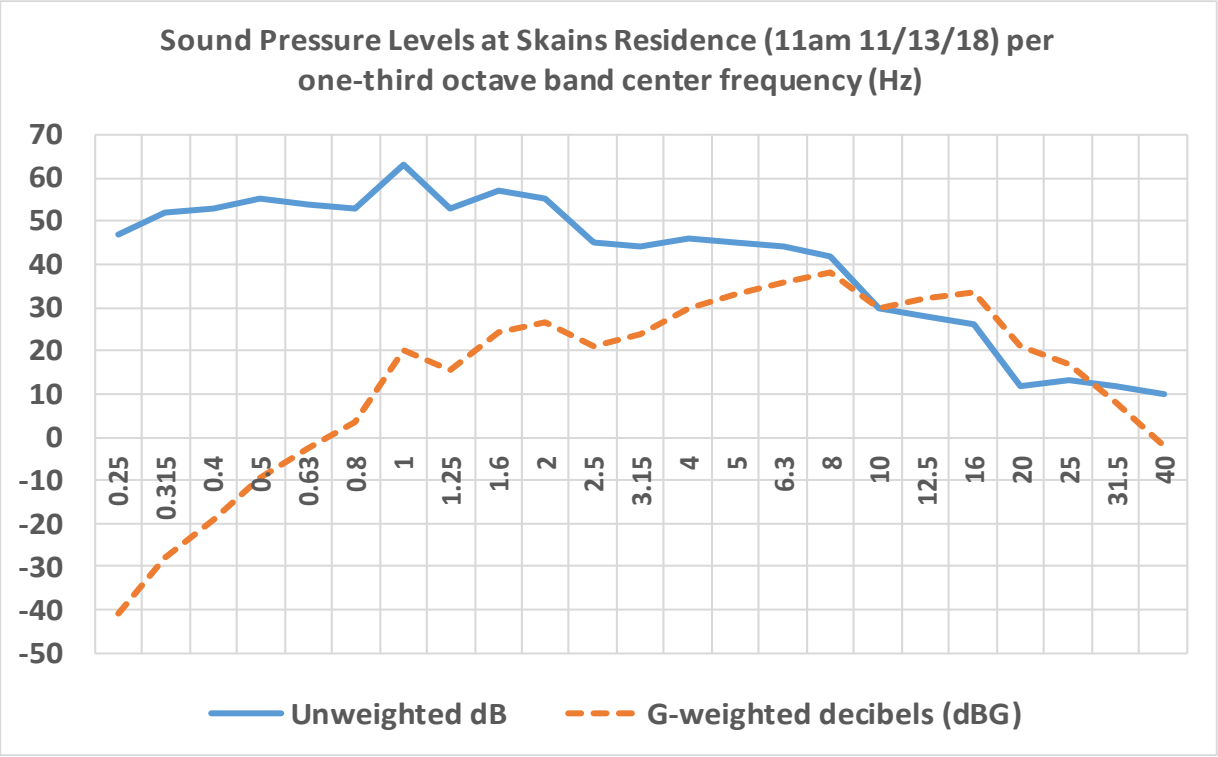

Figure GR-2-C. Contrast of unweighted sound pressure level and G-weighted sound pressure level plots for Skains residence

The above analysis applies not just to the Skains residence but also to all of the other sample measurements in the Wilson Ihrig and dBF reports. After application of G-weighting adjustments to the 13 unweighted noise level measurements from the December 16, 2019, dBF report, the 20 unweighted noise measurements from the Wilson-Ihrig 2014 report, and the 16 unweighted noise measurements from the Wilson-Ihrig 2019 report, it is apparent that the G-weighted threshold of 60 dBG is not exceeded at any of their surveyed locations.

In summary, the concerns raised by Wilson-Ihrig about potential direct health effects due to infrasound exposure from operating wind turbines include association with exceedance of the 60 dBG threshold. The anticipated infrasound from the Project's proposed wind turbines is not expected to exceed a G-weighted value of 60 and thus is not expected to cause direct health impacts.

Amplitude Modulation

Comment O5-16 includes quotations from a number of cited studies that are offered as evidence that amplitude modulation (AM) is related to adverse public health outcomes. For the following reasons, the County disagrees:

- The cited Pohl study (included as an attachment to Comment Letter O5) does not "confirm" that perceived AM is necessarily a health or annoyance issue; rather, it states that AM may explain "the origin of certain annoying noise patterns" in acoustical analysis of its collected data. Additionally, it is worth noting that the Pohl study concedes the following: "This study does not provide any empirical evidence for the repeatedly asserted relationship between annoyance or acceptance of wind turbine and distance to the residence. There is no numerically strong relationship between noise annoyance and the distance to the nearest wind turbine or the estimated sound pressure level."
- The cited Schaffer study (included as an attachment to Comment Letter O5) does not establish a connection between wind turbines, annoyance, and quantifiable health impacts. It used artificially-produced acoustic stimuli that associated wind turbine operation sound samples with four simulated observer-to-turbine distances ranging from 100 to 600 meters. At a simulated visual distance of 350 meters (approximately 0.2 miles), the study auralization samples of wind turbine operation without and with artificial AM included were 38.2 and 39.2 dBA L_{eq}, respectively. Not only are these simulated sound levels less than a decibel apart and thus unlikely to be distinguished outside of a controlled laboratory setting, they are also both less than 40 dBA L_{eq} and thus less than the County's 45 dBA hourly L_{eq} property line standard with respect to Off-Reservation residences. On these bases, the study would seem to have little relevance since the lease agreement requires that all installed turbines would be no closer than a 0.25 miles to a pre-existing On-Reservation residence, and that the closest Off-Reservation NSLU (i.e., on private lands) to a Project turbine site is approximately 1,030 feet away (0.2 miles) based on the evaluated 76 turbine layout whereas

only 60 turbines can be constructed. Further, while the study included AM as a tested characteristic to evaluate its effect on annoyance, it also evaluated the effects of the simulated wind turbine noise A-weighted magnitude, visual settings, audio/visual stimulus playback order, and the personal attitudes of the test participants. Among these five annoyance factors studied, AM was determined to have the least effect: a 0.6 change on an 11-point International Commission on the Biological Effects of Noise (ICBEN) scale, while unbiased visual setting had twice the effect (1.2 points), attitude had four times the effect (2.4 points), and simulated wind turbine noise level had nine times the effect (5.4 points). In fact, AM mattered as little as the playback order (0.6 points on the ICBEN scale) of the stimuli during the test. Thus, while the Schaffer study seems to offer little support for emphasizing AM as an annoyance factor, it underscores the appropriateness of A-weighted L_{eq} values to evaluate annoyance as practiced by the County with its noise ordinance.

- The suggestion in the comment that because there may be "important implications" for possible sleep disruption from wind turbine AM is not proof that AM from wind turbines causes sleep disruption generally or in this particular case. Further, the comment's quotation from the Hansen study (included as an attachment to Comment Letter O5) is partial, omitting an important final clause shown in italics as follows: "This has important implications for possible sleep disruption from wind farm AM, *particularly as ambient noise levels in rural South Australia can be as low as 15 and 5 dBA, outdoors and indoors, respectively*." Measurements of what the comment refers to as the "rural Backcountry" as disclosed in the Draft EIR and Appendix G of the Draft EIR, Acoustic Analysis Report Addendum, show that outdoor ambient noise levels are much higher than these extremely low values reported by the Hansen study, suggesting that AM from wind turbines may not even be audible and thus may not be an annoyance-producing concern.

In conclusion, the County has determined that the acoustical analysis in the Draft EIR has adequately considered potential Project wind turbine attributed AM as a very rare likelihood, and its effect would not change the assessment of Project noise impacts.

Electromagnetic Fields

Electromagnetic fields (EMFs) are invisible lines of force that are present wherever electricity flows, such as around appliances and power lines. These fields are low-energy, extremely low-frequency fields. Exposure to EMFs comes from common sources such as distribution and transmission lines, wiring in walls, ground currents in water pipes, and from electrical appliances such as microwaves, clothes washers, fluorescent lamps, computers, televisions, and hair dryers.

Several commenters state that there is a direct causal relationship between EMFs and adverse health effects. The following Project components would create varying amounts of EMFs: wind turbines on the Reservation, the On- and Off-Reservation gen-tie line, and the high voltage substation and switchyard (part of Boulder Brush Facilities).

As stated in Chapter 2.5, Section 2.5.3.5, of the Draft EIR, the California Public Utilities Commission (CPUC) has implemented a number of EMF measurements, research, and education programs, and provided direction that led to the preparation of the California Department of Health Services' review of existing studies related to EMFs from power lines and associated potential health risks. While CPUC does not have jurisdiction over the Project, other than the incoming and outgoing connection lines to be constructed by San Diego Gas & Electric, CPUC's evaluation of the potential health effects of EMF is instructive and is used by agencies and courts in California due to its oversight of extensive electrical infrastructure throughout the state. The CPUC has stated that "at this time we are unable to determine whether there is a significant scientifically verifiable relationship between EMF exposure and negative health consequences."[24] The CPUC has not established any connection between EMF exposure and negative effects to human health. Additionally, the County Public Health 2019 Position Statement summarized literature reviews on EMFs and concluded that available literature provides no clear evidence that the operation of wind turbines and associated infrastructure directly contributes to health concerns as a result of EMFs.

Shadow Flicker

Shadow flicker is a term used to describe the flickering of shadows that are cast by a wind turbine's rotating blades when the sun is behind them. It is caused when the rotor of the turbine is between the observer and the sun, and generally occurs during the morning or evening hours when the sun is low in the sky (Shadow Flicker Analysis, Appendix O to the Draft EIR).

Several commenters addressed the Draft EIR analysis of potential shadow flicker effects. Commenters also expressed concern regarding the health effects of shadow flicker, particularly the effects on individuals within photosensitive epilepsy.

The wind turbines proposed on the Reservation are anticipated to be a source of shadow flicker. As discussed in Chapter 2.5, Section 2.5.3.5, of the Draft EIR, shadow flicker may be a source of annoyance for those residing in the vicinity of turbines. The primary health concern raised by commenters regarding shadow flicker is related to the risk of seizures for individuals with photosensitive epilepsy. While shadow flicker at high enough frequencies could result in health effects for photosensitive receptors, the modern wind turbines that would be used for the Project would rotate well below any frequency of health concern. The County Public Health 2019 Position Statement included discussion from a peer-reviewed epidemiological study, which identified that three-blade wind turbines with a rotation of less than 60 rotations per minute (rpm) would not likely contribute to photo-induced epilepsy in individuals who are photosensitive (Knopper, et al. 2014). For turbines with three blades, a maximum speed of rotation of 60 rpm translates to a rotation frequency range of 3 Hz. Modern wind turbines, such as those that would be utilized by the Project, rotate at under 20 rpm (0.33 Hz).

[24] CPUC (California Public Utilities Commission). 2020. "PUC Actions Regarding EMFs." https://www.cpuc.ca.gov/General.aspx?id=3810.

The County Public Health 2019 Position Statement summarizes conclusions from the most recent peer-reviewed literature and scientific publications, including, among others, the U.S. Department of the Interior Office of Indian Energy and Economic Development and the U.K. Department of Energy and Climate Change. Additionally, a review of the literature by Knopper and Ollson[25] identified two seminal studies related to shadow flicker and the risk of seizures in individuals with photosensitive epilepsy: Harding et al. (2008)[26] and Smedley et al. (2010).[27] These studies, which are cited in the County Public Health 2019 Position Statement, indicate that shadow flicker at frequencies greater than 3 Hz pose a potential risk of causing photosensitive seizures in 1.7 people per 100,000 of individuals who are photosensitive.

The Epilepsy Society has also identified that, while photosensitive epilepsy is triggered by flashing lights, turbine blades would need to rotate at speeds faster than 3 Hz before shadow flicker would be considered a health risk.[28] For context, strobe lights used in discotheques have frequencies that range from approximately 3 Hz to 10 Hz (1 Hz = 1 flash per second).

As stated above, modern wind turbines, such as those that would be used for the Project, rotate at under 20 rpm (0.33 Hz). The operational characteristics of Project turbines would be far below what is considered to be a health risk for individuals who are photosensitive. Therefore, it was concluded within the Draft EIR that, although some receptors may experience shadow flicker, it is not anticipated that shadow flicker would result in adverse health effects due to the projected slow rate of rotation of the Project's turbine blades.[29] Comments on the Draft EIR to the effect that shadow flicker from modern wind turbines can have negative health effects, such as triggering seizures in people with epilepsy, are thus unsupported.

While the County does not have local regulations pertaining to shadow flicker, a Shadow Flicker Analysis (Appendix O to the Draft EIR) has been prepared for the Project by AWS Truepower LLC. This analysis identifies which receptors (both On- and Off-Reservation) may experience shadow flicker, and with what potential frequency.

The Shadow Flicker Analysis prepared for the Project, and included in the Draft EIR as Appendix O, assumed the tallest approximate tip height for any turbine under consideration (regardless of capacity), to be approximately 586 feet. With respect to turbine rotor diameter, the analysis

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25 Knopper, L.D., and C.A. Ollson. 2011. "Health Effects and Wind Turbines: A Review of the Literature." *Environmental Health* 10: 78. doi:10.1186/1476-069X-10-78.

26 Harding G., P. Harding, and A. Wilkins. 2008. "Wind Turbines, Flicker, and Photosensitive Epilepsy: Characterizing the Flashing that may Precipitate Seizures and Optimizing Guidelines to Prevent Them." *Epilepsia* 49: 1095–1098. doi:10.1111/j.1528-1167.2008.01563.x.

27 Smedley A.R.D., A.R. Webb, and A.J. Wilkins. 2010. "Potential of Wind Turbines to Elicit Seizures Under Various Meteorological Conditions." *Epilepsia* 51: 1146–1151.

28 Epilepsy Society. 2019. "Wind Turbines and Photosensitive Epilepsy." https://www.epilepsysociety.org.uk/wind-turbines-and-photosensitive-epilepsy#.Xyn-w0BFxPY.

29 Knopper et al. 2014.

assumed a rotor diameter of up to approximately 449 feet regardless of capacity. See Table 4.1 in the Shadow Flicker Analysis (Appendix O to the Final EIR).

Chapter 1, Project Description, of the Draft EIR identified dimensions' representative of turbines that would be installed including a rotor diameter of up to approximately 460 feet. The 2019 Shadow Flicker Analysis for the Draft EIR assumed the tallest approximate tip height for any turbine under consideration which is up to approximately 586 feet at tip height. Based upon public comments received which noted the difference in the rotor diameter described in Chapter 1 (up to approximately 460 feet) and the rotor diameter assumed in the Shadow Flicker analysis (450 feet), a Supplemental Shadow Flicker Analysis was prepared subsequent to public review of the Draft EIR (see Attachment 1 to Appendix O of the Final EIR). The supplemental analysis assumed a rotor diameter of 460 feet. The Supplemental Shadow Flicker Analysis compared the modelled results based on a rotor diameter of 460 feet versus a rotor diameter of 450 feet and determined no material change to results disclosed in the Shadow Flicker Analysis (Appendix O) in the Draft EIR.

The Shadow Flicker Analysis conservatively modeled 76 turbine sites (of which only 60 would be constructed in accordance with the Campo Lease) and assumed clear sky conditions, 100% turbine availability, and other factors prerequisite to shadow flicker conditions. Based on this conservative analysis, a number of On- and Off-Reservations receptors may experience nuisance-level shadow flicker effects for more than 30 minutes in a given day, 30 hours in a given year, or both (please refer to Table 5.1 in Appendix O of the Draft EIR as well as Tables 1 and 2 in Attachment 1 to Appendix O of the Final EIR). As this is based on a highly conservative model, these receptors would likely perceive shadow flicker far less frequently in a given day or year, if at all. In summary, the EIR's shadow flicker analysis is conservative to reflect a worst-case scenario; actual perception of shadow flicker by receptors is expected to be less than estimated because fewer turbines would be constructed than were modelled.

While shadow flicker is not regulated in applicable state or federal law, because some receptors may experience shadow flicker, **Project Design Feature (PDF) AE-1** and **PDF-AE-2** would be implemented by the Project to reduce potential shadow flicker experienced at On- or Off-Reservation receptors. **PDF-AE-1** and **PDF-AE-2** are outlined in Chapter 2.1, Aesthetics, of the Draft EIR and presented below.

PDF-AE-1 Shadow Flicker (On-Reservation). The Developer will coordinate with the relevant tribe to assess shadow flicker complaints made within one year from the initial operations date of the Project by the resident of any existing (existing as of the date of Record of Decision approval) On-Reservations receptor located within a distance of 15 x Rotor Diameter (i.e., approximately 6,750 feet) of a Project turbine. This assessment would include possible remedies that the Developer may implement depending upon the level of shadow flicker impacts occurring at the On-

Reservations receptor, including financial assistance for the installation of screening vegetation or window coverings. Requests for assistance can be made through a Project hotline to be established by the Developer and published to the Developer's website.

PDF-AE-2 Shadow Flicker (Off-Reservation). The Developer will coordinate with any resident of any Off-Reservation Receptor existing as of the date of approval of the Project by the County located within a distance of 15 x Rotor Diameter (i.e., approximately 6,750 feet) of a Project turbine to assess their shadow flicker complaints made within one year from the initial operations date of the Project. This assessment would include possible remedies that the Developer may implement depending upon the level of shadow flicker impacts occurring at the Off-Reservations receptor, including financial assistance for the installation of screening vegetation or window coverings. Requests for assistance can be made through a Project hotline to be established by the Developer and published to the Developer's website.

Valley Fever

As discussed in Chapter 2.2, Air Quality, of the Draft EIR, valley fever is an infection caused by the fungus *Coccidioides immitis* (Coccidioides), which is known to live in the soil in the southwestern United States and parts of Mexico and Central and South America. Valley fever can be contracted by inhalation of Coccidioides spores, which may occur during earthmoving activities. While most individuals exposed to Coccidioides are asymptomatic, the infection may be characterized by influenza-like symptoms such as fatigue, cough, and fever. Approximately 5%–10% of people who contract valley fever will develop serious or long-term lung problems. In about 1% of people with valley fever, the infection may spread from the lungs to other parts of the body.[30] According to the California Department of Public Health, incidences in the County vary from 2.7 cases per 100,000 to 8.3 cases per 100,000 between 2011 and 2018 or between 88 and 274 cases.[31] While the upper end of this range represents a modest rate increase compared to that cited for 2015, it does not severely increase the risks or change the conclusion presented in the Draft EIR.

Even if the fungus is present at a site, earthmoving activities may not result in increased incidence of valley fever. Propagation of Coccidioides is dependent on climatic conditions, with the potential for growth and surface exposure highest following early seasonal rains and long dry spells. Coccidioides spores can be released when filaments are disturbed by earthmoving activities,

[30] CDC (Centers for Disease Control and Prevention). 2020. "Symptoms of Valley Fever (*Coccidioidomycosis*)." April 2020. https://www.cdc.gov/fungal/diseases/coccidioidomycosis/symptoms.html.

[31] CDPH (California Department of Public Health). 2019. *Epidemiologic Summary of Coccidioidomycosis in California, 2018*. July 2019. https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/CocciEpiSummary2018.pdf.

although receptors must be exposed to and inhale the spores to be at increased risk of developing valley fever. Moreover, exposure to Coccidioides does not guarantee that an individual will become ill. Confirmed cases of valley fever have not been recorded near the Project site or during construction of other similar projects or earthmoving activities in the area. The Draft EIR identifies mitigation measure **M-BI-2**, which requires a Worker Environmental Awareness Program, which would include information on how to identify the symptoms of valley fever and require reporting when personnel express symptoms or general health concerns. In addition, **M-BI-10** and **PDF-AQ-3** include fugitive dust control measures that would regulate dust emissions during construction and blasting activities, and would lower potential risk for exposure if Coccidioides were present in the soils at the Project site. In addition, **PDF-AQ-2** establishes the development of a Health and Safety Plan, which would be amended, if appropriate, to include additional measures to protect construction workers from valley fever.

Summary

As impacts to public health are accurately and sufficiently analyzed in the Draft EIR and supporting technical appendices, and comments regarding public health impacts did not raise new information not previously addressed in the Draft EIR or identify deficiencies in the Draft EIR analysis, no modifications to the Draft EIR analysis are warranted.