PULLMAN & COMLEY 100 YEARS

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September 1, 2020

Via Electronic Filing
Melanie Bachman, Executive Director/Staff Attorney
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Docket 492 - Gravel Pit Solar – Application for Certificate of Environmental Compatibility and Public Need to The Connecticut Siting Council Regarding a Solar Project in East Windsor, Connecticut

Dear Ms. Bachman:

My client, Gravel Pit Solar, hereby submits this Report on Electric and Magnetic Fields ("Report") to the Connecticut Siting Council ("Council") as a supplement to the application for a Certificate of Environmental Compatibility and Public Need filed on July 31, 2020. The application requests the Council's approval of the location and construction of a solar photovoltaic project in East Windsor, Connecticut.

The enclosed Report was prepared by Exponent, of Bowie Maryland, for my client's engineering firm, Vanasse Hangen Brustlin, Inc. (VHB).

I certify that a copy of this submittal has been submitted to the parties listed on the service list for this Docket. Please feel free to contact me, should you have any questions or concerns regarding this submittal.

Sincerely,

Lee D. Hoffman

Enclosure

Exponent®

Gravel Pit Solar Project

Report on Electric and Magnetic Fields

Exponent®

Gravel Pit Solar Project

Report on Electric and Magnetic Fields

Prepared for

Vanasse Hangen Brustlin, Inc.
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Providence, RI 02903-1023

Prepared by

Exponent
17000 Science Drive
Suite 200
Bowie, MD 20715

August 31, 2020

Contents

Limitations

At the request of Vanasse Hangen Brustlin, Inc. (VHB) and Gravel Pit Solar, LLC, Gravel Pit Solar II, LLC, Gravel Pit Solar III, LLC, and Gravel Pit Solar IV, LLC (collectively, Gravel Pit Solar), Exponent modeled the electric- and magnetic-field levels associated with the operation of the proposed 120-megawatt (MW) Gravel Pit Solar Project (the Project) in East Windsor, Connecticut. This report summarizes work performed to date and presents the results of that work. In the analysis, we have relied on geometry, material data, usage conditions, specifications, and various other types of information provided by VHB and Gravel Pit Solar. We cannot independently verify this input data and rely on these firms for the data's accuracy. Although Exponent has exercised usual and customary care in the conduct of this analysis, the responsibility for the design and operation of the project remains fully with the client. VHB has confirmed to Exponent that the data contained herein are not subject to Critical Energy Infrastructure Information restrictions.

The findings presented herein are made to a reasonable degree of engineering and scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available, through any additional work, or review of additional work performed by others.

The scope of services performed during this investigation may not adequately address the needs of other users of this report outside of the permitting process, and any re-use of this report or its findings, conclusions, or recommendations presented herein other than for permitting of this project are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

Executive Summary

Gravel Pit Solar, LLC, Gravel Pit Solar II, LLC, Gravel Pit Solar III, LLC and Gravel Pit Solar IV, LLC (collectively, Gravel Pit Solar) propose to develop a 120 megawatt (MW) alternating current ground-mounted solar photovoltaic generator system, referred to as the Gravel Pit Solar Project (the Project). The Project Area is an approximately 485 acre subset of an approximately 737-acre Project Site located near Apothecaries Hall Road, Plantation Road, Wapping Road, and Windsorville Road in the Town of East Windsor, Connecticut. An existing right-of-way (ROW) with two 115 kilovolt (kV) transmission lines – designated the 1100 Line and 1200 Line – owned by Eversource Energy (Eversource) crosses the northern portion of the Project Site. The electricity generated by the Project solar arrays in different portions of the Project Area will be connected and brought together by underground 34.5-kV collector lines at the Project Substation and Eversource Switchyard which will then connect to the adjacent Eversource 1200 Line.

Exponent, Inc. (Exponent) measured the existing power line sources of 60-Hertz (Hz) electric- and magnetic-fields (EMF) levels around portions of the Project Site and existing ROW. Based upon the Project design and operation and conservative modeling assumptions, Exponent also calculated pre- and post-Project EMF levels associated with the operation of the 115-kV transmission lines crossing the Project Site and the Project's 34.5-kV underground collector lines.

Along the transmission line ROW edges, the existing EMF levels were calculated to be 0.6 kilovolts per meter (kV/m) and 7.3 milligauss (mG) or less, respectively, at average loading. These results are consistent with existing measurements of 0.5 kV/m and 7 mG at a distance of approximately 40 feet from the nearest transmission line conductor. The calculated electric-field levels will not change as a result of the project, and the calculated magnetic field level will increase by about 1 mG to 3.1 mG at the northern ROW edge and from 7.3 mG to 16 mG at the southern edge of the ROW. Calculated magnetic-field levels fall to 1.9 mG or less within 100 feet (ft) of either ROW edge. There will be no electric field from the voltage applied to the new underground 34.5-kV collector lines, and at average loading the magnetic field will be 11 mG or

less directly above the duct banks, falling to 3.2 mG or less within 10 feet of the duct bank center line.

The calculated EMF levels associated with existing electrical sources and the new Project sources are far below international safety- and health-based standards for EMF. The calculated electric-field levels along the transmission line ROW edges before or after the Project, are at least 7 times lower than the electric field exposure limits for the general public recommended by the International Commission on Non-Ionizing Radiation Protection [ICNIRP] (4.2 kV/m) or the International Committee on Electromagnetic Safety [ICES] (5.0 kV/m). Calculated magnetic-field levels along the transmission line ROW edges before or after the Project are at least 125 times lower than the ICNIRP (2,000 mG) or ICES (9,040 mG) limits. The calculated magnetic-field levels immediately above the duct banks of the underground 34.5-kV collector lines are also much lower than the ICNIRP and ICES guideline limits. The engineering design and other plans adopted by Gravel Pit Solar demonstrate compliance with the Connecticut Siting Council's EMF Best Management Practices (BMPs) and the Application Guide for Renewable Energy Facilities regarding EMF.

Note that this Executive Summary does not contain all of Exponent's technical evaluations, analyses, conclusions, and recommendations. Hence, the main body of this report is always the controlling document.

Introduction

Gravel Pit Solar, LLC, Gravel Pit Solar II, LLC, Gravel Pit Solar III, LLC and Gravel Pit Solar IV, LLC (collectively, Gravel Pit Solar) propose to develop a 120 megawatt (MW) alternating current (AC) ground-mounted solar photovoltaic generator system referred to as the Gravel Pit Solar Project (the Project or GPS). The Project Area is comprised of an approximate 485 acre subset of an approximately 737-acre Project Site located near Apothecaries Hall Road, Plantation Road, Wapping Road, and Windsorville Road in the Town of East Windsor, Connecticut.

The electricity generated by the solar panels will be converted to AC at inverters before connecting to a new collection substation and new switchyard (Project Substation and Transmission Owner (Eversource) Switchyard, respectively) in the northern area of the Project Site. In turn, the Substation and Switchyard will connect to the area grid at the adjacent existing 115-kV overhead transmission line (Line 1200), on an adjacent right-of-way (ROW) owned by The Connecticut Light and Power Company d/b/a Eversource Energy (Eversource), that connects the Barbour Hill and Windsor Locks Substations. The existing Line 1200 is supported on double-circuit structures adjacent to another existing transmission line (Line 1100) that will not be connected to the Project.

Figure 1 (below) shows the placement of the solar panels (light blue shading) on the southern, central, and northern areas, and the existing transmission line ROW. The figure also shows the paths of the underground 34.5-kV collector lines (dark blue dots). One collector line (dotted blue line) will run under Plantation Road to connect the solar panels in the southern area (the southern array) to the central array. The central array will connect to the northern array and to the Substation and Switchyard via a similar 34.5 kV collector line (dotted blue line) that will run under Ketch Brook and the existing Connecticut Department of Transportation (CT DOT) railroad ROW (purple lines).

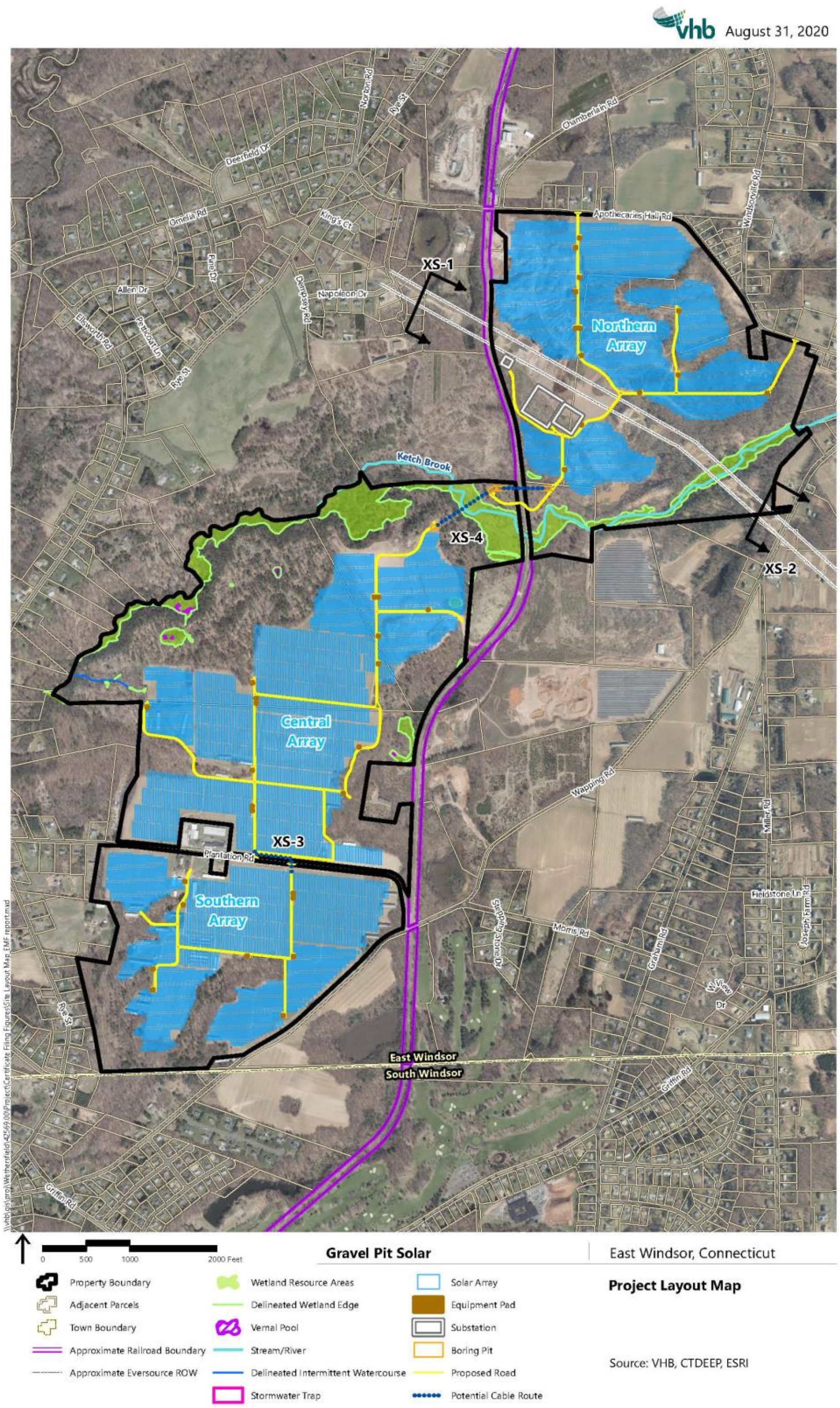

Figure 1. Proposed Site Plan for the Gravel Pit Solar Project annotated with locations of four representative modeling cross-sections.

Exponent, Inc. (Exponent) measured the existing 60-Hertz (Hz) EMF levels from existing power-line sources in the vicinity of the Project Site. Exponent also modeled pre- and post-Project 60-Hz EMF levels associated with the 115-kV transmission lines crossing the Project Site and the 34.5-kV underground collector lines connecting the solar arrays. This report summarizes the measurement and modeling methods and results.

EMF Sources and Characteristics

Sources that generate, transmit, or use electricity produce electric and magnetic fields (EMF). Electricity travels as current from distant generating sources on high-voltage transmission lines, to substations, then on to local distribution lines, and finally to our homes and workplaces for consumption. All things connected to our electrical system—power lines; wiring in our homes, businesses, and schools; and all electric appliances and machines—are sources of EMF. In North America, the vast majority of electricity is transmitted as alternating current (AC) at a frequency of 60 cycles per second measured in Hertz (Hz), i.e., 60 Hz. The EMF from these AC sources is commonly referred to as power-frequency or extremely low frequency EMF. These fields are not the same as the radiofrequency fields produced by mobile phones, AM/FM/TV stations, etc.

Electric fields

Electric fields are produced when voltage is applied to electrical conductors and equipment. The electric field is expressed in units of volts per meter (V/m) or kilovolts per meter (kV/m), where 1 kV/m is equal to 1,000 V/m. The electric-field level increases as the voltage increases.

Since grounded conducting objects such as buildings, fences, and trees easily block electric fields, the major sources of electric fields are the appliances, equipment, and machines inside homes, offices, and factories. Transmission lines, distribution lines, and other power-related equipment are the major source of electric fields outdoors. Electric fields emanate radially outward from the charged conductor and terminate on other conducting objects. Electric fields are vector quantities meaning that they have both a magnitude and direction.

Magnetic fields

Magnetic fields are the result of the flow of electric currents through wires and electrical devices. The strength of a magnetic field is expressed as magnetic flux density in units called gauss (G) or milligauss (mG), where 1 G = 1,000 mG.[1] In general, the strength of a magnetic field depends on characteristics of the source, including the arrangement and separation of the conductors. Magnetic field levels also depend on the amount of current flowing through the lines. Since power demand varies on a given day, throughout a week, or over the course of months and years, the magnetic field produced by the transmission line can also vary. Unlike electric fields, magnetic fields are not easily blocked by most objects. Like electric fields, magnetic fields are vector quantities described by both their magnitude and direction.

EMF Characteristics

The intensities of both electric fields and magnetic fields diminishes with increasing distance from the source. In the case of transmission lines, EMFs generally decrease with distance from the conductors in proportion to the square of the distance. Since line voltage is quite stable and does not change very much over time, electric-field levels are also stable. Magnetic-field levels, as just described, can vary depending on load conditions (i.e., the currents flowing in a conductor).

Figure 2 (below) depicts typical magnetic-field levels measured in residential and occupational environments, compared to levels measured on or at the edge of transmission line ROWs and other locations.

[1] Scientists also refer to magnetic flux density at these levels in units of microtesla (μT). Magnetic flux density in mG units can be converted to μT by dividing by 10 (i.e., 1 mG = 0.1 μT).

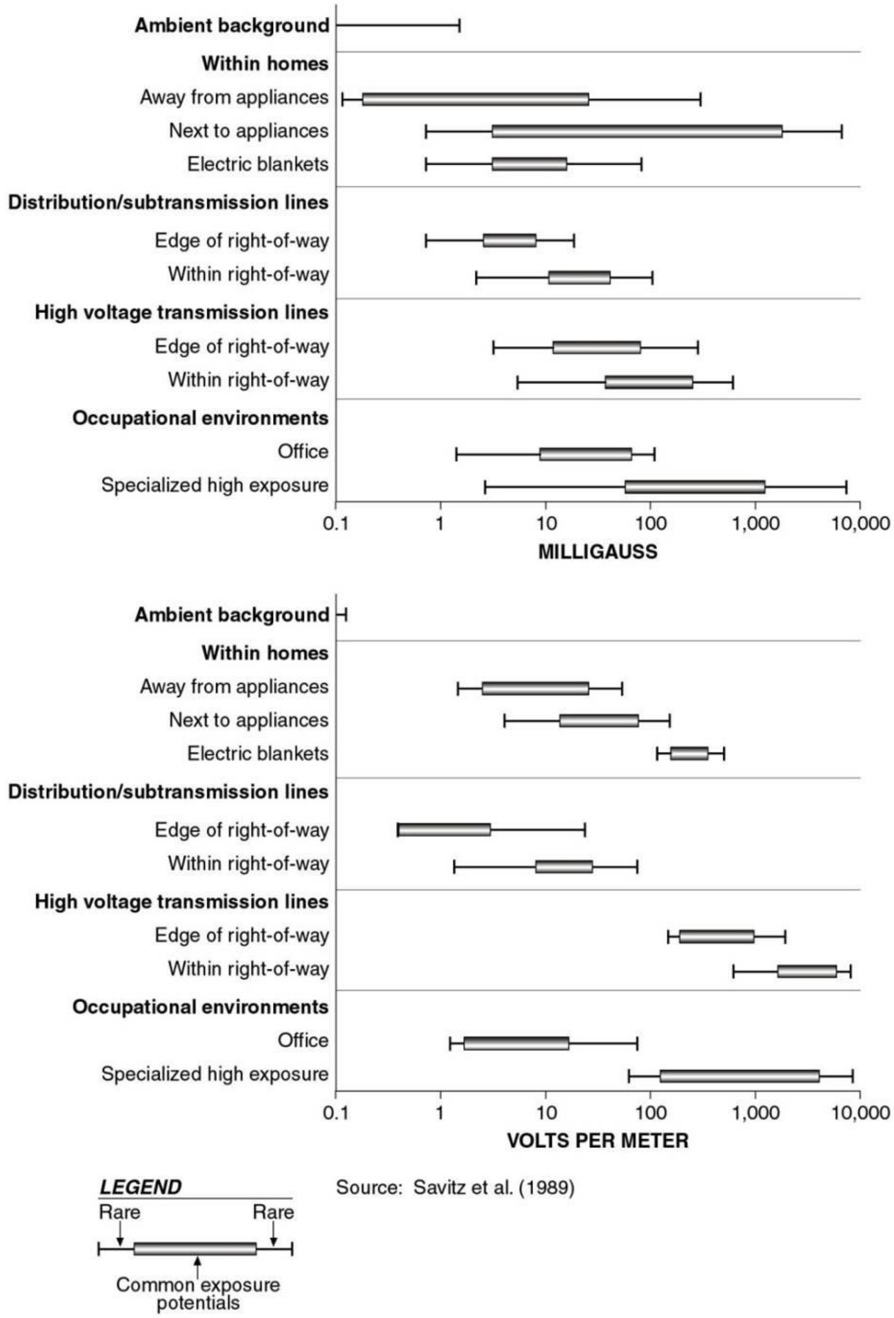

Figure 2. Electric- and magnetic-field levels in the environment.

On-Site EMF Sources

EMF levels were measured in the vicinity of the GPS Project Site from sources including the existing distribution lines along Plantation Road (which passes between the central and southern arrays), the existing distributions lines along Apothecaries Hall Road, and around the existing transmission lines, to characterize pre-development EMF levels.

Post-development EMF levels on the site will derive from new and existing sources. The new sources will include:

- Static (0 Hz) magnetic fields from the solar panels;
- Higher frequency (>60 Hz) AC magnetic fields associated with the direct current (DC) to AC power inverters;
- 60-Hz AC fields associated with the 34.5-kV collector line connecting the southern solar array (south of Plantation Road) to the central solar array (north of Plantation Road), and the 34.5-kV collector line that crosses under Ketch Brook and the CT DOT ROW to connect the central solar array to the northern solar array and to the Substation and Switchyard;
- 60-Hz AC fields from the equipment within the Substation and Switchyard;
- 60-Hz AC fields associated with the Eversource 115-kV transmission lines (1100 Line and 1200 Line) crossing the property on the northern section.

Based upon the considerable distance of the Project facilities from the boundary of the Project Site, the EMF from the solar panels, the Substation and Switchyard equipment, and the power inverters would not appreciably change the EMF levels outside the Project Site boundary (Tell et al., 2015), including at the nearest residence located more than 150 feet (ft) from the Project Site boundary.

Therefore, the focus of this report is on the sources of EMF that are sufficiently close to boundaries of public and private property to potentially affect field levels. These sources include the existing 115-kV transmission lines crossing the Project Site and the underground

34.5-kV collector lines. Shown on Figure 1 are four locations at which Exponent calculated EMF levels across cross-sectional transects to assess future conditions after Project construction.

XS-1 and XS-2 (Existing Transmission line ROW)

XS-1 and XS-2 represent the portions of the existing transmission line ROW northwest and southeast of the proposed Project interconnection, respectively. On this 175-ft wide ROW, the existing 115-kV Lines 1100 and 1200 are constructed on double-circuit horizontal structures. The Project is proposed to connect to the 1200 Line to carry the 120 MW of generated power. No upgrades or changes to the existing 1200 Line are proposed as a result of this project and the interconnecting tap will occur on the existing ROW so no new structures are proposed outside the Project Site. The Project will not connect to the existing 1100 Line.

XS-3 (Plantation Road Crossing)

The power generated by the Project array south of Plantation Road (the southern array) need to be connected to the solar array north of Plantation Road (the central array). This connection will be installed as an underground 34.5-kV collector line that will cross under Plantation Road. The three cables of the underground line will be bundled together in a single duct buried to a depth of at least 3 ft beneath the ground.

XS-4 (Ketch Brook/Railway ROW Crossing)

The central solar array will connect to the northern array and to the Project Substation and Switchyard through underground 34.5-kV collector lines and are modeled with the same configuration as that of XS-3 but will carry the higher currents contributed by more arrays. Collector lines also will pass beneath Ketch Brook and a pipeline that abuts the CT DOT ROW but at a burial depth much greater than the 3 feet used for modeling the collector line elsewhere.

Assessment Criteria

Exposure Guidelines

Neither the Federal Government nor the State of Connecticut has enacted standards for electric fields or magnetic fields from power lines or other sources at power frequencies, although the Connecticut Siting Council (Council, CSC) has developed EMF BMPs for siting new transmission lines as discussed in a subsequent section of this report.

In absence of any federal or state standards, EMF levels can be assessed based on assessment criteria, including exposure limits, recommended by two scientific organizations: (1) the International Committee on Electromagnetic Safety (ICES) and (2) the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The exposure limits set by these agencies, summarized in Table 1, were developed to protect health and safety of both workers and the general public and are based upon comprehensive reviews and evaluations of relevant health research. The World Health Organization (WHO) has recommended that policy makers should adopt international exposure limit guidelines, such as those from ICNIRP or ICES, for exposure to EMF (WHO, 2007).

Table 1. ICNIRP (2010) and ICES (2019) guidelines for EMF exposure at 60-Hz

	Exposure (60 Hz)	
	Electric Field	Magnetic Field
ICNIRP		
Occupational	8.3 kV/m	10 G (10,000 mG)
General Public	4.2 kV/m	2 G (2,000 mG)
ICES		
Occupational	20 kV/m	27.1 G (27,100 mG)
General Public	5 kV/m*	9.040 G (9,040 mG)

*Within power line ROWs, the guideline is 10 kV/m.

Connecticut Siting Council EMF Best Management Practices

The CSC has adopted "EMF Best Management Practices for the Construction of Electric Transmission Lines in Connecticut" (BMP) based upon a consensus of health and scientific agencies that the scientific evidence *"reflects the lack of credible scientific evidence for a causal relationship between MF [magnetic field] exposure and adverse health effects"* (CSC, 2014, p. 3). Nevertheless, the CSC concluded that precautionary measures for the siting of new transmission lines in the state of Connecticut are appropriate and advocates *"the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects"* (CSC, 2014, p.4).

The CSC's EMF BMP guidance (CSC, 2014) also expresses the CSC's interest in *"evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF"* (p. 5). For this project, the CSC's 2014 BMPs serve as the primary reference to new developments in EMF scientific research. However, Exponent notes that in 2015, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) of the European Union issued its opinion report in which the Committee concluded that research published up to 2014 did not confirm any adverse health effects of EMF exposure. The SCENIHR review was the most comprehensive of the reviews completed since the WHO review in 2007 (WHO, 2007). The conclusions of the 2015 SCENIHR review are consistent with the conclusions expressed in the WHO report and the BMPs published in 2014. The conclusions of the 2015 SCENIHR review and the 2007 WHO report are briefly summarized in this report (see *Summary of EMF and Health Research*).

The CSC has also developed an application guide, entitled "Application Guide for a Renewable Energy Facility" (Application Guide), when filing for a Certificate of Environmental Compatibility and Public Need for the construction of a renewable energy facility. Per the Application Guide, the Project falls under the definition of a "renewable energy facility"[2] and

[2] "A "**renewable energy facility**" is any electric generating or storage facility using renewable sources, including, but not limited to solar photovoltaic, solar thermal, wind, fuel cells, ocean thermal, wave or tidal, geothermal, landfill gas, hydropower, or biomass" (Application Guide).

therefore the application must contain the following contents related to EMF (Application Guide, pp. 6-7):

> "18. Justification that the location of the proposed facility would not pose an undue safety or health hazard to persons or property along the area traversed by the proposed facility, including:
>
> > a. Measurements of existing electric and magnetic fields (EMF) at the boundaries of the facility site with extrapolated calculations of exposure levels during expected normal and peak line loading;
> >
> > b. Calculations of expected EMF levels at the boundaries of the facility site that would occur during normal and peak operation of the facility; and
> >
> > c. A statement describing consistency with the Council's "Best Management Practices for Electric and Magnetic Fields," as amended"

Methods

EMF Measurements

To assess EMF from existing sources under pre-Project conditions, Exponent took measurements on Apothecaries Hall Road, which borders the northern perimeter of the proposed Project Site and on Planation Road, which crosses through the southern section of the Project Site. These measurements were performed on June 26, 2020 and all field levels were measured at a height of 3.28 ft (1 m) above ground using instruments meeting IEEE Std. 1308-1994 (R2010) for obtaining accurate field measurements at power line frequencies and calibrated by EMDEX, LLC, using methods like those described in IEEE Std. 644-2019. The measurements were taken and reported as the root mean square value of the field in accordance with IEEE Std. C95.3.1-2010 and IEEE Std. P644-2019. The calibration certificate for EMDEX II is included in Appendix D.

EMF Modeling

EMF levels were calculated using computer algorithms developed by the Bonneville Power Administration, an agency of the United States Department of Energy (BPA, 1991). These algorithms have been shown to accurately predict EMF levels measured near transmission lines. The electric fields and magnetic fields were calculated as the resultant of x, y, and z field vectors. Exponent calculated electric- and magnetic-field levels at 1 meter (m) (3.28 ft) above ground, in accordance with Institute of Electrical and Electronics Engineers (IEEE) Std. C95.3.1-2010 and IEEE Std. 644/-2019, as the root-mean-square value of the field ellipse at each location along a transect perpendicular to the transmission centerlines.

Data regarding voltage, current flow, phasing, and conductor configurations used to calculate EMF levels were provided by Gravel Pit Solar. The values of EMF associated with the transmission lines were calculated along profiles perpendicular to the transmission lines at the point of lowest conductor sag (mid-span), i.e., closest to the ground. The transmission line conductors were assumed to be positioned at maximum sag for the entire distance between structures and over flat terrain. An overvoltage condition of 5% was used for calculating electric fields from the transmission lines. These modeling assumptions are made to ensure that the calculated values represent the maximum expected EMF values for the cases analyzed.

Loading

Loading levels for the existing 1100 Line and 1200 Line were extracted from the Siemens System Impact Study (SIS) Report, prepared for ISO New England (Siemens PTI, 2020). Peak daily average (average) load levels were estimated based upon the Shoulder Load East-West and Shoulder Load West-East cases. Peak Load levels were determined from the Peak Load East-West 1, Peak Load East-West 2, and Peak Load West-East cases. The SIS did not provide information regarding the loading expected on the 1200 Line after the Project is put into service and so the full Project output (120 MW peak and 28.8 MW average) was assumed to flow on the 1200 Line towards Windsor Locks in one case and towards Barbour Hill in another case to conservatively overestimate the magnetic-field levels as a result of the Project whatever the direction of flow on Line 1200. The transmission line loadings used for calculations of the magnetic field are provided in Appendix B, Table B.2.

Results and Discussion

Measured EMF Levels

EMF levels measured on the ROW, beneath the existing transmission lines, were 1.1 kV/m or less and 27 mG or less, respectively. These values decreased to approximately 0.5 kV/m or less and 7 mG or less within 40 feet of the nearest transmission line conductor.

The EMF levels measured around other existing sources around the Project Site were in the vicinity of existing overhead distribution lines and are summarized in Table A.1 in Appendix A. The magnetic-field levels along Apothecaries Hall Road varied from 0.3 mG to 6.0 mG. The magnetic-field levels along Plantation Road varied from <0.1 mG to 3.4 mG.

Calculated EMF Levels

The line loadings used to calculate magnetic field levels from the existing transmission lines and the Project collector lines are included in Appendix A, Table A.2. The calculated pre- and post-Project electric-field levels, magnetic-field levels at average line loading, and magnetic-field levels at peak loading of the 115-kV transmission lines and 34.5-kV underground lines are summarized in Appendix B, Table B.1, Table B.2, and Table B.3, respectively. Appendix C includes graphic profiles of the calculated electric-field levels (Figure C1 and Figure C2) and magnetic-field levels at average loading (Figure C3 through Figure C6). The calculated EMF levels associated with the Project are far below international safety- and health-based standards for EMF.

XS-1 and XS-2 (Existing Transmission Line ROW)

In cross-sections XS-1 and XS-2, the electricity from GPS will not affect the voltage on the Line 1200 and therefore the electric field. The electric-field levels were calculated to be a maximum of 1.4 kV/m on the ROW and 0.6 kV/m or less at the edge of ROW. The injection of the full 120 MW power output of the Project on the 1200 Line changed the calculated magnetic field from the Line 1200 but the effect was different depending upon the assumed direction of power flow away from GPS. When power from the Project flows from GPS to Windsor Locks Hill, the magnetic field was calculated to be lower than in the case when Project power flows in the opposite direction to Barbour Hills. The latter load flow scenario was chosen to conservatively estimate the effect of the project on magnetic-field levels. For this conservative case, the magnetic-field levels post-construction were calculated to increase slightly above pre-construction levels. At the southern edge of the ROW closest to GPS, the calculated magnetic field increased from 7.3 to 16 mG for average loading and increased from 25 to 61 mG or less at the edge of ROW for peak loading. The change in the magnetic field level at the northern edge of the ROW was approximately 1 mG for average loading and 5 mG for peak loading.

XS-3 (Plantation Road Crossing)

In XS-3, the magnetic-field levels post-construction were calculated to be highest directly over the underground duct bank (4.2 mG average and 18 mG peak) decreasing rapidly with distance (1.3 mG average and 5.3 mG peak within 10 ft of the duct bank). These calculated magnetic-field levels are similar to the range of measured values along Plantation Road (<0.1 mG to 3.4 mG).

XS-4 (Ketch Brook/Railway Crossing)

In XS-4, the magnetic-field levels post-construction are somewhat higher than in XS-3 due to the higher loading on underground collector lines in this area; however, the magnetic field from the duct bank in XS-4 is more than 1,000 feet from the nearest residence. The highest magnetic-field level, directly over the underground duct banks (11 mG average and 44 mG peak) decrease rapidly with distance (3.2 mG average and 13 mG peak within 10 feet of the duct bank). Where the collector line passes beneath an existing pipeline that abuts the CT DOT ROW it would be buried far deeper and calculated field levels would be even lower than reported here.

Discussion

The calculated EMF levels associated with the Project are far below the exposure limits for the general public recommended by ICNIRP and ICES. The calculated electric-field levels along the transmission line ROW edges (XS-1 and XS-2) before or after the Project (0.6 kV/m or less), are at least 7 times lower than the recommended electric field exposure limit for the general public of either ICNIRP (4.2 kV/m) or ICES (5.0 kV/m). The calculated magnetic-field level along the southern transmission line ROW edge before or after the Project were 16 mG or less (at average loading), which is 125 times lower than either ICNIRP (2,000 mG) or ICES (9,040 mG) limits. At the northern edge of the ROW, the change in the magnetic field was much smaller. For XS-3 and XS-4, the magnetic-field levels immediately above the duct bank collector lines are 11 mG or less, also much lower than the ICNIRP and ICES guideline limits. The calculated magnetic-field levels are also similar to or lower than the levels typically measured in our homes and workplaces, as summarized in Figure 2; magnetic-field levels measured next to household appliances (such as a hair dryer or can opener) can be hundreds or thousands times higher than the levels calculated for this project. Exponent considers the Project as consistent with the CSC's EMF BMP for "no cost/low-cost" design because:

- The Project's solar arrays and related equipment will be far enough from the Project boundaries so that EMF off site would be negligible.
- The Project is proposed to be constructed immediately adjacent to, and tap into, an existing 115-kV transmission line. The line will not need to be reconductored or rebuilt as a result of the Project. No new transmission line will need to be constructed and the only changes to the local EMF environment will be from the change in load flow from the power added to the existing Line 1200 Line.
- The Project's connection to an existing transmission line is not expected to have any effect on the calculated EMF levels at the nearest residences (located north of the existing ROW along Apothecaries Hall Road).

Further, as demonstrated in this report, the requirements of the Renewable Energy Facility Application Guide for EMF have been met. To assess EMF from existing sources under pre-Project conditions [#18a], Exponent collected measurements around the boundaries of the proposed Project site. Exponent also calculated pre- and post-Project EMF levels at average and peak loading [#18a,b]. The Project's consistency with the CSC's EMF BMP [#18c] is described above.

Summary of EMF Health Research

Since the late 1970s, researchers have examined whether EMF from man-made sources can cause short- or long-term health effects in humans using a variety of study designs and techniques. This large amount of research has subsequently been reviewed by multidisciplinary scientific expert panels, assembled by national and international scientific and health organizations, to draw conclusions about EMF exposure in the general public. Organizations that have convened expert panels to conduct reviews of the EMF research include the International Agency for Research on Cancer (IARC, 2002), the National Radiological Protection Board (NRPB, 2004), the World Health Organization (WHO, 2007), the Health Council of the Netherlands (HCN, 2009), the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR, 2015), and the Swedish Radiation Safety Authority (SSM, 2016, 2018, 2019, 2020).

When conducting reviews of scientific research, the expert panels considered all the evidence on a particular issue in a systematic and thorough manner to evaluate whether the overall data presents a logically coherent and consistent picture. This is often referred to as a *weight-of-evidence review*, in which all research studies are considered together, giving more weight to studies of higher quality and using an established analytic framework to arrive at a conclusion about possibly causality between an exposure and disease. The weight-of-evidence review process helps to ensure that studies with a given result are not selectively chosen from the overall body of research to advocate for or suppress a preconceived idea of an adverse effect.

The reviews published by scientific and health organizations, including those listed above, have been consistent in their overall conclusions. None of the reviewing organizations have concluded that long-term exposure to EMF at the levels experienced in our everyday environment causes or contributes to adverse health effects in adults or children. The current guidance from the WHO on its website states that *"[b]ased on a recent in-depth review of the* *scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields"*.[3]

The only confirmed relationship between EMF exposure and adverse biological or health effects occurs at very high exposure levels to which neither electrical workers nor the general public could be exposed. If the current density or electric field induced by an extremely strong magnetic field exceeds a certain threshold, excitation of muscles and nerves is possible. Similarly, strong electric fields can induce charges on the surface of the body that can lead to small shocks (i.e., micro shocks). These short-term, acute effects cause no long-term damage or health consequences. As noted previously (see *Exposure Guidelines*), ICES and ICNIRP have developed recommended exposure guidelines for workers and the general public to protect against the occurrence of these effects.

Childhood Leukemia

The 2007 WHO report, and much of the subsequent research on EMF, has paid particular attention to childhood leukemia because of epidemiologic associations in some between this disease and high estimates of time-weighted average (TWA) magnetic-field levels.[4] The WHO report noted that *"[c]onsistent epidemiological evidence [i.e., differences in the estimated exposures of case and control children] suggests that chronic low-intensity ELF magnetic field exposure is [statistically} associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted"* (WHO, 2007, p. 355). The WHO concluded that reconciling the epidemiologic data on childhood leukemia and the absence of findings (i.e., no hazard or risk observed) in experimental studies through innovative research is currently the highest priority in the field of EMF research.

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3 https://www.who.int/peh-emf/about/WhatisEMF/en/index1.html

4 TWA is the average exposure over a given specified time period (i.e., an 8-hour workday or a 24-hour day) of a person's exposure to a chemical or physical agent.

The suggested weak statistical association between and childhood leukemia reported in some earlier studies has not been strengthened or substantially diminished by subsequent research, although the more recent and larger studies tend to show no overall associations with distance from power lines or measured or calculated magnetic fields (Sermage-Faure et al., 2013; Bunch et al., 2014, 2015, 2016; Amoon et al., 2018). Thus, the recent literature does not alter the previous conclusions of the WHO and other reviews that the epidemiologic evidence on magnetic fields and childhood leukemia is weak, inconsistent, and includes outstanding questions about study design or other methodological issues (WHO, 2007; HCN 2009; SCENIHR 2015; SSM 2020). The recent weight-of-evidence review released in 2015 by SCENIHR concluded that the epidemiological data on childhood leukemia and EMF exposure continued to *"prevent a causal interpretation"* and that *"no mechanisms have been identified and no support is existing from experimental studies that could explain these findings"* (SCENIHR, 2015, p. 7).

Conclusion

This report summarizes measurements and calculations of the EMF levels associated with the pre- and post-Project construction of a 120 MW AC solar photovoltaic system on approximately 485 acres of land in East Windsor, Connecticut. These calculations were performed using methods accepted within the scientific and engineering community and that have been found to match well with measured values.

Magnetic-field levels for the cross-sections XS-1 and XS-2 containing existing 115-kV transmission lines are low and will increase slightly as a result of the Project due to the addition of power to the 1200 Line; electric-field levels will be unchanged. Along the transmission line ROW edges, calculated electric- and magnetic-field levels before or after the Project are 0.6 kV/m and 16 mG (at average loading) or less, respectively. The short underground interconnection crossing Plantation Road (XS-3) will increase magnetic field levels within approximately 10 ft of the duct bank but even directly above the duct bank, field levels (4.2 mG) are similar to measured levels from existing sources (3.4 mG or less). In XS-4 (crossing Ketch Brook/Railway) field levels above the duct bank are higher (11 mG or less at average loading) but this portion of the project is more than 1,000 feet from the nearest residence and would not affect field levels at residences. The EMF levels on site from the Project sources will decrease rapidly with distance such that at the Project Site's boundary, the field levels are expected to be negligible.

The calculated EMF levels associated with the Project are far below international safety- and health-based standards for EMF. For the existing transmission lines, the calculated electric-field levels along the transmission line ROW edges (XS-1 and XS-2) before or after the Project are at least 7 times lower than the ICNIRP/ICES electric field exposure limits for the general public. Calculated magnetic-field levels along the transmission line ROW edges before or after the Project are at least 125 times lower than the ICNIRP/ICES limits.

For the new Project collector lines in XS-3 and XS-4, the magnetic-field levels immediately above the duct bank are 11 mG or less, also much lower than the ICNIRP and ICES guideline limits. The engineering design and other activities initiated by Gravel Pit Solar demonstrate compliance with the CSC's EMF BMPs and Renewable Energy Facility Application Guide.

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Appendix A

Measured
Electric and Magnetic Fields
and Power Line Loadings

Table A.1. Measurements of existing magnetic field levels (mG) along nearby roads

Measurement Path	Min	Mean	Max
Apothecaries Hall Road – North Side	0.5	1.7	5.0
Apothecaries Hall Road – South Side	0.3	2.3	6.0
Plantation Road – North Side	0.0	0.4	3.1
Plantation Road – South Side	0.0	0.7	3.4

Table A.2. Loading levels for magnetic-field calculations

Line	**Voltage (kV)**	**Condition**	**Average**		**Peak**	
			MW	**MVAR**	**MW**	**MVAR**
1100 Line	115	Existing	20.2	7.5	56.6	14.5
		Proposed	20.2	7.5	56.6	14.5
1200 Line*	115	Existing	15.5	8.4	61.5	16.5
		Proposed	44.3	14.5	181.5	41.8
Collector Line (Plantation Rd Crossing)	34.5	Proposed	8.2	0**	34.2	0**
Collector Line (Ketch Brook Crossing/CT DOT ROW)	34.5	Proposed	20.6	0**	85.9	0**

* The primary existing load flow direction is from Windsor Locks to Barbour Hill. The full 120 MW power output of the Project was modeled to flow either to Barbour Hill or in the other direction to Windsor Locks s. The scenario of power flow from GPS toward Windsor Locks (i.e., a reversal in the existing direction of bulk load flow) resulted in lower magnetic-field levels than for the scenario in which the Project power flows in the same direction as the existing level (i.e., GPS toward Barbour Hill.

** Calculated EMF levels for the collector lines will not depend on the power factor (i.e., MVAR) and all power has been assumed to be MW.

Appendix B

Calculated Levels of Electric and Magnetic Fields

Table B.1. Electric-field levels (kV/m) at 1 meter above ground

Section	Description	Configuration	100 feet from –ROW edge	edge of –ROW	Max on profile	edge of +ROW	100 feet from +ROW edge
XS-1	Windsor Locks Substation to GPS	Existing	< 0.1	0.1	1.4	0.6	< 0.1
		Proposed	< 0.1	0.1	1.4	0.6	< 0.1
XS-2	GPS to Barbour Hill Substation	Existing	< 0.1	0.1	1.4	0.6	< 0.1
		Proposed	< 0.1	0.1	1.4	0.6	< 0.1

Table B.2. Magnetic-field levels (mG) at 1 meter above ground at average loading

Transmission Lines

Section	Description	Configuration	100 feet from –ROW edge	edge of –ROW	Max on profile	edge of +ROW	100 feet from +ROW edge
XS-1*	Windsor Locks Substation to GPS	Existing	0.6	2.0	21	7.3	1.0
		Proposed	0.9	3.1	45	16	1.9
XS-2	GPS to Barbour Hill Substation	Existing	0.6	2.0	21	7.3	1.0
		Proposed	0.9	3.1	45	16	1.9

Collector Lines

Section	Description	Configuration	–100 feet	–10 feet	Max on profile	+10 feet	+100 feet
XS-3	Connecting Southern and Central Arrays	Proposed	<0.1	1.3	4.2	1.3	<0.1
XS-4	Connecting Central and Northern Arrays	Proposed	<0.1	3.2	11	3.2	<0.1

* Field levels presented calculated assuming full load flow adds to the existing load. Calculations for the case that the injection of 120 MW causes the bulk power flow to reverse direction are lower and so not presented.

Table B.3. Magnetic-field levels (mG) at 1 meter above ground at peak loading

Section	Description	Configuration	100 feet from –ROW edge	edge of –ROW	Max on profile	edge of +ROW	100 feet from +ROW edge
XS-1	Windsor Locks Substation to GPS	Existing	1.7	6.1	62	25	3.2
		Proposed	3.2	11	179	61	7.2
XS-2	GPS to Barbour Hill Substation	Existing	1.7	6.1	62	25	3.2
		Proposed	3.2	11	179	61	7.2
Section	**Description**	**Configuration**	**-100 feet**	**-10 feet**	**Max on profile**	**+10 feet**	**+100 feet**
XS-3	Connecting Southern and Central Arrays	Proposed	0.1	5.3	18	5.3	0.1
XS-4	Connecting Central and Northern Arrays	Proposed	0.2	13	44	13	0.2

Appendix C

Graphical Profiles of Calculated Electric and Magnetic Fields

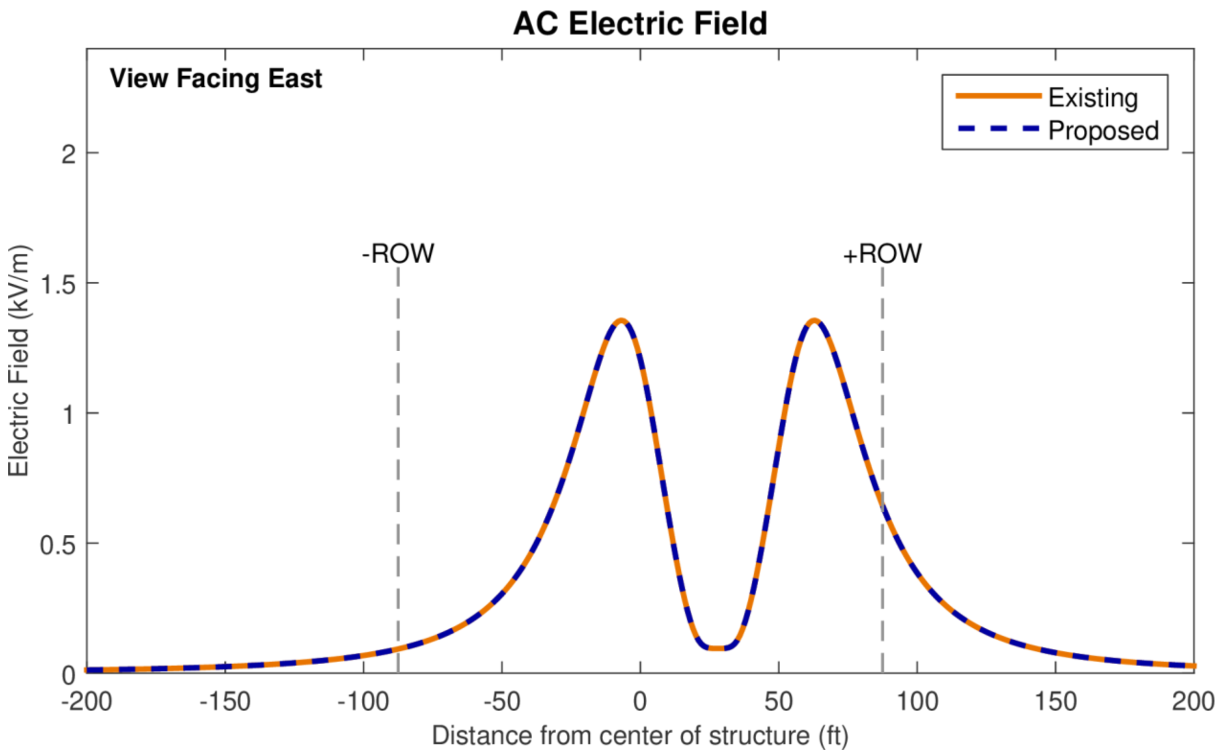

Figure C1. Calculated electric-field profile for pre-Project and post-Project configurations of 115-kV transmission lines in XS-1 (Line 1100 at left; Line 1200 at right).

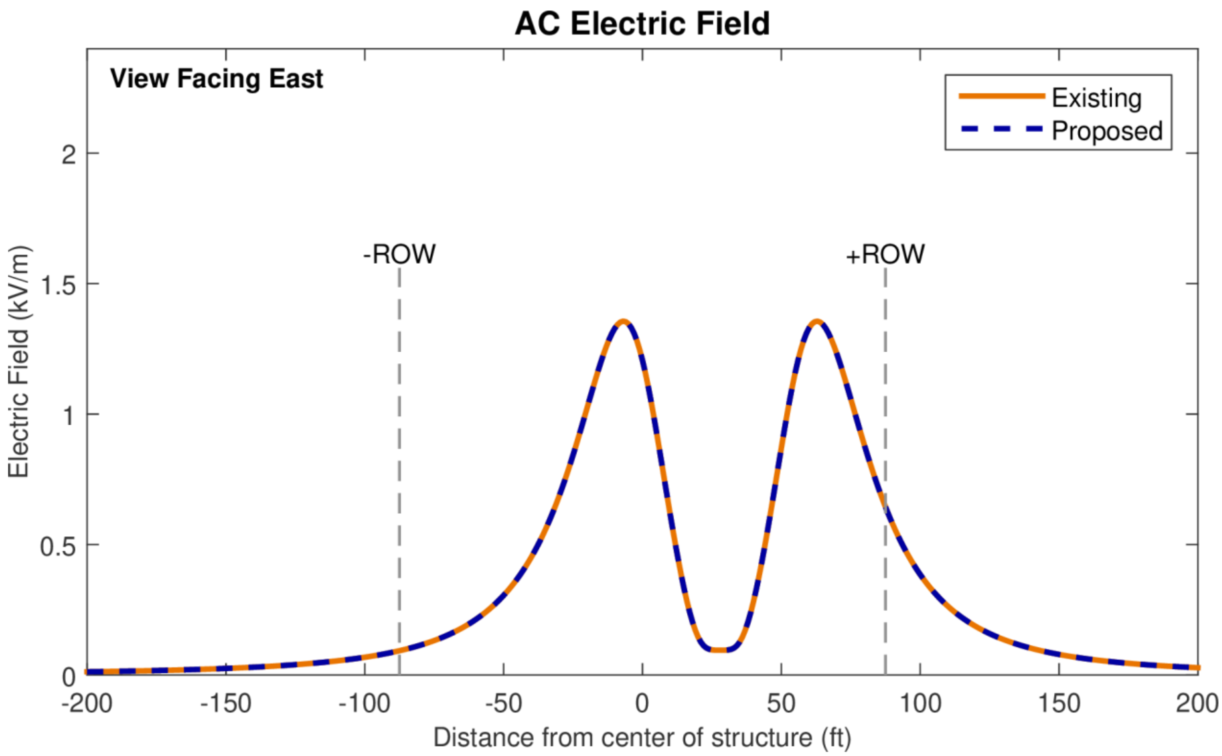

Figure C2. Calculated electric-field profile for pre-Project and post-Project configurations of 115-kV transmission lines in XS-2 (west of the substation) (Line 1100 at left; Line 1200 at right).

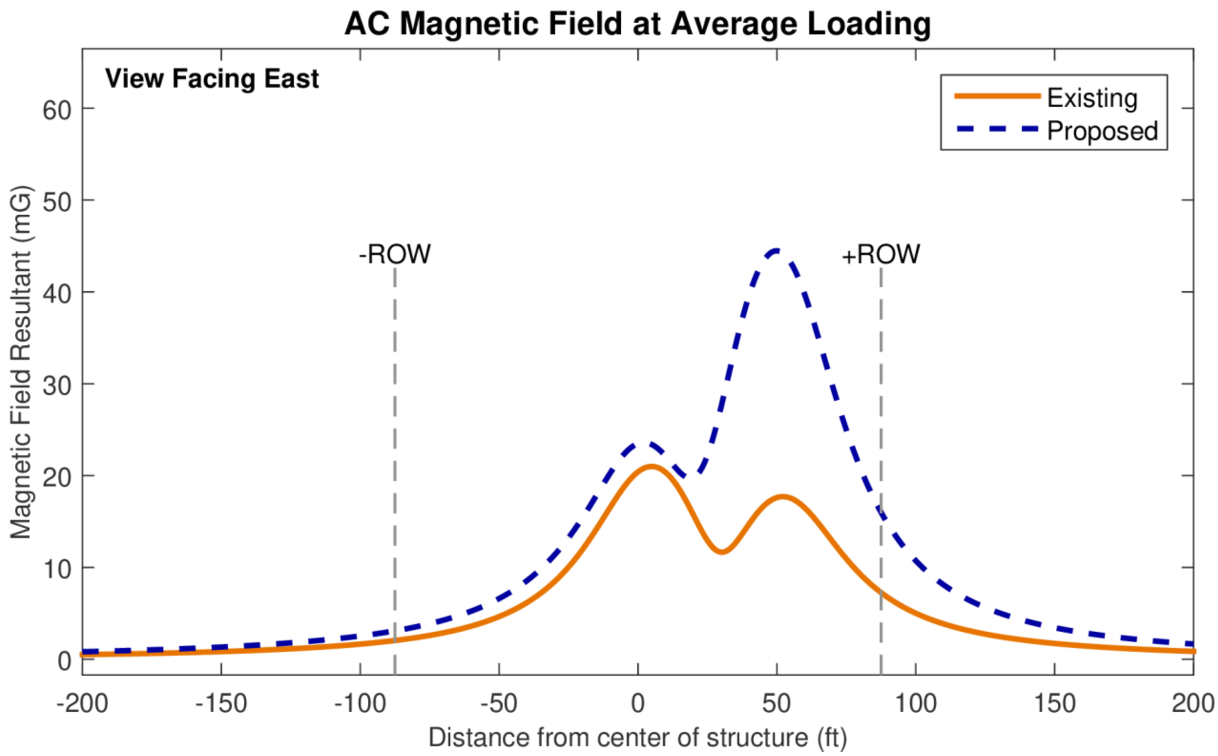

Figure C3. Calculated AC magnetic-field profile at average loading for pre-Project (existing) and post-Project (proposed) configurations of 115-kV transmission lines in XS-1 (Line 1100 at left; Line 1200 at right).

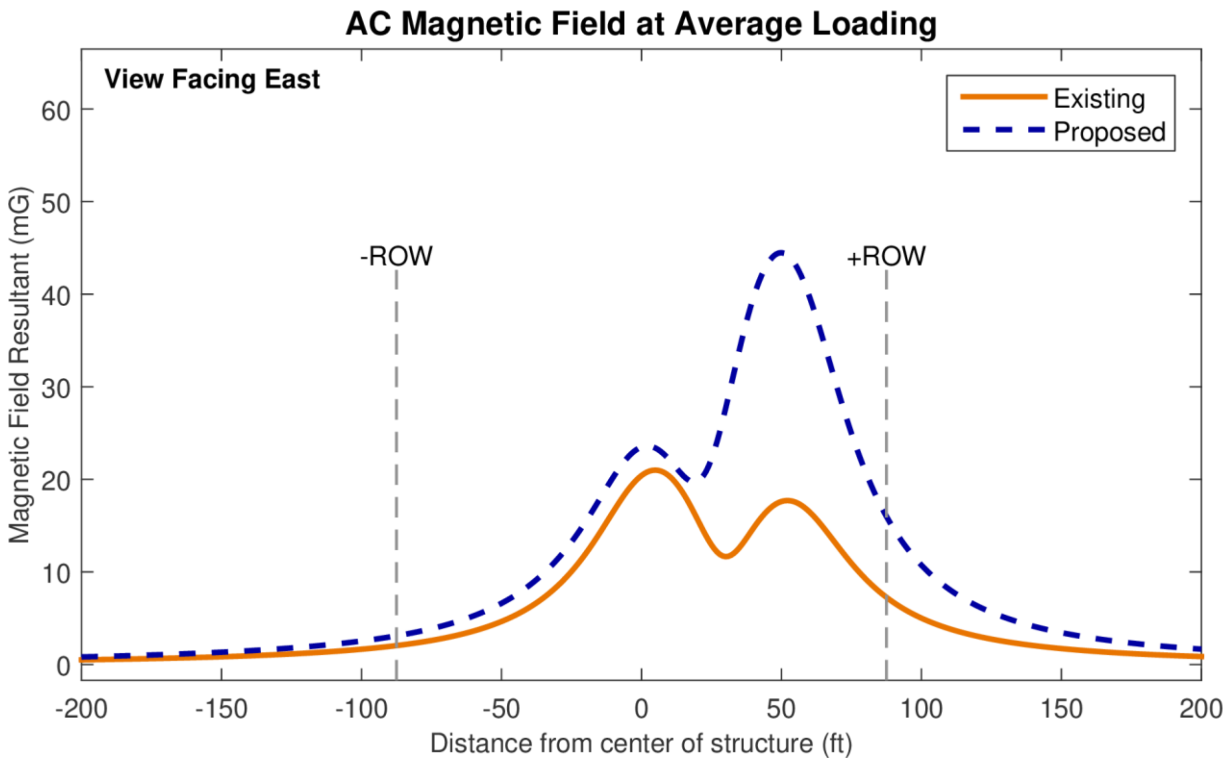

Figure C4. Calculated AC magnetic-field profile at average loading for pre-Project (existing) and post-Project (proposed) configurations of 115-kV transmission lines in XS-2 (Line 1100 at left; Line 1200 at right).

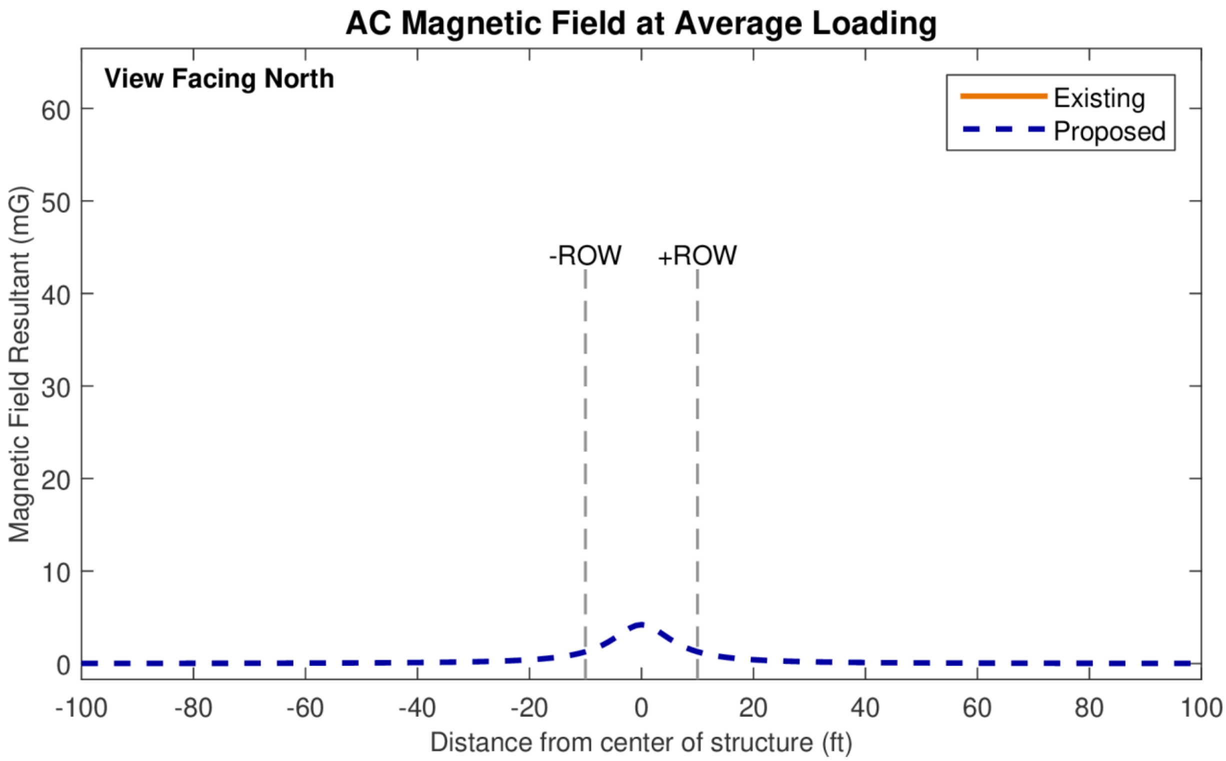

Figure C5. Calculated AC magnetic-field profile at average loading for post-Project configuration of underground 34.5-kV line at the Planation Road Crossing in XS-3.

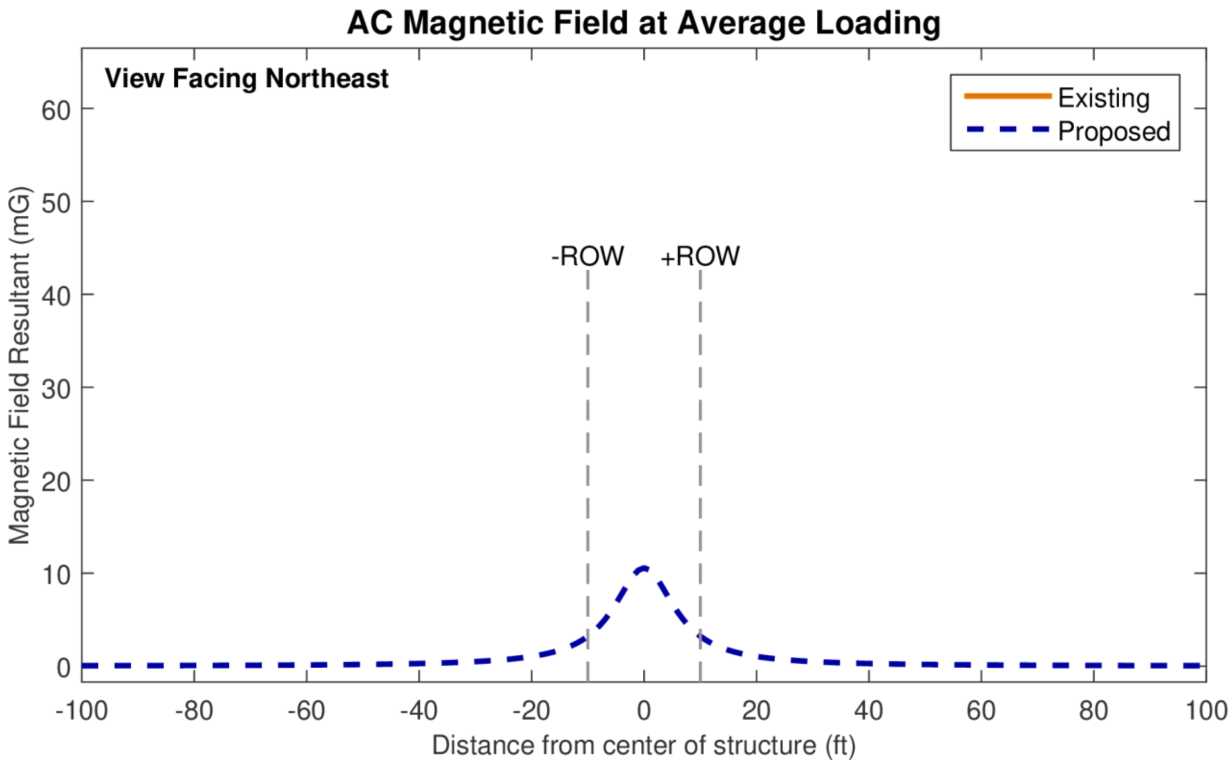

Figure C6. Calculated AC magnetic-field profile at average loading for post-Project configuration of underground 34.5-kV line connecting central and northern arrays to the Substation and Switchyard in XS-4.

Appendix D

EMDEX II Calibration Certificate

Certificate of Calibration

The calibration of this instrument was controlled by documented procedures as outlined on the Certificate of Testing Operations and Accuracy Report using equipment traceable to N.I.S.T., ISO/IEC 17025:2017(E), and ANIZ540-1 COMPLIANT.

Instrument Model: EMDEX II - Standard

Frequency: 60 Hz

Serial Number: 1134

Date of Calibration: 01/16/2020

Re-calibration suggested at one year from above date.

Calibration Inspector: H. Christopher Hooper

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