An Assessment of The Impact of the Kitty Hawk Wind Project on the Sandbridge Area

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This report seeks to investigate the potential impacts of the proposed Kitty Hawk Offshore Wind Facility where it comes onshore in the Sandbridge area, with a focus on A) the generation of Electromagnetic Fields (EMF) onshore and B) the potential effects of directional drilling. We also investigated the reliability of the data presented by the TetraTech and Avangrid reports, and independently surveyed the available scientific literature for other studies that can provide additional insights on these topics. This provides an independent analysis of these factors for the Virginia Beach City Council.

EMF Modelling

We reviewed the recent sources (last 8 years) included in the materials presented to the Virginia Beach City Council, which pertain to EMF impacts on marine or terrestrial areas. We also independently searched the available scientific literature using Google Scholar to identify additional current (2018-present) studies on the potential impacts of wind power. This yielded the resources found in the Bibliography, including several comprehensive review articles (Caulson and Gill 2018, Taormina et al. 2018, Albert et al. 2020, Hutchison et al. 2020b, and Svendsen et al. 2022), which which focused on potential EMF impacts, and included other aspects of wind power generation.

Studies examining the EMF generation of buried power cables indicate that EMF effects can be mitigated by burying the cable, with reduced EMF impacts associated with greater burial depths (Albert et al. 2020, Hutchison et al. 2021). In this case, the cables are proposed to be buried at a minimum depth of 3 feet and are enclosed in heat dissipating concrete along the terrestrial route. Along the dunes and coastal areas, horizontal drilling allows them to avoid these sensitive features and be buried at much greater depths (29-85 feet) that yield no measurable magnetic field at the surface. The data reported by TetraTech and Avangrid appear to be reasonable and conservative, and in line with the values reported for EMF generation in the available scientific literature (Kavet et al. 2015, Taormina et al. 2018, Otremba et al. 2019, Hutchison et al. 2020a).

In the studies we reviewed, the EMF values produced by modeling generally matched very well with in situ measurements (Kavet et al. 2015, Taormina et al. 2018). The values estimated by the TetraTech report match well with the values reported from field measurements conducted in other studies (Kavet et al. 2015, Otremba et al. 2019, Hutchison et al. 2020a); this assumes equivalent distances from the cable, and correcting to ensure the same units of measurement. The maximal fields reported in the TetraTech report are within the ranges of the magnetic fields generated in many of the aforementioned studies, and are also equal to or smaller than the fields generated by many common household appliances, such as hair dryers, fluorescent lights, air cleaners, and electric razors (National Institute of Environmental Health Sciences, & National Institutes of Health 2002).

We found no scholarly sources that reported any negative impact of these levels of exposure on human health. Some speculation on potential health impacts was raised in the 1990’s, but since that time no studies have reported significant human health effects despite the myriad of studies conducted (National Institute of Environmental Health Sciences, & National Institutes of Health 2002). A more recent and thorough review of all available health literature also documented no effect of wind power generation and its associated EMF on human health (Knopper et al. 2014). Research of the effects of EMFs on marine organisms has generally noted only weak and localized effects adjacent to cables (Taormina et al. 2018). Review articles (Hutchison et al. 2020b. Albert et al. 2020) have noted that the available research shows no consistent trends, and that some of the studies only observed effects on marine species in unrealistically high magnetic fields generated in a laboratory setting. As two examples of the conflicting trends reported: Hutchison et al. (2020a) documented minor behavioral changes for marine species sensitive to realistic magnetic fields, leading to increased foraging behavior in skates (which could potentially be beneficial). However, Cresci et al. (2022) reported no effects on the behavior of sand eels, an important marine organism at that location, which would be subjected to greater exposure because of its benthic habits. In all cases the effects did not impact any species' mortality, posed no impacts on migration, were very minor in magnitude, and were localized to areas adjacent to the cable (Albert et al. 2020). Regardless, in this project any possible effects on marine organisms will be mitigated by using directional drilling to emplace the cables at depths sufficient to completely eliminate EMF exposure at the coastline.

Several studies on the impacts of wind power on marine organisms noted the positive benefits, including enhancement of benthic macroinvertebrate diversity because of the "reef effect" (Caulson & Gill. 2018). They observed higher diversity of invertebrates because in some cases underwater cables and associated structures used to bury or anchor them can provide habitat and attachment sites for marine organisms and refugia from predation.

Directional Drilling

We have also reviewed materials provided regarding the horizontal directional drilling plan. We concur with the assessment that this method is significantly better than other options. Horizontal drilling is a technique for the underground installation of utilities such as pipelines or cables underground without trenching. As such, it causes minimal surface disruption (Hendershot 2022). It has been employed for utility installation in one form or another since Martin Cherington developed the technique in Sacramento, California in the mid 1970's (Farr 2012). Although these early attempts were quite crude and lacked a way of precisely tracking and controlling the direction, the advantage of using the technique as an alternative to digging up streets and disrupting traffic for long periods of time was evident. Its potential to mitigate disruption of environmentally sensitive areas was demonstrated when, in 1971, Cherington successfully drilled under the Pajaro River near Watsonville, California and emplaced a 4-inch gas line for PG&E.

Since that time, the technology has greatly matured, allowing remarkably precise computerized directional control. It has emerged as the preferred method in urban areas where trenching disrupts the flow of traffic for long periods of time and allows cables to be placed at depths of tens of feet to avoid structures such as building foundations. As concern for the environment has emerged, the importance and use of the technique as a way to safely traverse environmentally sensitive areas has grown.

Some advantages of horizontal directional drilling that have been cited in the literature include:

- minimal disruption to traffic patterns in urban areas
- flexibility in locating the utilities as they can be precisely navigated along complex curving pathways to avoid foundations and other hazards.
- minimal landscape rehabilitation and a reduced potential for importation of invasive species via construction equipment and fill material.
- lower cost when the cables and pipelines must be emplaced at considerable depth.
- the ability to install utilities well beneath the surface when crossing environmentally sensitive areas.

In the case of the Sandbridge project, the importance of burying the cables is critical because of the threat of hurricanes. If the cable lies, unburied, on the seafloor it is subjected to large swells which can damage the cable and cause disruption to the sea bed ecosystem (Taormina et al. 2018). The damage to transatlantic cables on the New Jersey coast during hurricane Sandy is a prime example of what can happen to cables sitting on the seabed during storms. Additionally, anchors and fishing gear have been known to damage unburied cables. There is also concern about their susceptibility to intentional malicious cutting. While it may be difficult to impossible to bury cables in areas with a rocky substrate such as the northern latitudes, the soft, unconsolidated seabed characteristic of the Virginia coast makes burial simple.

The alternative to horizontal directional drilling in burying an offshore cable is trenching, which requires considerable disruption of the seabed compared to horizontal drilling (Taormina et al. 2018). The intention is to bury the cables up to 85 feet deep ensuring virtually no EMF exposure to sea life (or human life at the beach). As it approaches the shore, the cable will still be at 29 feet deep. Such a depth ensures the preservation of the vital dune system and makes future exposure due to erosion highly unlikely. It also is really only made practical with directional drilling, as dredging to that depth would be very difficult and damaging to the environment.

Structural and environmental concerns with horizontal drilling may include stabilization of the drill bore and pollution of soil and shallow aquifers. The former is mitigated by the use of a drilling fluid, also called drilling mud, which is composed of a mixture of bentonite clay and mud. This mixture is pumped through the drill string to the bit where it serves three purposes: 1) lubricating the drill bit, ensuring that it lasts for the entire drilling operation, 2) cleaning cuttings from the drilling, transporting them back to the point of origin, and importantly 3) stabilizing the borehole during and after the drilling process to prevent collapse. The efficacy of drilling mud as a strengthening agent has been proven in oil drilling, where the strength of the mud is capable of keeping the borehole from collapsing and preventing “blowouts”. A YouTube video which shows experimentally how drilling mud prevents borehole collapse in sandy sediments is found at https://practical.engineering/blog/2022/7/1/how-do-you-steer-a-drill-below-the-earth .

The drilling fluid is carefully concocted so that it is viscous enough to seal the borehole from shallow aquifers, preventing connectivity with the borehole and the aquifer while drilling. The mud itself does not contain dangerous chemicals. Strict environmental regulations provide rules for recycling and disposal of drilling fluids.

There are numerous informative videos on YouTube explaining how horizontal directional drilling is done. The two linked below are particularly good.
https://www.youtube.com/watch?v=bMSQTzJxro4
https://www.youtube.com/watch?v=0Sgxy0xLHoQ

Conclusions

In conclusion, we find no evidence for negative environmental effects of the proposed wind projects due to EMF generation or Directional Drilling. The data reported by TetraTech and Avangrid appear to be reasonable and conservative, and in line with the values reported in the available scientific literature. The literature surveyed indicates that in situ measures of EMF generation typically fall very close to the modeled predictions. Peak EMF levels at the sites investigated fall within the typical values of household exposure, and are well below the threshold values reported for many common household appliances. The literature surveyed indicates no negative EMF impact on human health. The literature also reports no consistent impact on sensitive marine species, except for in laboratory studies which used unrealistically high magnetic fields. In contrast, several studies noted the positive benefits of wind power, including positive impacts on benthic macroinvertebrate diversity. Directional Drilling is clearly the best way to minimize environmental impacts and precisely position underground utility lines where they will have no negative effects. In contrast, the positive benefits of renewable energy sources are clearly evident and this project is estimated to reduce CO_2 emissions by over 1.3 million tons annually, plus substantial reductions in SO_2 and NO_x emissions. These reductions in pollutant emissions are substantial, whereas we find no evidence for any likely negative impacts of EFM generation or directional drilling.

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