Sunrise Wind Farm Project

Appendix J2
Onshore EMF Assessment

Prepared for:

Sunrise Wind | Powered by Ørsted & Eversource

August 23, 2021

Revision 1 – October 28, 2021

Revision 2 – August 19, 2022

Onshore DC and AC Magnetic-Field Assessment

Sunrise Wind Farm Project

Prepared for: Sunrise Wind LLC

Prepared by: Exponent Engineering P.C.

August 2022

REVISION HISTORY

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Contents

List of Tables

List of Figures

Acronyms and Abbreviations

µT	Microtesla
A	Ampere
AC	Alternating current
cm	Centimeter
DC	Direct current
Eversource	Eversource Investment LLC
Exponent	Exponent Engineering PC
ft	Feet
GCC	Ground continuity conductor
HDD	Horizontal directional drilling
Hz	Hertz
ICD	Implantable cardioverter defibrillator
ICES	International Committee on Electromagnetic Safety
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
km	Kilometer
kV	Kilovolt
kV/m	Kilovolt per meter
Lease Area	Renewable Energy Lease Area OCS-0487
LIPA	Long Island Power Authority
m	Meter
mi	Mile
mG	Milligauss
mm	Millimeter
nm	Nautical mile
nT	Nanotesla
NY	New York
OCS–DC	Offshore Converter Station (direct current electrical technology)
OD	Outer diameter
OnCS–DC	Onshore Converter Station (direct current electrical technology)
Orsted NA	Orsted North America, Inc.
PDE	Project design envelope
Project	Sunrise Wind Farm Project
PVC	Polyvinyl chloride
SRWEC	Sunrise Wind Export Cable
SRWF	Sunrise Wind Farm
Sunrise Wind	Sunrise Wind LLC
TJB	Transition joint bay
XLPE	Cross-linked polyethylene

Limitations

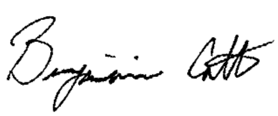
At the request of TRC Environmental Corporation (TRC) and Sunrise Wind LLC (Sunrise Wind), Exponent Engineering PC (Exponent) modeled the alternating current and direct current magnetic fields and induced electric fields associated with the operation of the onshore cables proposed for the Sunrise Wind Offshore Wind Farm Project (the Project).

This report summarizes the analysis performed to date and presents the findings resulting from that work. In the analysis, we have relied on cable design geometry, usage, specifications, and various other types of information provided by TRC and Sunrise Wind. We cannot verify the correctness of this input data and rely on TRC and Sunrise Wind 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. TRC has confirmed to Exponent that the data contained herein are not subject to Critical Energy Infrastructure Information restrictions.

The analyses 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, and any re-use of this report or its findings, conclusions, or recommendations presented herein for purposes other than for project permitting 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.

Benjamin R.T. Cotts, Ph.D., P.E. (Licensed Electrical Engineer, New York, #103209), employed by Exponent, performed and reviewed calculations of the electric and magnetic fields associated with the operation of the proposed Project.



Benjamin Cotts, Ph.D., P.E.

Executive Summary

Orsted North America Inc. (Orsted NA) and Eversource Investment LLC (Eversource) have proposed the Sunrise Wind Farm Project (the Project) to be located off Rhode Island and Long Island, New York. The electricity generated by the Project will be brought to shore over direct current (DC) submarine cables and then delivered by an underground Onshore Transmission Cable to the Onshore Converter Station (OnCS–DC). At the OnCS–DC, the electricity is converted to 60 Hertz (Hz) alternating current (AC) at 138 kilovolts for transmission over the underground Onshore Interconnection Cable to the existing Holbrook Substation in the Town of Brookhaven, New York. At the request of TRC Environmental Corporation (TRC) and Sunrise Wind LLC (Sunrise Wind), Exponent Engineering PC (Exponent) calculated the DC and AC magnetic fields associated with the operation of these onshore underground cables.

The Onshore DC Transmission Cable will produce a DC magnetic field that will, in turn, produce a local change in the Earth's geomagnetic field in the area immediately surrounding the cable. The resulting deviations from the Earth's ambient geomagnetic field and compass deflections will diminish rapidly with distance. The highest total magnetic field from the cable at 3.3 feet (ft) (1 meter [m]) above ground at average loading is 653 milligauss (mG), and at peak loading is 780 mG, which reflects the contribution from the ambient geomagnetic field of 506 mG and a maximum increase from the DC cables of 147 mG and 275 mG for average and peak loading, respectively. Elsewhere on the Onshore Transmission Cable route, the cables are calculated to reduce the ambient geomagnetic field to a minimum of 360 mG and 236 mG for average and peak loading, respectively, which reflects the contribution from the ambient geomagnetic field of 506 mG and respective reductions of 146 mG and 270 mG. Over the few tens of feet where cables are separated from one another at the Transition Joint Bay, DC magnetic-field levels will be higher, but also decrease rapidly with distance, deviating from the ambient geomagnetic field by 99 mG or less at ±25 ft (7.6 m) from the cables at 3.3 ft (1 m) above ground.

The calculated DC magnetic-field levels are far below the International Commission on Non-Ionizing Radiation Protection's standard for human exposure to static (i.e., DC) magnetic fields (i.e., < 0.1 percent of the general public exposure limit of 4,000,000 mG) for all cable configurations evaluated. The highest calculated magnetic field is also well below the applicable medical device standard of 10,000 mG for exposure of implanted medical devices to static magnetic fields.

These calculated AC magnetic fields are well below the New York State Public Service Commission's limit of 200 mG from 60-Hz magnetic fields from new transmission lines at right-of-way edges.

The DC and AC magnetic-field levels within the OnCS–DC were not calculated, since fields from sources within will be minimal outside the boundaries of the OnCS–DC. The dominant sources of magnetic fields at the perimeter of the OnCS–DC will be the new underground Onshore Transmission Cable and the new underground Onshore Interconnection Cable.

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 at all times the controlling document.

1.0 Introduction

1.1 Project Description

Sunrise Wind LLC (Sunrise Wind), a 50/50 joint venture between Orsted North America Inc. (Orsted NA) and Eversource Investment LLC (Eversource), proposes to construct, own, and operate the Sunrise Wind Farm Project (the Project) in federal waters on the outer continental shelf in the designated Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A 0487 (Lease Area).[1] The Lease Area is approximately 18.9 statute miles (mi) (16.4 nautical miles [nm]; 30.4 kilometers [km]) south of Martha's Vineyard, Massachusetts; approximately 30.5 mi (26.5 nm; 48.1 km) east of Montauk, New York (NY); and 16.7 mi (14.5 nm; 26.8 km) from Block Island, Rhode Island. Components of the Project will be located in federal waters on the outer continental shelf, in state waters of NY, and onshore in the Town of Brookhaven, Long Island, NY. The proposed interconnection termination will be the existing Holbrook Substation, which is owned and operated by the Long Island Power Authority.

The electricity generated by the offshore wind turbines will be converted to direct current (DC) for transmission to shore over the ±320 kilovolt (kV) Sunrise Wind Export Cable (SRWEC). Near landfall, the submarine cables enter conduits installed by horizontal directional drilling (HDD). For a short distance at the landfall location, the SRWEC will be installed in a duct bank configuration (i.e., the SRWEC–Transition) before connecting to the underground Onshore Transmission Cable at transition joint bays (TJB). The Onshore Transmission Cable will connect the TJBs to the Onshore Converter Station (OnCS–DC) where the DC power will be converted to 60-Hertz (Hz) alternating current (AC) for transmission over a 138-kV AC Onshore Interconnection Cable to the Holbrook Substation. Exponent evaluated the magnetic fields associated with each of the onshore Project components:

- The SRWEC–Transition along a short transition segment at landfall;[2]
- The TJB where the cables of the SRWEC will separate to prepare for splicing;[3]
- The Onshore Transmission Cable between TJBs and the OnCS–DC; and,
- The Onshore Interconnection Cable between the OnCS–DC and the existing Holbrook Substation.[4]

Figure 1 provides an overview of the routes of the Onshore Transmission and Interconnection Cables.

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1 A portion of Lease Area OCS-A 0500 (Bay State Wind LLC) and the entirety of Lease Area OCS-A 0487 (formerly Deepwater Wind New England LLC) were assigned to Sunrise Wind LLC on September 3, 2020, and the two areas were merged and a revised Lease OCS-A 0487 was issued on March 15, 2021. Thus, when using the term Lease Area within this COP, Sunrise Wind is referring to the new merged Lease Area OCS-A 0487.

2 For a distance of approximately 100 ft (30 m) between the HDD installation and the TJB, the SRWEC will be installed in a duct bank configuration wherein the two conductors will be separated by 16 inches between conductor centers.

3 Over a few tens of feet at the TJB, the cables of the SRWEC will separate to facilitate installation and allow each cable to bend to prepare for splicing to the Onshore Transmission Cable. Two design options are evaluated for the TJB—one in which the two cables are separated vertically from one another and one in which they are separated horizontally from one another.

4 The fields associated with the operation of the OnCS–DC itself were not calculated because the strongest fields at the site boundary will come from the lines connecting to this type of facility as described in Institute of Electrical and Electronic Engineers Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility (IEEE Std. 1127-2013). New York: IEEE, 2013.

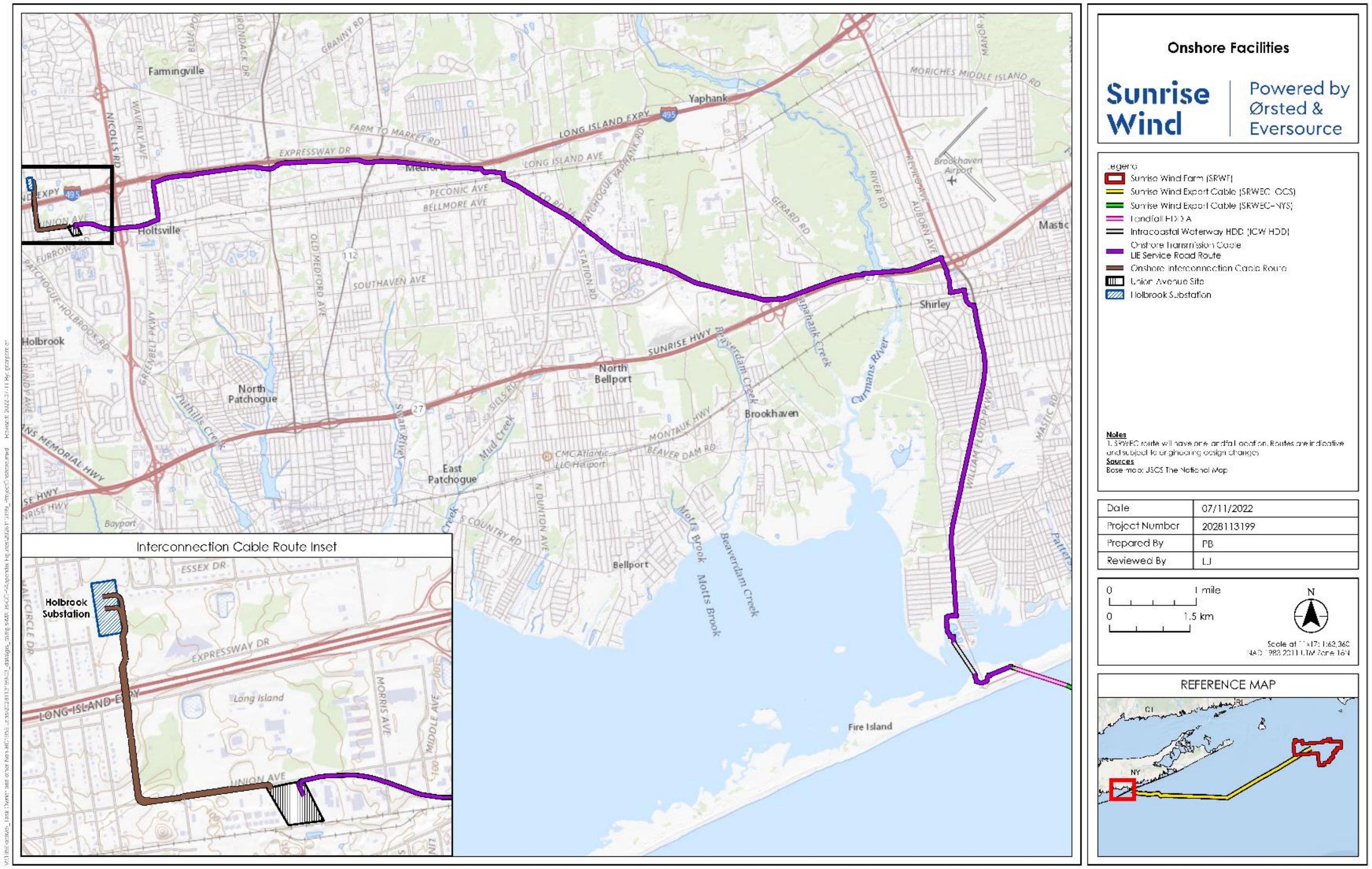

Figure 1. Overview of the proposed onshore facilities.

A range of onshore Project design and routing alternatives are being considered to allow for assessments of proposed activities and the flexibility to make development decisions prior to construction. The Project design envelope (PDE) involves scenarios with potential magnetic-field effects that are associated with onshore Project infrastructure. This onshore magnetic-field assessment considers the information available at this time; the precise locations and schedule of the construction and operation scenarios may be subject to change as the engineering design progresses.

The Onshore Transmission Cable and Onshore Interconnection Cable will be the dominant sources of magnetic fields above ground. This report presents the calculated 0-Hz DC (i.e., static) magnetic field associated with the Onshore Transmission Cable and the calculated 60-Hz AC magnetic field associated with the Onshore Interconnection Cable.[5]

An assessment of the magnetic fields and induced electric fields in the marine environment associated with the operation of offshore elements of the Project is provided in the companion report, *Offshore DC and AC Electric- and Magnetic-Field Assessment* (Exponent 2022a). An additional report for the regulatory permitting of the cables in NY, titled *Sunrise Wind Magnetic-Field Assessment in New York* (Exponent 2022b) has been provided to the New York Department of Public Service in compliance with requirements of Article VII projects in NY.

1.2 Technical Background

1.2.1 DC and AC Magnetic-Fields

Magnetic fields associated with electricity flowing on the Onshore Transmission Cable and Onshore Interconnection Cables are reported as magnetic flux density in units of milligauss (mG), where 1 Gauss is equal to 1,000 mG. In some countries and in some technical literature, magnetic fields may be reported as microtesla (µT), where 1 mG is equal to 0.1 µT.

The Onshore Transmission Cable will generate a static DC magnetic field like the static geomagnetic field of the Earth, and the Onshore Interconnection Cable will generate an AC magnetic field for which the direction oscillates 60 times each second (i.e., a frequency of 60 Hz). These magnetic fields differ in their interactions with organisms and the environment, so are calculated and evaluated separately.

The Earth's geomagnetic field (used for compass navigation) is ubiquitous. As noted, the Earth's geomagnetic field is a static magnetic field, meaning that it does not vary substantially in strength or direction with time. The DC magnetic field generated by the Onshore Transmission Cable will combine via vector addition with the Earth's geomagnetic field (i.e., the DC field from the Onshore Transmission Cable may increase or decrease the magnitude of the local geomagnetic field and its direction near the cable).

The voltage applied to the conductors within the both the Onshore Transmission Cable and Onshore Interconnection Cable creates an electric field, but it will not be a direct source of any electric field above ground due to the cable construction, the duct bank, and burial underground, so above-ground electric fields are not discussed further in this report.

5 The calculated DC magnetic field associated with the SRWEC where installed in the Transition Duct Bank and where the SRWEC cables are separated within the TJB are also presented in this report. However, these Project components make up only a small fraction of the onshore cable route.

The magnetic-field levels for both the Onshore Transmission Cable and the Onshore Interconnection Cable, around the Onshore Interconnection Cable's conductors, will vary depending on the magnitude of the electrical current—expressed in units of amperes (A)—that flows through the cables. Since current on the conductors will vary with varying power generation (dependent upon the speed of the wind and operational status), measurements or calculations of these fields represent only a snapshot of conditions at one moment in time. On a given day, throughout a week, or over the course of months or years, the magnetic-field and induced electric-field levels also will vary. To account for this variability, calculations were performed for annual average load and for the peak load generated by the Project, which will produce the average and maximum field levels expected for the proposed Project.

1.2.2 Guidelines for Human Exposure to DC Magnetic Fields

There is no federal standard for exposure to magnetic fields from DC transmission lines. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) recommends a limit of 4,000,000 mG for general public exposure, not including persons with implantable medical devices, such as pacemakers or implantable cardiac defibrillators (ICD) (ICNIRP 2009). For individuals with implanted medical devices, the standard from the Association for the Advancement of Medical Instrumentation (ISO/ANSI/AAMI 14117:2019) specifies that pacemaker and ICD functions should not be affected when exposed to DC magnetic fields less than 10,000 mG. Exposure of these devices to magnetic fields up to 500,000 mG should not affect functions after discontinuation of exposure (ISO 2019).

1.2.3 Guidelines for Human Exposure to AC Magnetic Fields

The federal government has not enacted any limits for electric fields or magnetic fields from land- or marine-based AC cables or other sources of 60-Hz fields.[6] The World Health Organization recommends that countries follow limits on human exposure to AC electric fields and magnetic fields, such as those developed by two international organizations—the International Committee on Electromagnetic Safety (ICES) and ICNIRP. ICES operates "under the rules and oversight of the Institute of Electrical and Electronics Engineers (IEEE) Standards Association Board,"[7] and developed an exposure reference level limit to 60-Hz magnetic fields of 9,040 mG for the general public (ICES 2019). ICNIRP, an independent organization that provides scientific advice and guidance on health and environmental effects of non-ionizing radiation, determined a reference level limit of 2,000 mG for whole-body exposure to 60-Hz magnetic fields (ICNIRP 2010). These limits are the result of extensive review and evaluation of relevant research of health and safety issues, and the limits they propose are designed to protect the health and safety of persons in an occupational setting and for the general public. The electric fields induced by AC magnetic fields from the Onshore Interconnection Cable are roughly one million times lower than limits recommended by either ICES or ICNIRP for electric-field exposure, so human exposure to electric fields is not addressed further.

For individuals with implanted medical devices (such as pacemakers or ICDs), the European Committee for Electrotechnical Standardization (CENELEC) has recommended a not-to-exceed reference level of 1,000 mG for magnetic fields (CENELEC 2010).

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[6] While NY has guidelines for electric fields and magnetic fields from new AC transmission lines; these are addressed in a separate report regarding Article VII compliance, titled *Sunrise Wind Magnetic-Field Assessment in New York* (Exponent 2022b).

[7] http://www.ices-emfsafety.org/.

2.0 Transmission Cable Configurations and Calculation Methods

The configurations of the Onshore cables used to calculate the magnetic fields are described in Attachment A and calculation methods are detailed in Attachment B. The DC and AC fields from the equipment within the OnCS–DC and Holbrook Substation are not included in this report since the highest magnetic-field levels around the perimeter of these facilities will be due to the Onshore Transmission Cable and Onshore Interconnection Cable entering and exiting the substation. This is consistent with IEEE Standard 1127, which notes:

> In a substation, the strongest fields near the perimeter fence come from the transmission and distribution lines entering and leaving the substation. The strength of fields from equipment inside the fence decreases rapidly with distance, reaching very low levels at relatively short distances beyond substation fences (IEEE 2013).

2.1 DC Project Cables

The Onshore DC Transmission cable represents the majority of the onshore portion of the Project route with short distances described by the SRWEC–Transition and TJB configurations.

2.1.1 DC Onshore Transmission Cable

The Onshore Transmission Cable will consist of two conductors encased in cross-linked polyethylene (XLPE), each installed in a separate 8-inch (20-centimeter [cm]) polyvinyl chloride (PVC) conduit. Over the majority of the onshore route, the Onshore Transmission Cable will be installed in an underground duct bank as shown in Attachment A, Figure A-1. For short portions of the route, the Onshore Transmission Cable will be installed in a trenchless configuration shown in Attachment A, Figure A-2. A summary of DC modeling parameters is provided in Attachment A, Table A-1.

2.1.2 SRWEC–Transition

The SRWEC–Transition configuration is a short segment (approximately 100 ft [30 m]) of onshore duct bank between the termination of the HDD installation and the TJB. The configuration of this duct bank is the same as the duct bank installed elsewhere along the onshore portion and will be buried to a depth of 3 ft (0.9 m), as measured from ground level to the top of the concrete duct bank. The conductors will be separated by a distance of 16-inches center-to-center, as shown in Attachment A, Figure A-1. The magnetic field from the model of the SRWEC–Transition was calculated for one geographic direction of the duct bank and current flow in each direction. The DC model parameters are provided in Attachment A, Table A-2.

2.1.3 SRWEC at TJB

The cables of the SRWEC will be separated for a short segment (a few tens of feet) at the TJB. There are two design options currently under consideration for the TJB. In one configuration the two cables of the SRWEC are separated vertically from one another and in the second configuration the two cables of the SRWEC are separated horizontally from one another, as shown in Attachment A, Figure A-3. Each of these configurations was modeled for one geographic direction and for current flow in each direction at one burial depth. A summary of DC modeling parameters is provided in Attachment A, Table A-2.

2.2 DC Cable Magnetic-Field Modeling Methods

The total DC magnetic field near the SRWEC depends on the magnitude and direction of the cables and the strength and direction of the Earth's ambient geomagnetic field (from the International Geomagnetic Reference Field [IGRF-13] Model).[8] The static magnetic field from the DC current was calculated by the application of the Biot-Savart Law, which was added to the earth's geomagnetic-field vector to obtain the total magnetic field. Further discussion regarding magnetic-field strength and compass deflection is included in Attachment B.

2.3 AC Project Cables

2.3.1 AC Onshore Interconnection Cable

At the OnCS–DC, the electricity will be converted from DC to 138-kV AC for transmission to the point of interconnection at the Holbrook Substation. The 138-kV Onshore Interconnection Cable will be installed in twin duct banks, separated by a typical edge-to-edge distance of 20 ft (6.1 m) (as shown in Attachment A, Figure A-5).[9] Each duct bank will house a single-circuit comprising six single-core XLPE cables, two for each phase (shown in Attachment A, Figure A-4). The XLPE-covered cables in each duct bank will be installed in separate 8-inch (20-cm) PVC conduits. A summary of the input data used in the AC modeling is provided in Attachment A, Table A-3.

2.4 AC Cable Modeling Methods for Magnetic Fields

Exponent calculated the magnetic-field levels for the Onshore Interconnection Cable using the commercial software package COMSOL MultiPhysics Version 5.5, which is a finite element analysis, solver, and simulation software suite. Calculations were performed using conservative assumptions designed to ensure that the calculated levels overestimate the field levels that would be measured above the cables at any specified loading. Further discussion regarding AC magnetic-field calculations is included in Attachment B.

[8] https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php.

[9] Although the separation between duct banks will be as small as 10 ft (3 m) for short distances along Union Avenue (far from any residences), the maximum magnetic-field values were calculated to be higher for duct banks separated by 20 ft (6 m), and thus this dominant configuration represents a more conservative estimate of magnetic-field values.

3.0 Calculated Magnetic Fields

3.1 DC Magnetic Fields

For the Onshore Transmission Cable, SRWEC–Transition, and the TJB, the total DC magnetic field from the cable and the Earth's ambient geomagnetic field of 506 mG were evaluated together. The deviation from the Earth's ambient geomagnetic field also was evaluated.

3.1.1 Onshore Transmission Cable

At the DC duct bank, the highest calculated total magnetic field at 3.3 ft (1 m) above ground at average loading is 653 mG, which reflects the contribution from the ambient geomagnetic field of 506 mG and a maximum change of 147 mG from the DC cables (where the DC duct bank is installed in an east-west direction). Elsewhere on the Onshore Transmission Cable route, the DC fields are calculated to reduce the ambient geomagnetic field to a minimum of 360 mG (a reduction of about 146 mG). These maximum deviations (both increases and decreases) occur close to the duct bank and decrease rapidly with distance. At 10 ft (3 m) from the DC duct bank, the total magnetic field is within about 10 percent of background levels (i.e., a deviation of 37 mG or less). An example graphic for the duct bank traveling in the east-west direction is shown below in Figure 2.

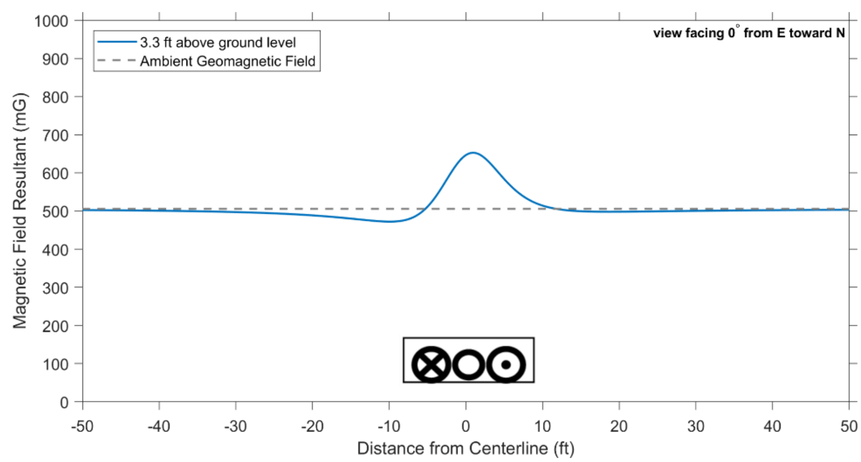

Figure 2. Total magnetic field at average loading for the Onshore Transmission Cable.

Calculations are shown for a configuration oriented along an east-west direction, at a height of 3.3 ft (1 m) above ground for a DC duct bank configuration. The current polarity is indicated by the inset figure at the bottom-center of the plot.

Magnetic-field deviations at peak loading will be larger—reducing or increasing the total magnetic field by at most -270 mG to 275 mG, respectively, but falling to -59 to 70 mG at a distance of 10 ft (3 m) from the DC duct bank, which is about a 15 percent change from background levels. Detailed calculated magnetic-field values at average loading are summarized in Attachment C, Table C-1, Table C-2, and Table C-6; calculations at peak loading are summarized in Attachment C, Table C-7.

Where the Onshore Transmission Cable is installed in a trenchless configuration, the DC magnetic-field levels (and deviations) are much lower due to the greater burial depth; a maximum deviation from the ambient geomagnetic field is calculated to be approximately 44 mG relative to the Earth's ambient geomagnetic field at average loading. For peak loading, this calculated maximum deviation is approximately 83 mG. Graphical results for all configurations are shown in Attachment C, Figure C-1 to Figure C-7.[10] The results of the deviation from the Earth's ambient geomagnetic field at average loading for both Duct Bank and Trenchless configurations are shown in Table 1.

Table 1. Calculated DC magnetic-field deviations from the Earth's ambient geomagnetic field of 506 mG evaluated at various horizontal distances 3.3 ft (1 m) above ground and at average loading

Configuration*	DC Magnetic Fields (mG)					
	–25 ft (–7.6 m)	–10 ft (–3 m)	(+) Max	(–) Max	+10 ft (+3 m)	+25 ft (+7.6 m)
DC Duct Bank	-12 to 12	-34 to 37	20 to 147	-146 to -18	-29 to 33	-11 to 11
DC Trenchless†	-6.3 to 6.4	-8.4 to 9.3	5.8 to 44	-44 to -5.6	-10 to 11	-6 to 6

* As shown in Attachment B, the deviation from the Earth's ambient geomagnetic field depends on the geographic orientation of the cables. These results summarize the range of deviations over all assessed geographic directions, summarized in Attachment A, Table A-1.

† The trenchless configuration shown is representative of the intracoastal waterway. A jack and bore configuration also is proposed which will have similar conductor spacing but greater burial depth than the DC Duct Bank configuration. Magnetic-field levels above the jack and bore configuration would therefore be similar to or lower than reported above for the DC Duct Bank.

3.1.2 SRWEC–Transition

Where the SRWEC will be installed in a duct bank configuration along the brief onshore transition between the HDD installation and the TJB, field levels are very similar to, but slightly lower than, the values for the Onshore Transmission Cable. The highest total DC magnetic field at 3.3 ft (1m) above ground and at average loading was calculated to be 652 mG, which is an increase of 146 mG above the ambient geomagnetic field. Along some portions of the SRWEC-Transition, the DC fields are calculated to reduce the total field to a minimum of 363 mG (a reduction of 143 mG). Maximum deviations from the ambient geomagnetic field occur near the duct bank and decrease to near ambient levels (517 mG) within ±25 ft (±7.6 m) (from the center of the duct bank. For peak leading magnetic fields and deviations are higher. Graphs of the DC magnetic field as a function of horizontal distance above the SRWEC-Transition are shown in Attachment C, Figure C-8. Tabular results showing the deviation from the earth's geomagnetic field are shown in Attachment C, Table C-4, Table C-6, and Table C-7.

3.1.3 SRWEC at TJB

Where the SRWEC conductors are separated and installed within the TJB over a few tens of feet, magnetic-field modeling calculations were somewhat higher than for the Onshore Transmission Cable resulting from the greater distance between cables required for installation. The highest total DC magnetic field for either design option at 3.3 ft (1 m) above ground and at average loading is 853 mG, which is an increase of 348 mG above the ambient geomagnetic field. Magnetic-field deviations from the ambient geomagnetic field decrease to 99 mG or less within ±25 ft (±7.6 m) of the center-line between the cables. As with the Onshore Transmission Cable and SRWEC–Transition, field levels at peak loading are higher as described in Attachment C. Graphs of

[10] Magnetic-field levels where the Onshore Transmission cable passes via HDD beneath water bodies (e.g., Carmans River) were not calculated because of the much greater burial depth expected at these locations. Field levels in the water above the HDD-buried cables are likely to be similar to or lower than magnetic-field levels in Table 1 due to greater burial depths and similar or smaller conductor spacings.

the DC magnetic field as a function of horizontal distance for both configurations of the TJB are shown in Attachment C, Figure C-8 and Figure C-10Figure C-9. Tabular results showing the deviation from the earth's geomagnetic field for both TJB configurations are shown in Attachment C, Table C-5, Table C-6, and Table C-7.

3.1.4 Compass Deflection

Traditional mechanical compasses that rely on the Earth's geomagnetic field may detect a small change in the compass reading above the Onshore Transmission Cable that will diminish quickly with distance. Modern navigational instruments that obtain compass readings and locations from global positioning system receivers would not be affected by the DC magnetic-field deflections from the Onshore Transmission Cable.

Computed compass deviations at a height of 3.3 ft (1 m) above ground at average loading are 28 degrees or less directly above the DC duct bank, and 1.7 degrees or less at 25 ft (7.6 m) from the centerline. Maximum deviations over the DC trenchless configuration at a height of 3.3 ft (1 m) above ground at average loading are lower (8.1 degrees or less), but decrease somewhat more slowly (a maximum deviation of 1.3 degrees at a distance of 25 ft [7.6 m] from the centerline). Given the widespread use of navigation systems that do not rely on the Earth's geomagnetic field and the proposed location of the Onshore Transmission Cable, a local deviation of a few degrees for such a short distance would not likely interfere with the use of ordinary compasses. Detailed results of this analysis are provided in Attachment C, Figure C-12 to Figure C-20 and Table C-8 to Table C-14.

3.2 AC Magnetic Fields

The calculated AC magnetic-field levels from the Onshore Interconnection Cable are summarized below in Table 2. The magnetic-field level decreases rapidly with distance from the centerline. At 3.3 ft (1 m) directly above the Onshore Transmission Cable at average loading, the magnetic field is calculated to be 60 mG. At a distance of ±10 ft (±3 m) and ±25 ft (±7.6 m) from the duct bank centerline, the values decrease to 21 mG and 5.4 mG, respectively.

A graph of the AC magnetic field as a function of horizontal distance from the Onshore Interconnection Cable is shown in below in Figure 3. Tabular results for peak and average loading are shown in Attachment C,

Table 2. Calculated AC magnetic-field levels (mG) at various horizontal distances 3.3 ft (1m) above ground at average loading

Configuration	**AC Magnetic Fields (mG)***				
	–25 ft (–7.6 m)	**–10 ft (–3 m)**	**Max**	**+10 ft (+3 m)**	**+25 ft (+7.6 m)**
Onshore Interconnection Cable	4.3	15	60	20	5.2

* As shown in Attachment A, Figure A-5, for the Onshore Interconnection Cable, the 12 phase cables are divided into two groups (separated by 20 ft [6 m]). The horizontal distance is measured from the inner edges of the two duct banks comprising the Onshore Interconnection Cable. The ± horizontal distance is measured from the centerline above the left and right duct bank, respectively

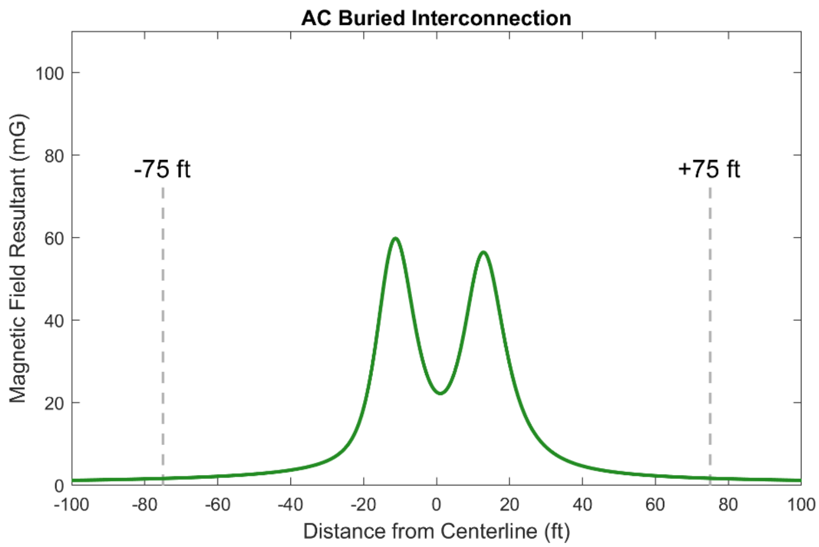

Figure 3. AC magnetic field for the twin Onshore Interconnection duct bank configuration.

4.0 Conclusions

Magnetic-field levels are routinely assessed in terms of standards and guidelines developed by scientific and health agencies to protect health and safety and are based on reviews and evaluations of relevant health research.

The calculated DC magnetic-field levels for the Onshore Transmission Cable are far below ICNIRP's standard for human exposure to static magnetic fields (i.e., < 0.1 percent of the general public exposure limit of 4,000,000 mG) for all cable configurations evaluated. The highest calculated magnetic-field level also is well below the applicable medical device standard of 10,000 mG for exposure of implanted medical devices to static magnetic fields.

The maximum calculated AC magnetic-field levels directly above the Onshore Interconnection Cable at average or peak loading are substantially below the guidelines for the general population of 2,000 mG and 9,040 mG set by ICNIRP and ICES, respectively, and decrease rapidly with distance. These levels are also far below the 1,000 mG limit specified in the CENELEC 50527-1:2010 standard for medical devices.

The AC and DC magnetic fields associated with the operation of equipment within the OnCS–DC were not calculated, as fields from these sources can be expected to be at minimal levels outside the perimeter of the OnCS–DC. Therefore, the dominant sources of magnetic fields at the OnCS–DC perimeters will be the new underground Onshore Transmission Cable and underground Onshore Interconnection Cable that connect the OnCS–DC to the Holbrook Substation.

The Onshore Transmission Cable, SRWEC–Transition, SRWEC at the TJB, and the Onshore Interconnection Cable will not be a direct source of any electric field above ground due to the cable construction, duct bank, and burial underground.

5.0 References

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Attachment A

Cable Specifications and Cross Section Diagrams

Onshore Transmission Cables

The Onshore Transmission Cables will traverse the distance between the TJB and the OnCS–DC. Over the majority of this route, the Onshore Transmission Cable will be installed in an underground duct bank, as shown below in Figure A-1. For short portions of the route, the Onshore Transmission Cable will be installed in a trenchless configuration, as shown in Figure A-2. Modeling for both installation configurations was performed for two current flow directions at average and peak loading and six geographic directions. Design parameters for the Onshore Transmission Cable in both the dominant duct bank configuration and the trenchless configuration are summarized below in Table A-1.

Table A-1. Summary of DC Onshore Transmission Cable Specifications

Configuration	1	2
Description	DC Onshore Transmission Cable (Duct Bank)	DC Onshore Transmission Cable (Trenchless)†
Source capacity	1,034 MW	
Voltage	±320 kV	
Average Loading per Cable*	922 A	
Peak Loading per Cable*	Confidential	
Number of Cables	2 (positive and negative poles)	
Phase Cable Type, Outer Diameter (OD)	Single-core XLPE: 4.8-inch OD (122.1 millimeters [mm])	
Horizontal conduit spacing	16-inches (406 mm)	10-inches (254 mm)
Geographic Orientation (Degrees North from East)	30° and 75° 110° and 155° north-south east-west	
Burial Depth	4 ft (1.2 m)	7.2 ft (2.2 m)
Evaluation Height	At 3.3 ft (1 m) above ground	

* The polarity (direction) of current flow affects the calculated magnetic field. Therefore, both polarities have been assessed (i.e., left cable carrying current towards the OnCS–DC, with right cable carrying current away from the OnCS–DC, and vice-versa).

† Trenchless configuration shown is representative of the intracoastal waterway. A jack and bore configuration also is proposed which will have similar conductor spacing (16.25” [413 mm]) as the DC Duct Bank configuration but also a greater burial depth of 3 to 8 ft (0.9 to 2.4 m). Magnetic-field levels above the jack and bore configuration would therefore be similar to or lower than reported for the DC Duct Bank.

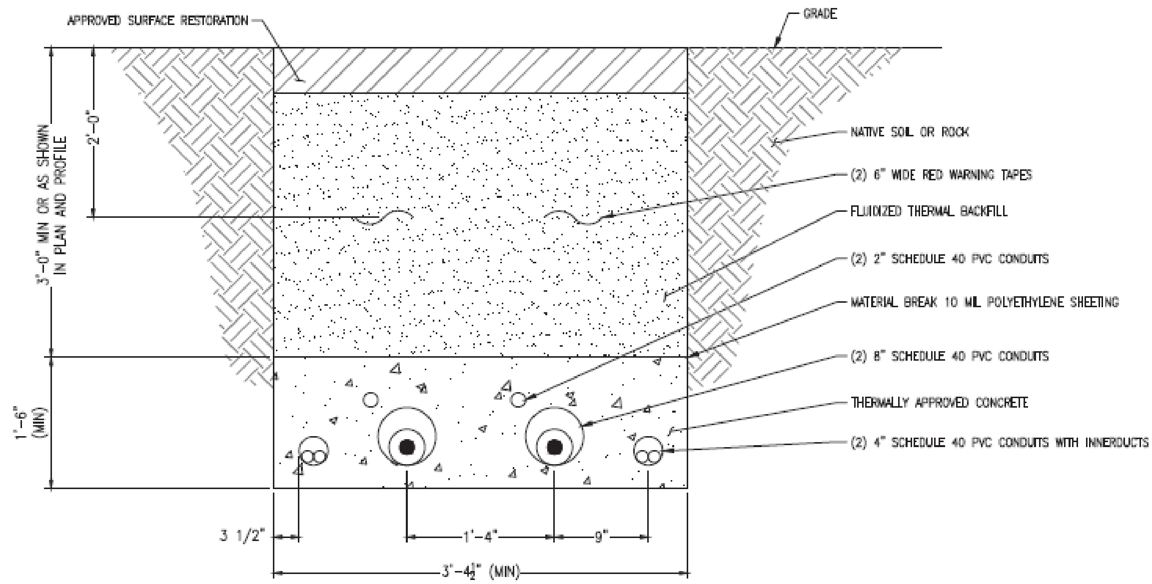


Figure A-1. Typical duct bank configuration proposed to be used for the DC Onshore Transmission Cable and for the short SRWEC–Transition between the HDD and TJB configurations.

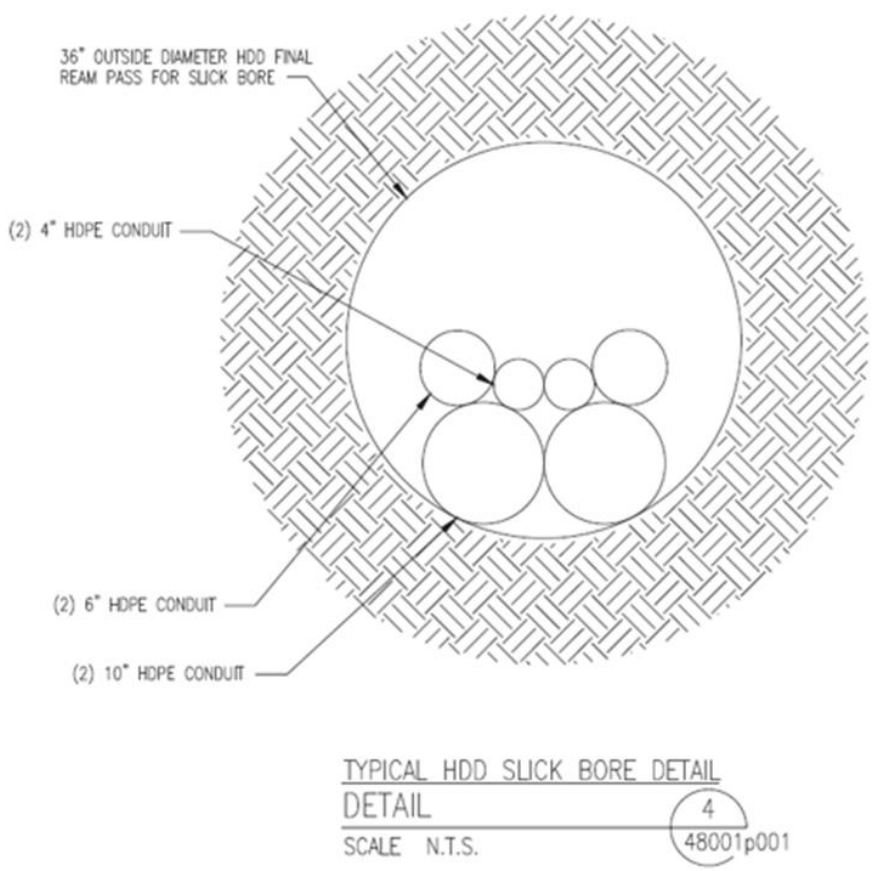


Figure A-2. DC Onshore Transmission Cable in Trenchless configuration. Burial depth to top of the 36-inch bore is modeled at a minimum target of 5 ft (1.5 m).

SRWEC—Transition

Over the short transition segment (approximately 100 ft [30 m]) between the HDD installation and the TJB, the SRWEC will be installed in a duct bank configuration as shown in Figure A-1. This is the same duct bank geometry proposed as the dominant configuration installed elsewhere along the onshore portion of the route. The typical configuration will have conductors with a center-to-center spacing of 16 inches (41 cm) (noted as 1 ft, 4 inches in Figure A-1). As the duct bank approaches the TJB, the separation and burial depth of the conductors will increase, when necessary, to match the conductor separation at the TJB (see below). The modeling cases for the SRWEC–Transition configuration were performed for two current flow directions at average and peak loading for one burial depth and one geographic direction.

Design parameters relevant for magnetic-field modeling of the SRWEC–Transition configuration are summarized below in Table A-2.

Transition Joint Bay

At the TJB, the cables will separate for a short distance of approximately a few tens of feet to provide for improved constructability and sufficient bending radii when handling each cable to prepare for splicing. Two design options are currently under consideration for the TJB—one in which the two cables are separated vertically from one another and one in which they are separated horizontally from one another. A graphical depiction of the configurations under consideration is shown in Figure A-3. Modeling for the TJB was performed for two current flow directions at average and peak loading and one geographic direction.

Design parameters relevant for magnetic-field modeling of the TJB configurations are summarized below in Table A-2.

Table A-2. Summary of modeling parameters for SRWEC—Transition and TJB installations.

Description	SRWEC–NYS Transition	TJB Installation (Option 1)	TJB Installation (Option 2)
Source capacity	1,034 MW		
Voltage	±320 kV		
Average Loading per Cable*	922 A		
Peak Loading per Cable*	Confidential		
Number of Cables	2 (positive and negative poles)		
Phase Cable Type, OD	Single-core XLPE, 5.3 inches (134 mm)	Single-core XLPE, 4.8 inches (122.1 mm)	
Separation Distance Between Conductors	16 inches (406 mm)	3 ft (vertical) (0.9 m)	7 ft (horizontal) (2.1 m)
Geographic Orientation (Degrees North from East)	161^{o} north of east		
Specified Burial Depth	3 ft (0.9 m) (to top of concrete duct bank)	4 ft (1.8 m) (to center of top cable)	7 ft (2.1 m) (to center of cables)
Burial Depth to Center of Cable	4 ft (1.2 m)	4 ft (1.2 m)	7 ft (2.1 m)
Evaluation Height	At 3.3 ft (1 m) above ground		

* The polarity (direction) of current flow affects the calculated magnetic field. Therefore, both polarities have been assessed (i.e., left cable carrying current towards the OnCS–DC, with right cable carrying current away from the OnCS–DC, and vice-versa).

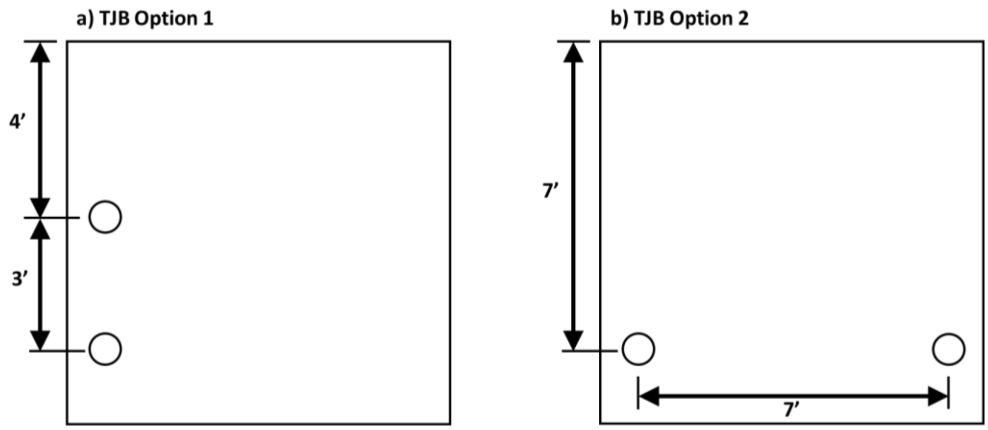


Figure A-3. TJB Option 1: cables are separated vertically (a); TJB Option 2: cables are separated horizontally (b).

Onshore Interconnection Cable

Electricity from the ±320-kV DC Onshore Transmission cable will be converted to AC and transformed to 138-kV at the OnCS–DC. Design parameters for the AC Onshore Interconnection Cables, consisting of a 138-kV AC transmission line installed in a twin-duct-bank configuration, are summarized below in Table A-3. A cross-section of each cable is shown in Figure A-4. A cross-section of the twin duct bank geometry is shown in Figure A-5, wherein each duct bank will consist of six single-core XLPE cables, each installed in separate 8-inch (20-cm) PVC conduits.

Table A-3. Summary of AC Onshore Interconnection Cable and Installation Specifications

Description	AC Onshore Interconnection Cable
Source capacity	1,034 MW
Voltage	138 kV
Average Loading per Cable	681 A
Peak Loading per Cable	Confidential
Number of Cables	12 (4 of each phase)
Separation between Duct Banks	20 ft (6.1 m)
Spacing between adjacent conduits	16 in (406 mm)
Phase Cable Type, OD	Single-core XLPE, 4.9-inch OD (123.2 mm)
Phase Conductor Diameter	2.5-inches (64.5 mm)
GCC cable type, OD	500 kcmil copper, 0.707 inch OD (18 mm)
Burial Depth	3.3 ft (1 m)
Evaluation Height	At 3.3 ft (1 m) above ground

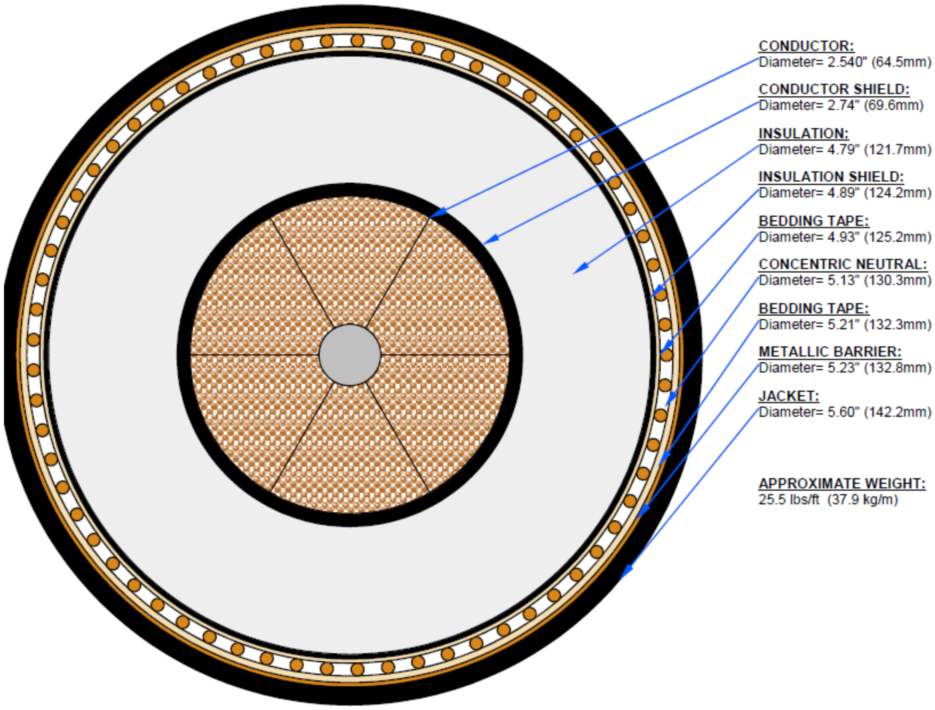


Figure A-4. Illustrative cross section of an onshore single-core AC cable.

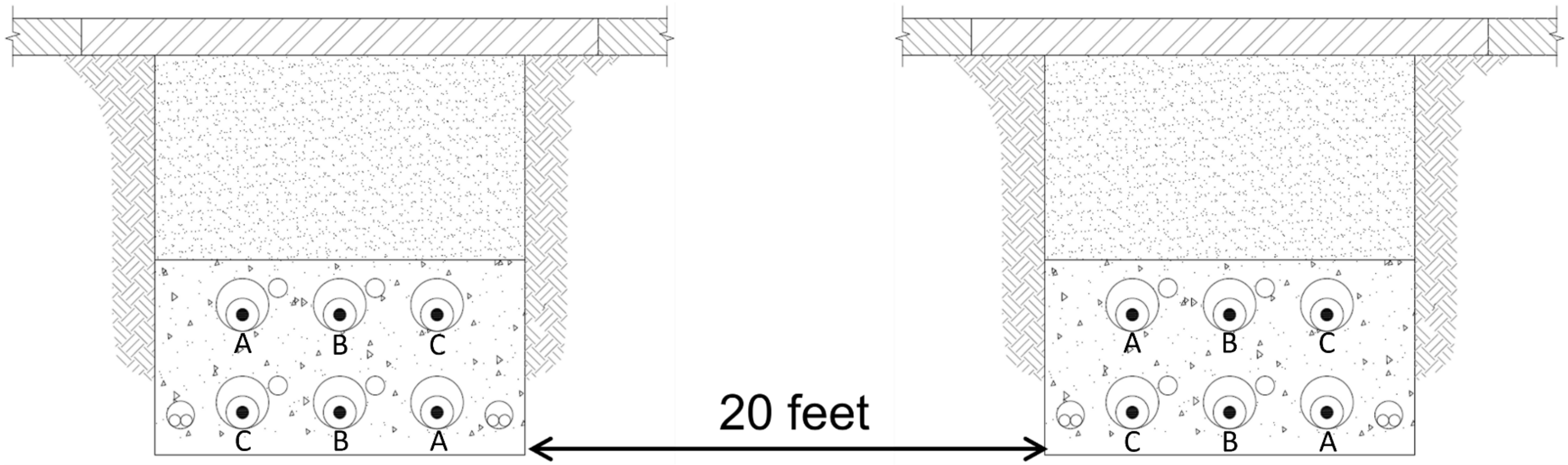


Figure A-5. AC 138-kV Onshore Interconnection Cables in twin duct bank configurations.

For each duct bank, the Onshore Interconnection Cable is proposed to be installed with two conductors per phase, with the phasing arrangement of the conductors selected to minimize magnetic fields above ground (as indicated by the letters below the respective conduits. Two ground continuity conductors will be installed in 2-inch conduits. The phase-phase spacing (both horizontal and vertical) between the conduits is 16-inches (406 mm).

Attachment B

Calculation Methods

DC Magnetic-Field Calculation Methods

Since the magnetic field from the DC project cables and the Earth's geomagnetic field are vectors, the relative orientation of these two fields changes the resulting total magnetic field. To assess the range of DC magnetic-field levels that could be associated with the Onshore Transmission Cable when oriented in different directions, calculations were performed for six representative cable directions, as shown in Figure B-1—two between Fire Island and where the route turns west (75 and 110 degrees north of east); two in a general westerly direction (30 and 155 degrees north of east), and along a north-south orientation and an east-west orientation to provide additional bounds on the calculated field levels.

Since in principle it is possible for the direction of current flow to change during operation (i.e., which cable will carry current towards the DC offshore converter station [OCS–DC], and which will carry current away from the OCS–DC, both options were assessed for each segment of the onshore routes. Typical DC magnetic-field levels were calculated by assuming an average load on the cables. To obtain peak DC magnetic-field levels, a current flow equal to the maximum power output of the Project was assumed.

The DC magnetic-fields calculated for the Onshore Transmission Cable are shown for each of four cable and current flow configurations at both peak and average loading and six geographic directions to describe the upper bound of potential magnetic-field levels.

Earth's Geomagnetic Field

The total DC magnetic field near the Onshore Transmission Cable depends on the magnitude and direction of the DC magnetic field from the cables, as well as the strength and direction of Earth's ambient geomagnetic field. The strength of Earth's ambient geomagnetic field was obtained from the International Geomagnetic Reference Field (IGRF-13) Model.[11] The geomagnetic field at 40.83°N, 71.53°W (approximately at the center of the SRWEC cable route) is used in all calculations, corresponding to the geomagnetic components shown in Table B-1. At this location, the geomagnetic field has a -14-degree declination (westward of geographic north) and a 65.8-degree inclination (downward). Along the Onshore Transmission Cable route, the geomagnetic field does not vary sufficiently to affect the reported ambient geomagnetic-field values by more than approximately 1 percent.

Table B-1. Geomagnetic magnetic field at coordinates 40.83°N, 71.53°W

Component	Geomagnetic field (in nanotesla [nT] and mG)		
Northern component	20,510.9 nT	=	205 mG
Eastern component	–5,036.1 nT	=	–5.0 mG
Downward component	45,945.6 nT	=	459 mG
Total geomagnetic field*			506 mG

*The total geomagnetic field is calculated as the square root of the sum of the components squared.

Magnetic-Field From DC Cable

DC current flowing through a conductor creates a DC (i.e., static) magnetic field. The static magnetic field from the DC current is calculated by the application of the Biot-Savart Law, which is derived from fundamental laws

11 https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php

of physics. Application of the Biot-Savart Law is particularly appropriate for long straight conductors such as the Onshore Transmission Cable for which analytical solutions are straightforward and are given by the formula:

$$|B| = \mu_0 |H| = \frac{\mu_0 \mathrm{I}}{2\pi r}$$

where B is the magnetic flux density, μ_0 is the magnetic permeability of a vacuum, I is the current, and r is the distance from each cable conductor. In order to calculate the total magnetic field, the calculated magnetic-field vector from the Onshore Transmission Cable is added to Earth's geomagnetic-field vector.

Compass Deflection

The strength of the total DC magnetic field determined by the combined field from the Onshore Transmission Cable and the Earth's geomagnetic field is one way to describe the effect of the DC cable on the local environment. Another is to evaluate how much the local geomagnetic field changes direction and strength as a result of the Onshore Transmission Cable. For example, a compass needle typically points along the direction of the Earth's geomagnetic field, but a new nearby DC magnetic-field source may cause a local deviation to a new apparent direction of magnetic north around the cable. Here, this deviation is calculated as the compass deflection, which is the difference in angular direction in degrees between the horizontal component of the ambient geomagnetic field and the horizontal component direction of the combined geomagnetic field from the Earth and from the Onshore Transmission Cable.

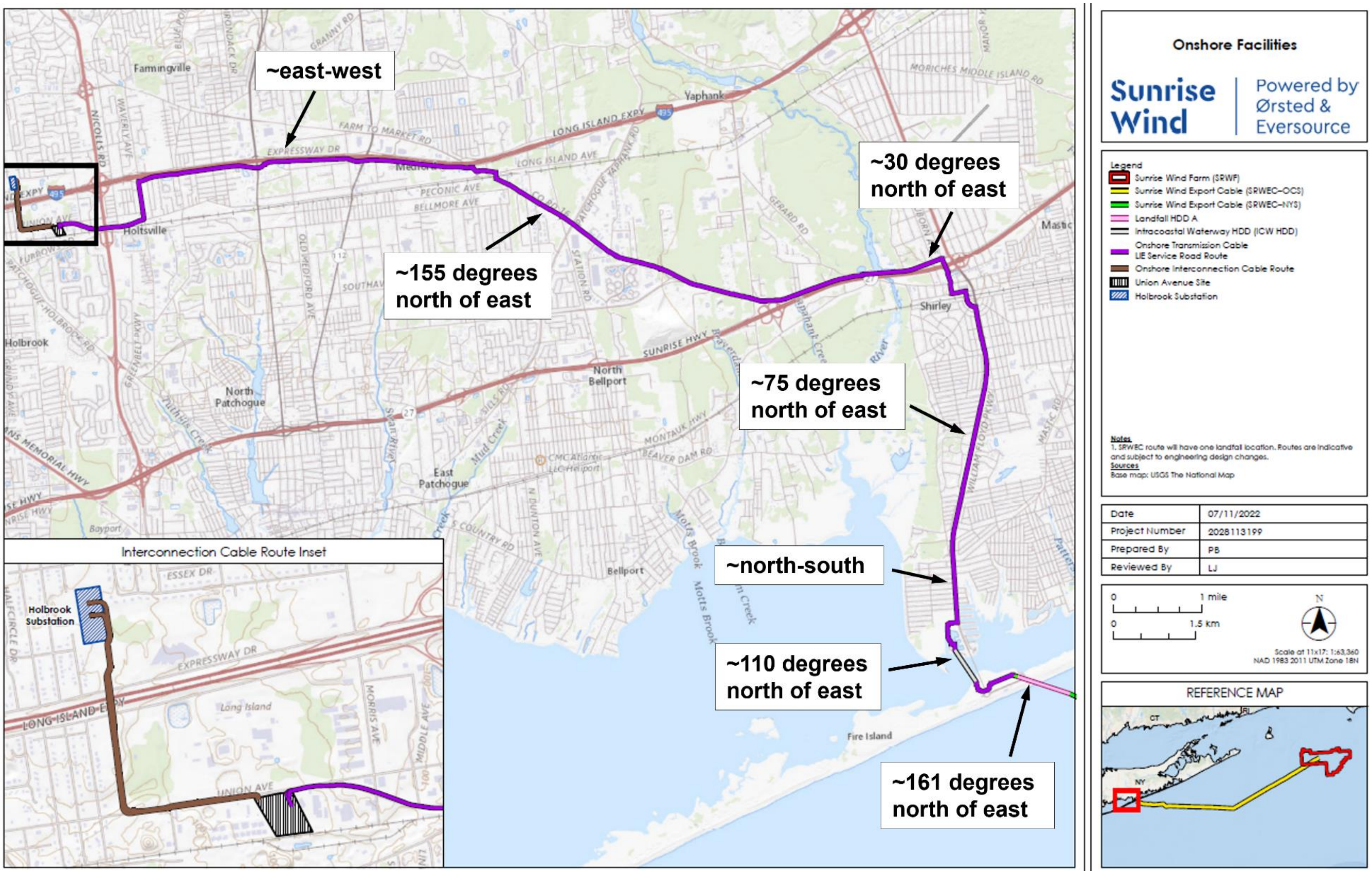


Figure B-1. Geographic orientation of Onshore Transmission Cable and Onshore Interconnection Cable routes. The segment labeled as 161 degrees north of east corresponds to the orientations of the SRWEC–Transition and TJB.

AC Magnetic-Field Modeling Methods

For the Onshore Interconnection Cable, magnetic-field levels were calculated using the commercial software package COMSOL MultiPhysics Version 5.5, which is a finite element analysis, solver, and simulation software suite. The conductor locations were determined with the assumption that each cable rests at the bottom of its containing conduit. All conductors were modeled as straight, parallel to one another, and infinite in extent below a flat ground.[12] The proximity of ground continuity conductors (GCC) to the phase conductors results in an induced current flowing on the GCC, which in turn is the source of an opposing magnetic field. This current on the GCCs is included in the calculations of the total resultant magnetic field. Typical magnetic-field levels were calculated by assuming an average load on the cable. To obtain peak AC magnetic-field levels, a current flow equal to the maximum power output of the Project was assumed.[13]

Magnetic-field levels are reported at 3.3 ft (1 m) above ground as the root mean square value of the resultant field in accordance with IEEE Standard C95.3.1-2010 and IEEE Standard 644-2019 (IEEE 2010, 2019). Magnetic-field levels are reported out to a distance of ±100 ft (±30 m) from the centerline of the duct bank.

[12] The effects of current imbalance, sheath currents, ground currents, and cable materials surrounding the copper conductor, including ferromagnetic shielding effects and eddy currents, were not modeled. It was further assumed there would be no attenuation of magnetic fields by any surrounding materials (e.g., the duct bank, the Earth, etc.).

[13] New York Article VII filings require magnetic-field modeling to be performed at winter normal conductor rating (rather than average or peak loading presented herein) and reported as the maximum of the magnetic field ellipse (rather than the resultant of three orthogonal vectors as reported herein). Field levels calculated and presented in Exponent (2022b) therefore will be different than reported herein.

Attachment C

Calculated Magnetic Fields

DC Onshore Transmission Cables

DC Magnetic Field

The DC current load within the Onshore Transmission Cable, whether installed in duct banks or via trenchless, generates a static magnetic field around these cables. The magnetic field was calculated for four representative cable directions (30 degrees, 75 degrees, 110 degrees, and 155 degrees north of east), plus the two cardinal directions, north-south and east-west, to cover the full range of possible directions. For each of the cable orientations, the magnetic field was calculated for the DC duct bank configuration and the DC trenchless configuration. For both configurations, current was modeled to flow toward the OnCS–DC in the left duct and flow away from the OnCS–DC in the right duct, as well as for opposite polarity (current flowing toward the OnCS–DC in the right duct and away from the OnCS–DC in the left duct). Calculations were performed for both average and peak loading.

Figure C-1 shows calculations for the DC duct bank configuration in an east-west orientation for average loading. In each subplot, the dashed gray line is the value of Earth's ambient geomagnetic field at the location of the cable, and the solid blue line is the total magnetic-field level (DC Onshore Transmission Cables + Earth's geomagnetic field) calculated at 3.3 ft (1 m) above ground. This figure shows that the direction of the current has a significant effect on the total calculated field level. Both graphs show the total magnetic-field level ($\boldsymbol{B}_{total} = \boldsymbol{B}_{cable} + \boldsymbol{B}_{earth}$), but for current flowing out of the page in the left conduit (Figure C-1a), the total magnetic field decreases near the duct bank, whereas for current flowing out of the page in the right conduit (Figure C-1b), the total magnetic field increases near the duct bank.

This same information can be summarized in tabular format, but instead of presenting the total magnetic-field level (Btotal = Bcable + Bearth), Figure C-1 shows the difference (or deviation) between the total field and the ambient geomagnetic field ($B_{Deviation} = |B_{total}| - |B_{earth}|$). Table C-1 shows the maximum positive deviation '(+) Max,' maximum negative deviation '(–) Max,' and the deviation at ±10 ft (±3 m) from the Onshore Transmission Cable centerline. The first two rows of Table C-1 show the results corresponding to Figure C-1 for the DC duct bank, with the two subsequent rows showing the results for the same orientation (east-west) for the DC trenchless configuration. For example, the maximum negative deviation (–146 mG) from the Earth's geomagnetic field (the first row of ,Table C-1, corresponding to the solid blue line in Figure C-1a) is larger than the maximum positive deviation (+38 mG). At a distance of –10 ft (–3 m) from the DC duct bank centerline, the deviation is +37 mG, while at +10 ft (+3 m) from the DC duct bank centerline, the deviation is –3 mG. Using a similar analysis of Figure C-1b, the combined summary for the east-west direction is that the maximum positive deviation varies from 38 to 147 mG and the maximum negative deviation varies between –146 and –34 mG. Table C-1 also shows that at ±10 ft (±3 m) from the centerline, the magnetic-field deviation varies between –34 and +37 mG and demonstrates that within ±10 ft (±3 m) from the Onshore Transmission Cable (whether installed in duct banks or via direct burytrenchless), the effect on the local magnetic field is quite small—a change of less than 10 percent relative to the ambient geomagnetic field. Detailed results of every configuration, including the Transition and TJB configurations, and geographic orientation at average loading are presented below in Figure C-1 to Figure C-10. Tabular summaries at both average and peak loading for each configuration are provided in Table C-1 to Table C-7.

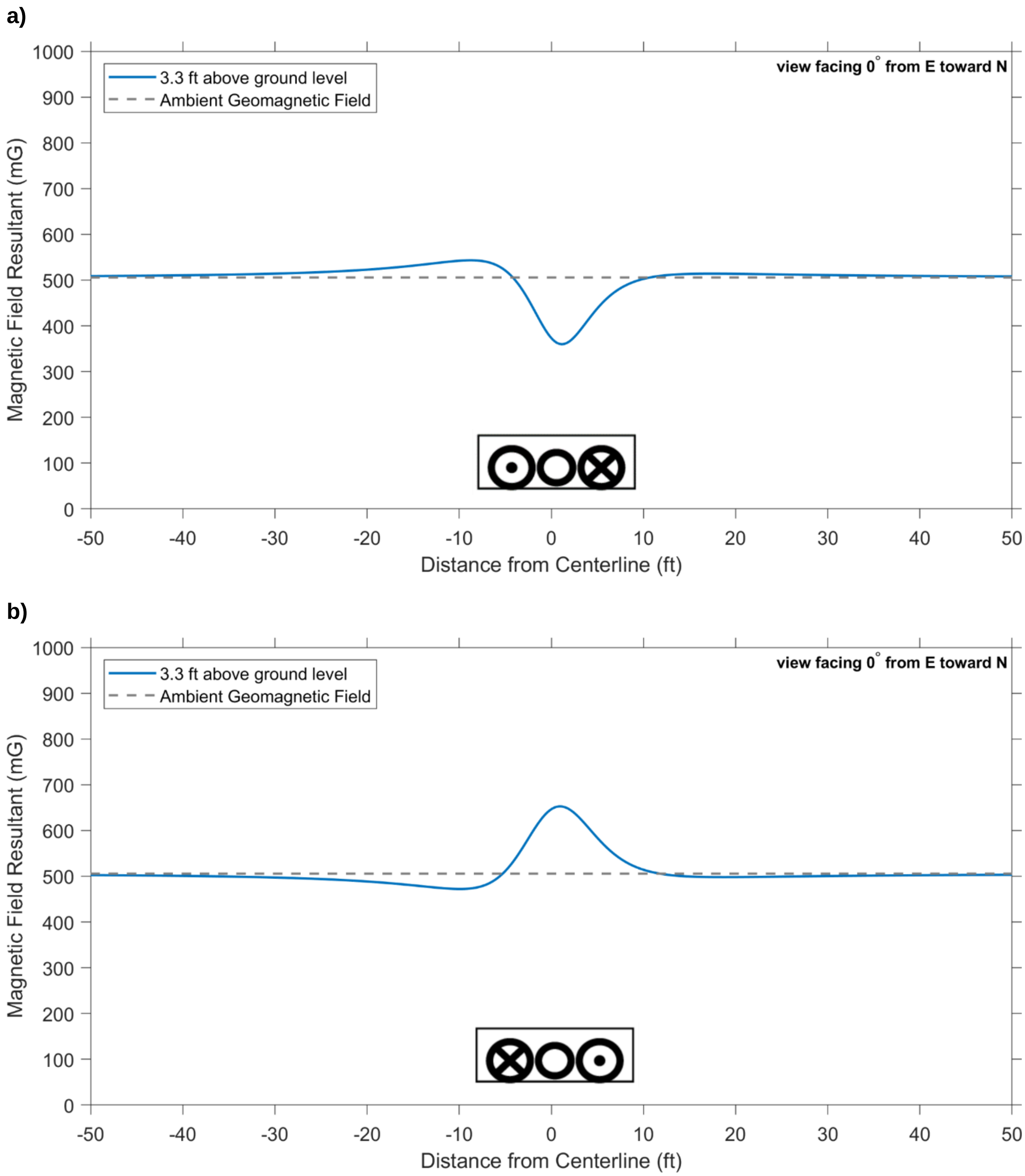
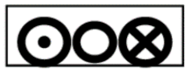
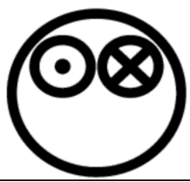
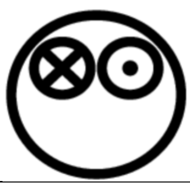


Figure C-1. Total calculated magnetic field at average loading for the Onshore Transmission Cable in the DC duct bank configuration for cables oriented along the east-west direction, evaluated at a height of 3.3 ft (1 m) above ground.

The figure insets depict two current flow scenarios. For (a), the cables are modeled with current flowing out of the page on the left conduit and into the page on the right conduit, while for (b), the cables are modeled with current flowing out of the page on the right conduit and into the page on the left conduit.

Table C-1. Magnetic-field deviation (mG) from the ambient geomagnetic field for an east-west cable orientation, evaluated at various horizontal distances 3.3 ft (1 m) above ground and average loading

Installation Type	Configuration*,†	DC Magnetic-Field Deviation (mG)			
		–10 ft (–3 m)	(+) Max	(–) Max	+10 ft (+3 m)
DC Duct Bank		37	38	-146	-3
		-34	147	-34	8.5
	east-west summary	**-34 to 37**	**38 to 147**	**-146 to -34**	**-3 to 8.5**
DC Trenchless		9.2	11	-44	-10
		-8.2	44	-11	11
	east-west summary	**-8.2 to 9.2**	**11 to 44**	**-44 to -11**	**-10 to 11**

* Figures depict direction of current flow.

† Trenchless configuration shown is representative of the intracoastal waterway. Field deviations for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-2. Summary of DC magnetic-field deviations (mG) from the ambient geomagnetic field for each of the six geographic orientations, evaluated at various horizontal distances 3.3 ft (1 m) above ground at average loading

Installation Type	Cable Route	DC Magnetic-Field Deviation (mG)			
		–10 ft (–3 m)	(+) Max	(–) Max	+10 ft (+3 m)
DC Duct Bank	north-south	-17 to 22	22 to 141	-133 to -20	-6.9 to 12
	east-west	-34 to 37	38 to 147	-146 to -34	-3 to 8.5
	30° north of east	-33 to 36	37 to 147	-146 to -33	-2.8 to 8.3
	75° north of east	-23 to 27	27 to 143	-136 to -24	-1.7 to 7.2
	110° north of east	-9.7 to 15	20 to 141	-133 to -18	-14 to 19
	155° north of east	1.0 to 4.5	33 to 145	-141 to -29	-29 to 33
DC Trenchless*	north-south	-0.8 to 1.9	6.4 to 42	-41 to -6.2	-2.9 to 4.0
	east-west	-8.2 to 9.2	11 to 44	-44 to -11	-10 to 11
	30° north of east	-8.1 to 9.1	11 to 44	-44 to -10	-10 to 11
	75° north of east	-3.2 to 4.3	7.7 to 43	-42 to -7.4	-5.3 to 6.4
	110° north of east	-1.6 to 2.7	5.8 to 42	-41 to -5.6	0.5 to 0.6
	155° north of east	-8.4 to 9.3	9.5 to 44	-43 to -9.2	-6.2 to 7.3

* Trenchless configuration shown is representative of the intracoastal waterway. Field deviations for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-3. Summary of DC magnetic-field deviations (mG) from the ambient geomagnetic field for each of the six geographic orientations, evaluated at various horizontal distances 3.3 ft (1 m) above ground at peak loading

Installation Type	Cable Route	DC Magnetic-Field Deviation (mG)			
		–10 ft (–3 m)	(+) Max	(–) Max	+10 ft (+3 m)
DC Duct Bank	north-south	-28 to 44	45 to 266	-232 to -35	-8.4 to 27
	east-west	-59 to 70	74 to 275	-270 to -60	-1.2 to 20
	30° north of east	-59 to 70	73 to 274	-269 to -59	-0.8 to 20
	75° north of east	-38 to 53	53 to 268	-240 to -42	1.2 to 18
	110° north of east	-14 to 32	40 to 266	-231 to -31	-22 to 40
	155° north of east	6.3 to 13	66 to 272	-255 to -52	-51 to 64
DC Trenchless*	north-south	-0.5 to 4.5	12 to 79	-76 to -11	-4.4 to 8.3
	east-west	-14 to 18	21 to 83	-82 to -19	-18 to 22
	30° north of east	-14 to 18	20 to 83	-82 to -19	-18 to 21
	75° north of east	-5.1 to 8.9	15 to 80	-78 to -14	-9 to 13
	110° north of east	-2 to 5.9	11 to 79	-76 to -10	1.9 to 2.1
	155° north of east	-15 to 18	18 to 81	-80 to -17	-11 to 14

* Trenchless configuration shown is representative of the intracoastal waterway. Field deviations for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-4. Magnetic-field deviation (mG) from the 506 mG geomagnetic field, evaluated 3.3 ft (1 m) above ground and average loading, where SRWEC is guided via a transition duct between the HDD and the TJB along a geographic direction of 161 degrees north of east

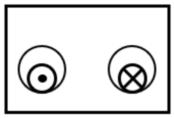
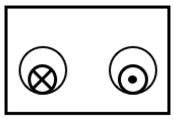
Configuration	Cable Orientation	DC Magnetic-Field Deviation (mG)			
		-10 ft (-3 m)	(+) Max	(-) Max	+10 ft (+3 m)
Transition Duct		-0.2	35	-143	34
		5.8	146	-31	-31
	161° north of east Summary	-0.2 to 5.8	35 to 146	-143 to -31	-31 to 34

Table C-5. Magnetic-field deviation (mG) from the 506 mG geomagnetic field, evaluated 3.3 ft (1 m) above ground and average loading, where SRWEC is installed at the TJB along a geographic direction of 161 degrees north of east

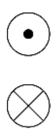
Configuration	Cable Orientation	DC Magnetic-Field Deviation (mG)			
		-10 ft (-3 m)	(+) Max	(-) Max	+10 ft (+3 m)
Onshore TJB (Option 1)		-96	191	-110	89
		98	128	-174	-84
	161° north of east Summary	-96 to 98	128 to 191	-174 to -110	-84 to 89
Onshore TJB (Option 2)		-49	96	-323	89
		116	348	-71	-14
	161° north of east Summary	-49 to 116	96 to 348	-323 to -71	-14 to 89

Table C-6. Summary of DC magnetic-field deviations (mG) at various horizontal distances 3.3 ft (1 m) above ground at average loading

Evaluation Height	DC Magnetic-Field Deviation (mG)											
	–75 ft (–23 m)	–50ft (–15 m)	–25 ft (–18 m)	–10ft (–3 m)	–5 ft (–1.5 m)	(+) Max	(–) Max	+5 ft (+1.5 m)	+10 ft (+3 m)	+25 ft (+18 m)	+50 ft (+15 m)	+75 ft (+23 m)
DC Duct Bank	-1.4 to 1.4	-3.1 to 3.1	-12 to 12	-34 to 37	-59 to 71	20 to 147	-146 to -18	-67 to 78	-29 to 33	-11 to 11	-3.1 to 3.1	-1.4 to 1.4
DC Trenchless*	-0.9 to 0.9	-1.9 to 1.9	-6.3 to 6.4	-8.4 to 9.3	-30 to 31	5.8 to 44	-44 to -5.6	-33 to 33	-10 to 11	-6.0 to 6.0	-1.9 to 1.9	-0.8 to 0.8
Transition Duct	-1.2 to 1.2	-2.4 to 2.5	-6.8 to 7	-0.2 to 5.8	-61 to 74	35 to 146	-143 to -31	10 to 11	-31 to 34	-11 to 11	-3.1 to 3.1	-1.4 to 1.4
Onshore TJB (Option 1)	-1.7 to 1.8	-4.5 to 4.5	-22 to 22	-96 to 98	-86 to 127	128 to 191	-174 to -110	-170 to 175	-84 to 89	-6.9 to 8.1	-0.1 to 0.2	-0.4 to 0.4
Onshore TJB (Option 2)	-5.8 to 5.8	-11 to 12	-20 to 26	-49 to 116	-222 to 280	96 to 348	-323 to -71	-15 to 170	-14 to 89	-51 to 53	-16 to 16	-7.2 to 7.2

* Trenchless configuration shown is representative of the intracoastal waterway. Field deviations for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-7. Summary of DC magnetic-field deviations (mG) at various horizontal distances 3.3 ft (1 m) above ground at peak loading

Evaluation Height	DC Magnetic-Field Deviation (mG)											
	–75 ft (–23 m)	–50ft (–15 m)	–25 ft (–18 m)	–10ft (–3 m)	–5 ft (–1.5 m)	(+) Max	(–) Max	+5 ft (+1.5 m)	+10 ft (+3 m)	+25 ft (+18 m)	+50 ft (+15 m)	+75 ft (+23 m)
DC Duct Bank	-2.6 to 2.6	-5.8 to 5.8	-22 to 22	-59 to 70	-94 to 140	40 to 275	-270 to -31	-113 to 151	-51 to 64	-21 to 21	-5.7 to 5.7	-2.5 to 2.5
DC Trenchless*	-1.6 to 1.6	-3.6 to 3.6	-12 to 12	-15 to 18	-56 to 59	11 to 83	-82 to -10	-61 to 63	-18 to 22	-11 to 11	-3.5 to 3.5	-1.6 to 1.6
Transition Duct	-2.2 to 2.2	-4.5 to 4.6	-13 to 13	4.1 to 15	-100 to 144	68 to 273	-260 to -54	35 to 36	-54 to 66	-21 to 21	-5.7 to 5.7	-2.5 to 2.6
Onshore TJB (Option 1)	-3.2 to 3.3	-8.3 to 8.5	-40 to 41	-175 to 184	-107 to 254	254 to 365	-302 to -190	-302 to 327	-148 to 169	-12 to 16	-0.1 to 0.4	-0.7 to 0.8
Onshore TJB (Option 2)	-11 to 11	-21 to 22	-32 to 52	-20 to 248	-225 to 534	206 to 651	-315 to -119	110 to 378	39 to 206	-94 to 99	-30 to 30	-13 to 13

* Trenchless configuration shown is representative of the intracoastal waterway. Field deviations for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

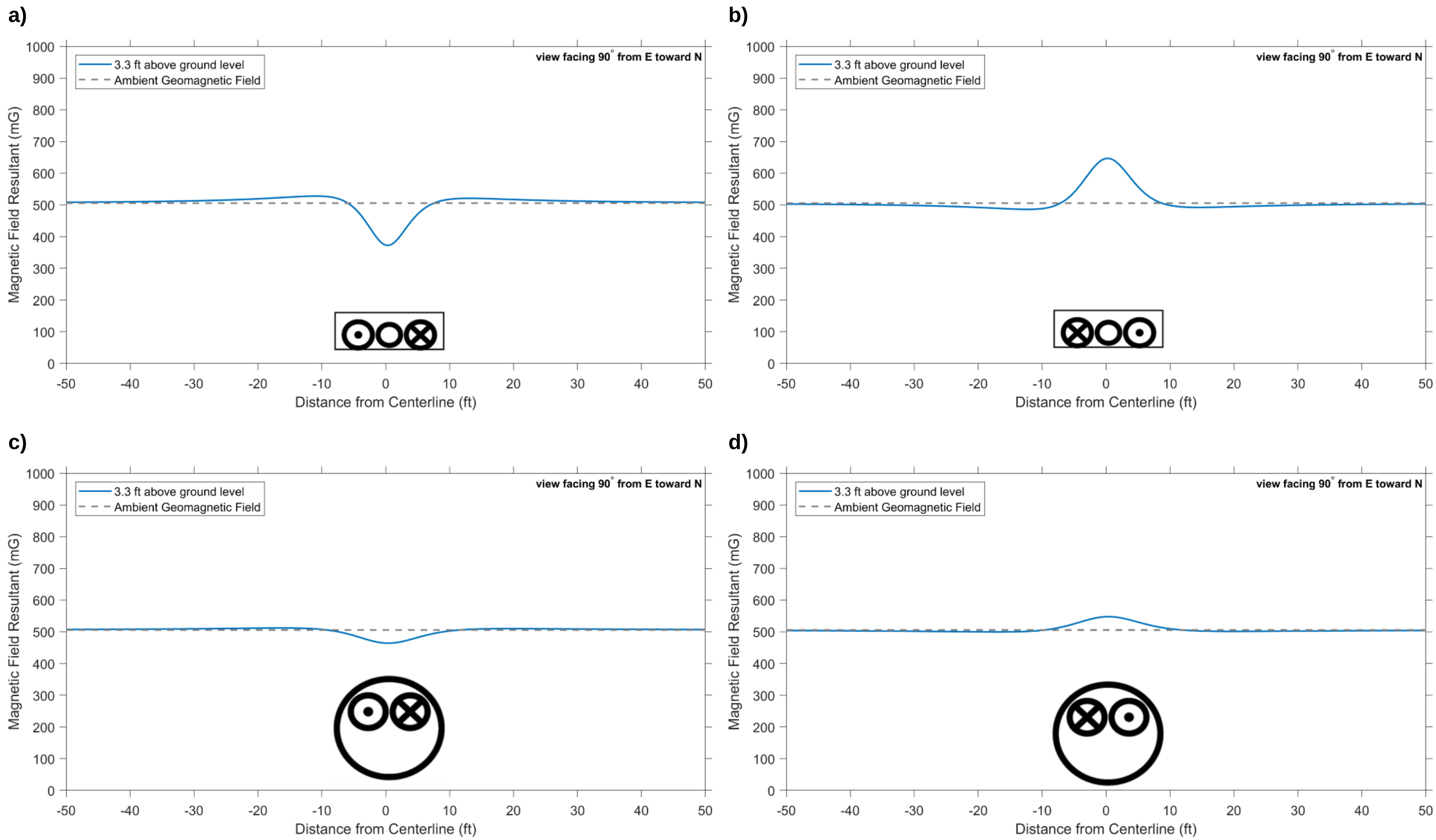


Figure C-2. Total magnetic field at average loading for the Onshore Transmission Cable oriented in a north-south direction, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

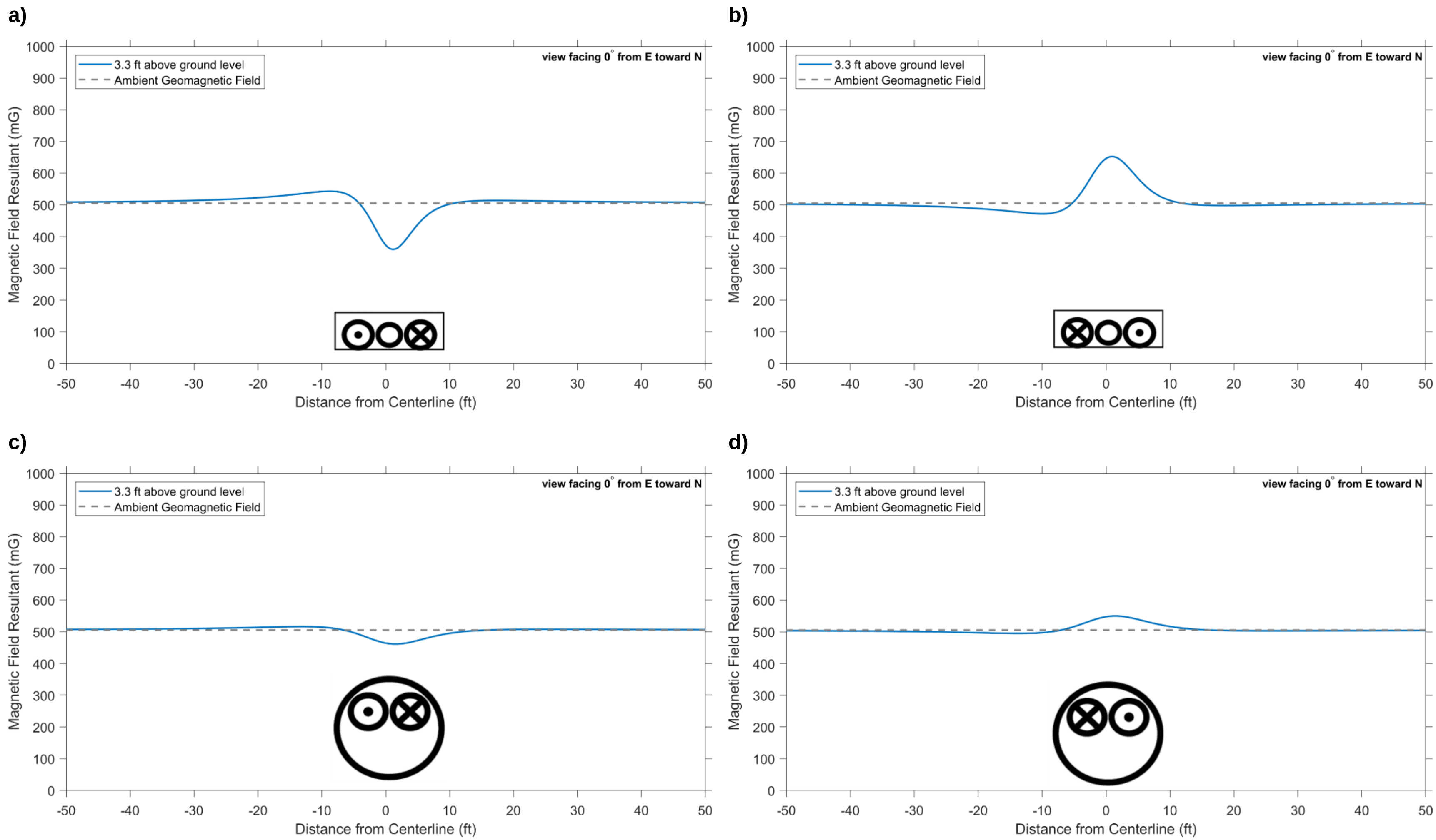


Figure C-3. Total magnetic field at average loading for the Onshore Transmission Cable oriented along an east-west direction, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot). Note that plots a and b are repeated from Figure C-1.

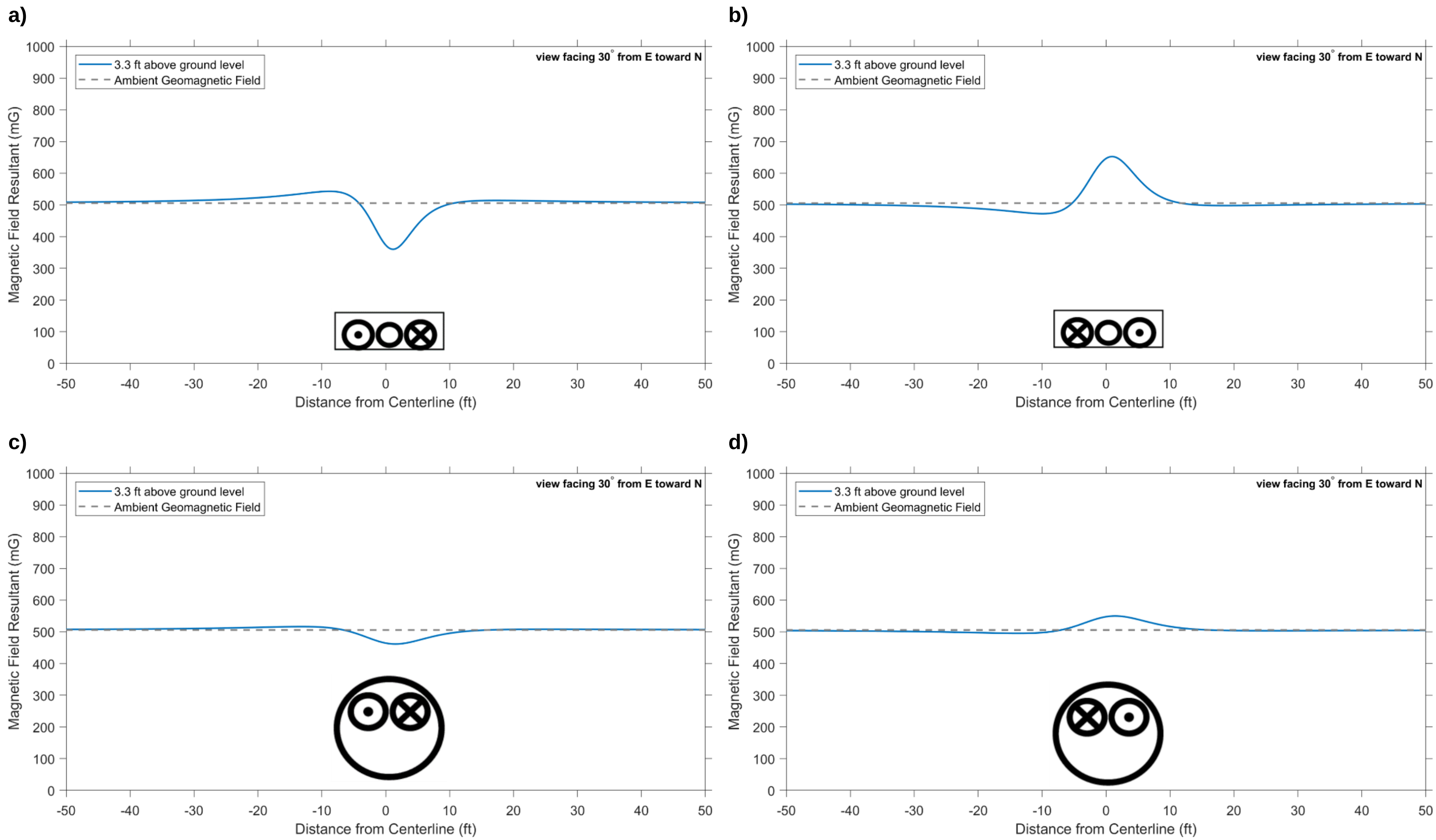


Figure C-4. Total magnetic field at average loading for the Onshore Transmission Cable oriented 30 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

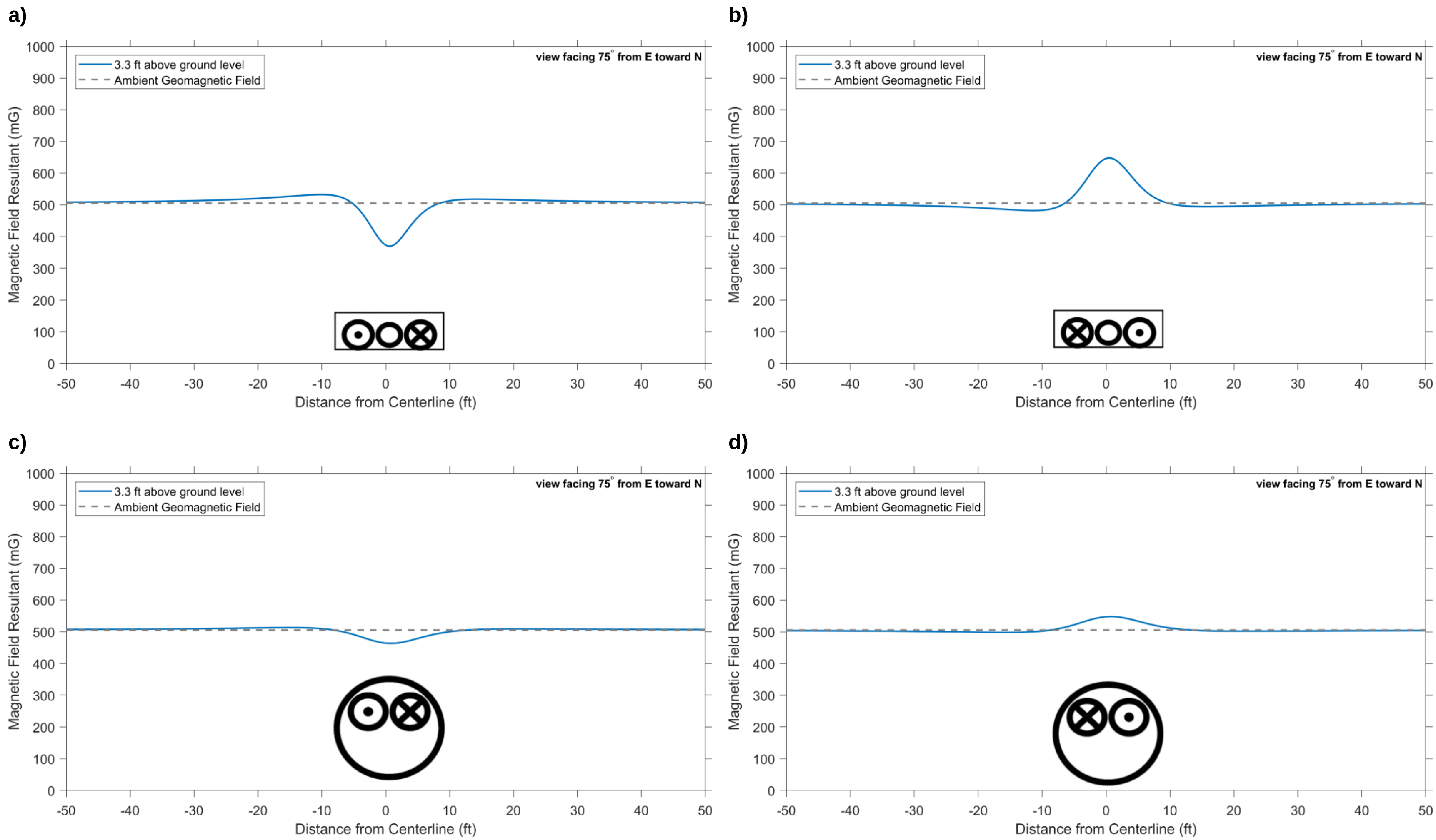


Figure C-5. Total DC magnetic field at average loading for the Onshore Transmission Cable oriented 75 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

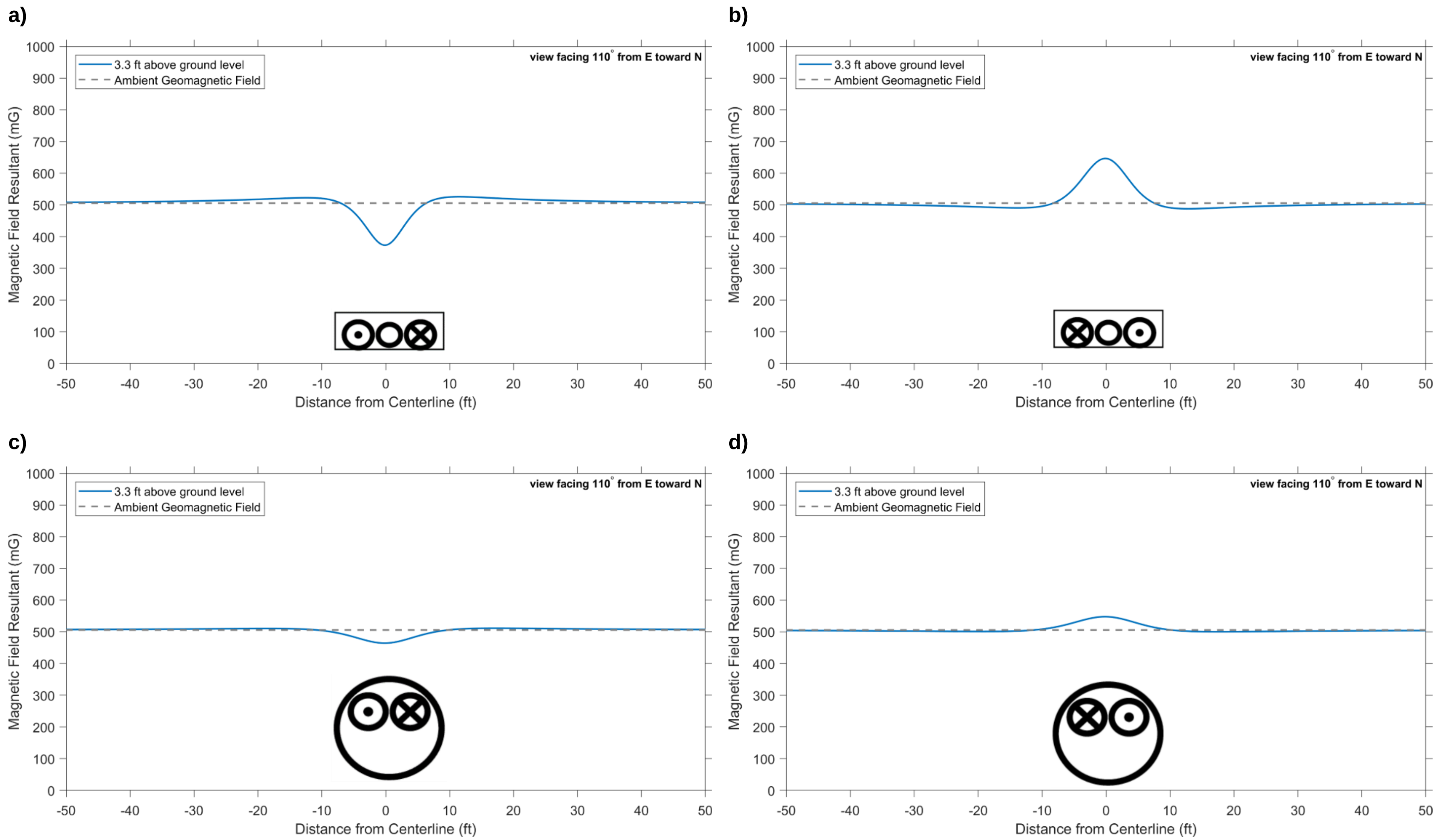


Figure C-6. Total DC magnetic field at average loading for the Onshore Transmission Cable oriented 110 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

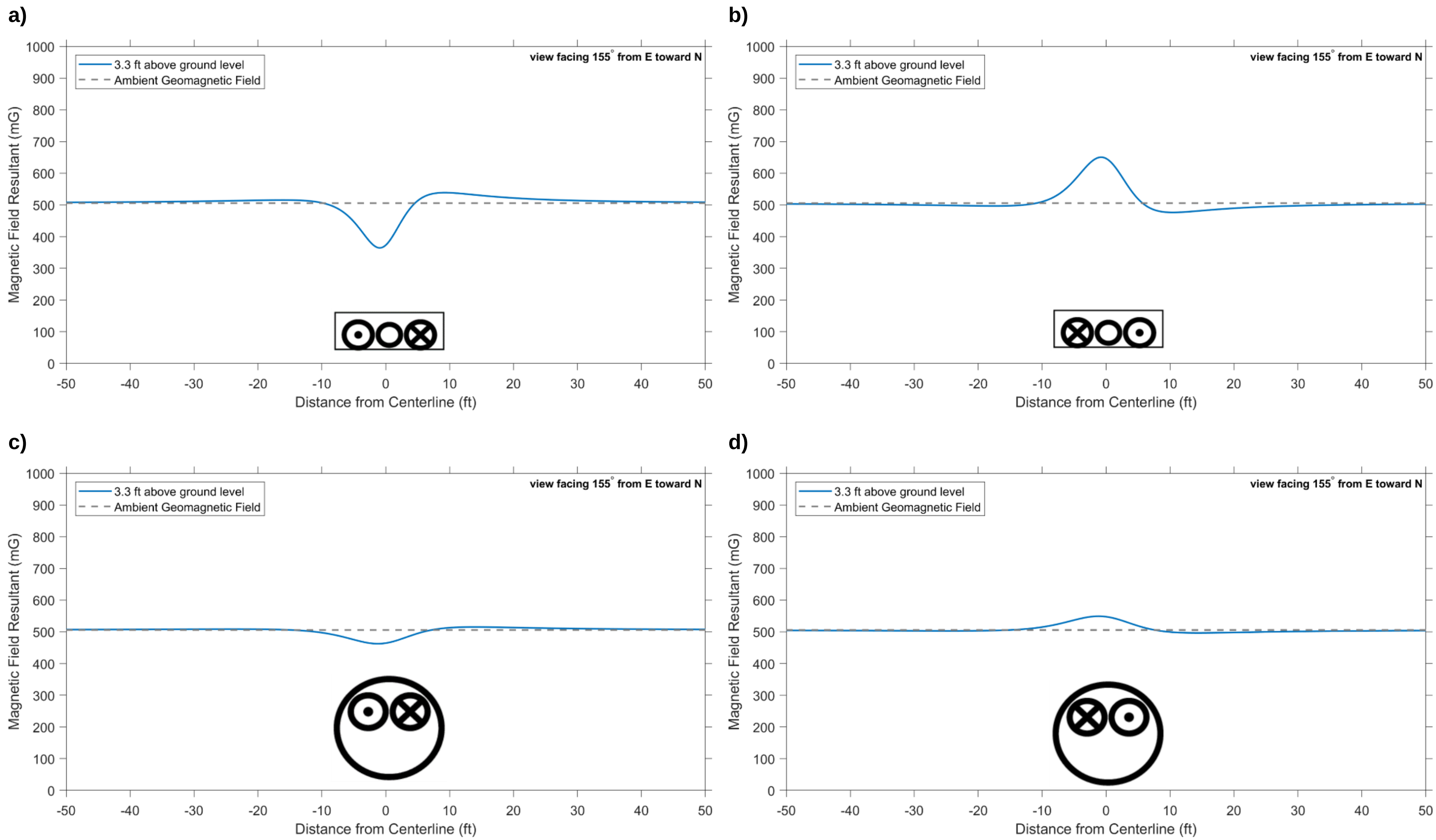


Figure C-7. Total DC magnetic field at average loading for the Onshore Transmission Cable oriented 155 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

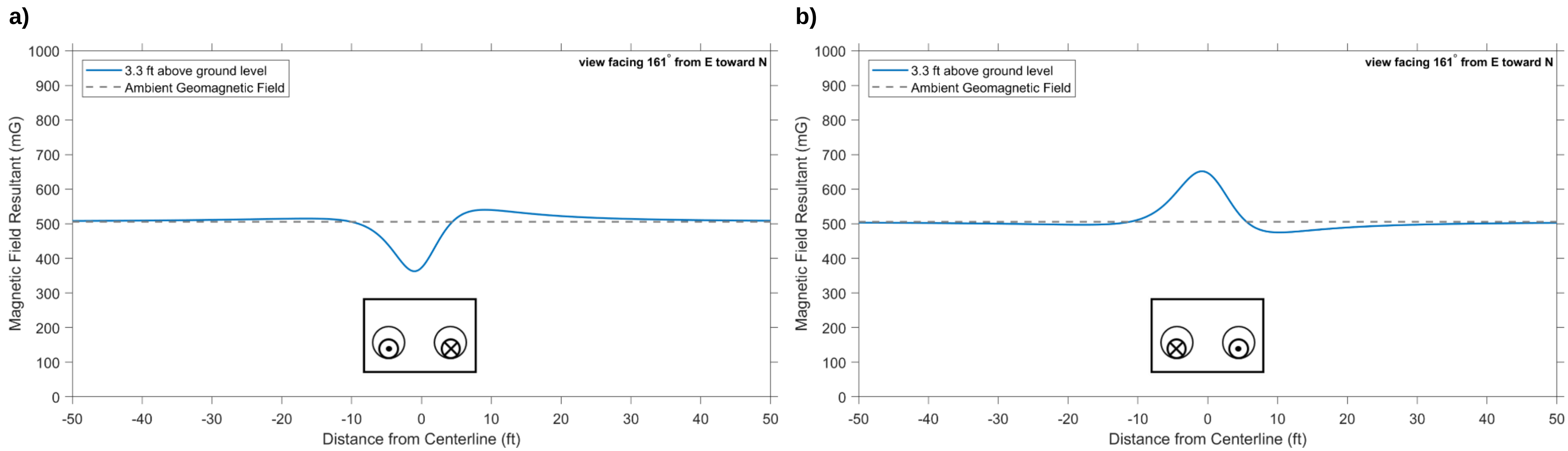


Figure C-8. Total DC magnetic field for SRWEC cables installed in a transition duct bank and buried to a depth of 3 ft (0.9 m) at average loading, evaluated at 3.3 ft (1 m) above the ground and oriented 161° north of east for two different installation scenarios, indicated by the figure at the bottom center of each plot.

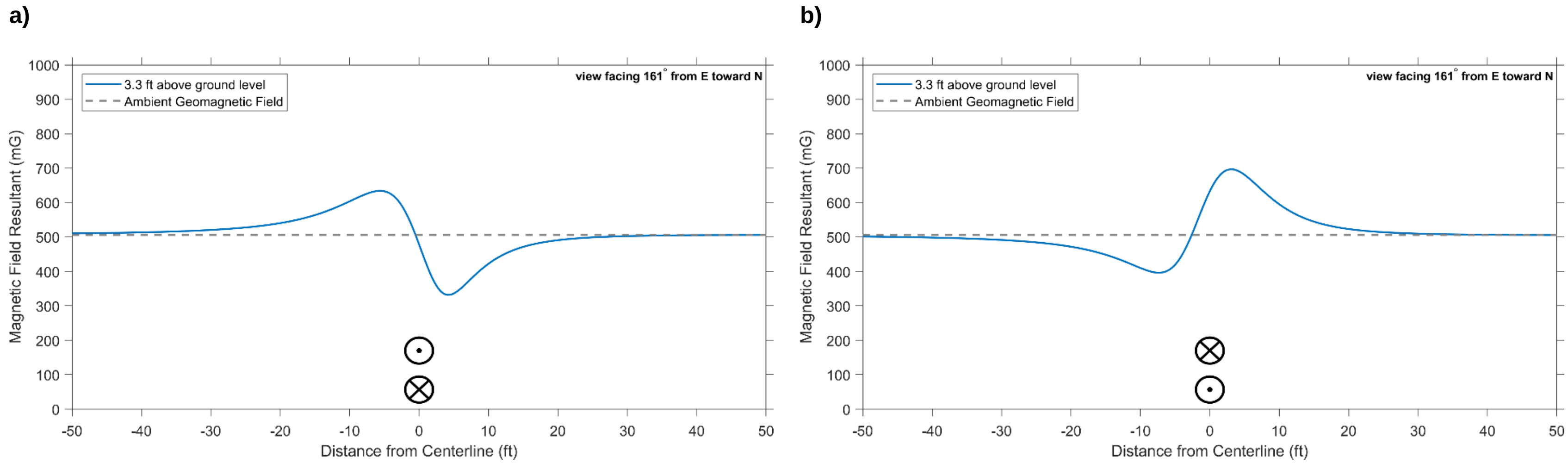


Figure C-9. Total DC magnetic field for SRWEC in which cables are installed vertically separated at the TJB (TJB Option 1) and buried to a minimum depth of 4 ft (1.2 m) at WNC loading 3.3 ft (1 m) above the ground oriented 161 degrees north of east for two different current flow direction scenarios, indicated by the figure at the bottom center of each plot.

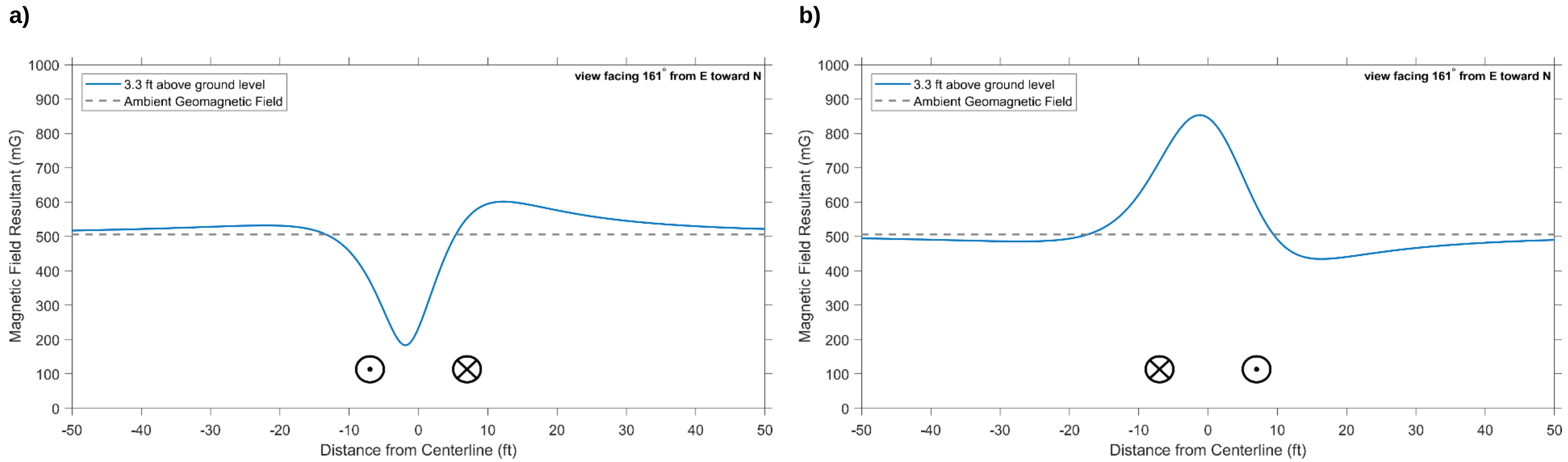


Figure C-10. Total DC magnetic field for SRWEC in which cables are installed horizontally separated at the TJB (TJB Option 2) and buried to a minimum depth of 7 ft (2.1 m) at WNC loading 3.3 ft (1 m) above the ground oriented 161 degrees north of east for two different current flow direction scenarios, indicated by the figure at the bottom center of each plot.

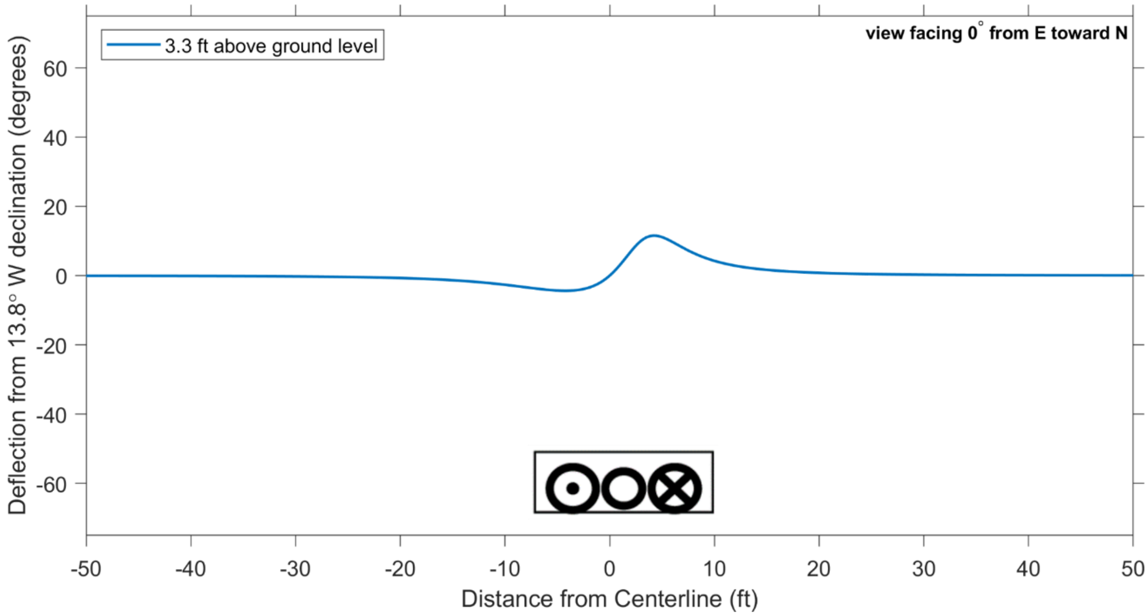
Compass Deflection

A compass needle typically points along the direction of the Earth's geomagnetic field, but a new DC magnetic-field source may cause a local deviation in the apparent direction of magnetic north. Here, this deviation is calculated as the compass deflection, which is the difference in angular direction in degrees between the horizontal component of the ambient geomagnetic field and the horizontal component direction of the combined DC field from the Earth and from the Onshore Transmission Cable. Modern navigational instruments that obtain compass readings and locations from global positioning system receivers would not be affected by magnetic-field deflections from the Project cables.

To assess the effect of the Onshore Transmission Cable on potential compass readings, the deflections of the horizontal component of the total magnetic field from that of the Earth's geomagnetic field were calculated. As an illustrative representation of the results, the plotted data in Figure C-11 show the calculated compass deflection for both of the DC cable configurations when the cables are oriented east-west for the DC duct bank configuration. This figure shows that the direction of the current plays a role in the location of where the maximum compass deviation will be observed but does not play as large a role as in the magnetic-field deviation from the ambient geomagnetic field (discussed above in relation to Figure C-1).

The results of this analysis, summarized in Table C-1, show that the maximum compass deviation for either current direction is approximately 12 degrees and that within ±10 ft (±3 m) of the DC duct bank centerline, compass deviations are approximately 4.2 degrees or less. Detailed compass deflection results for every configuration, including Transition and TJB configurations, and geographic orientation at average loading are presented below in Figure C-12 to Figure C-17. Tabular summaries at both average and peak loading are provided in Table C-8 to Table C-14.

a)



b)

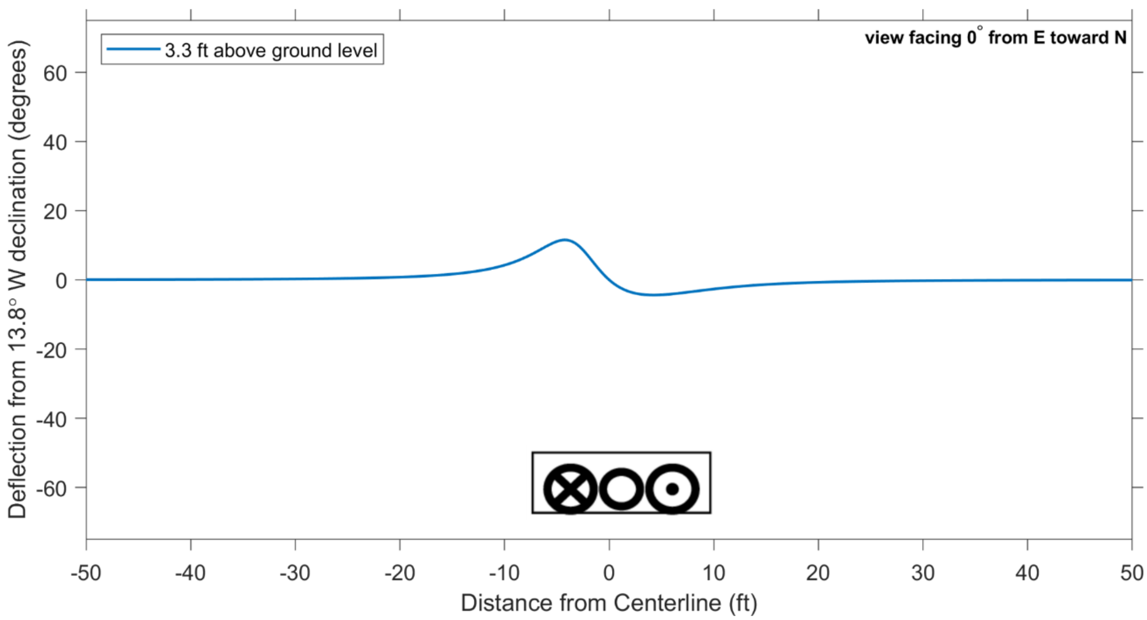
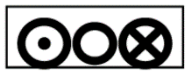
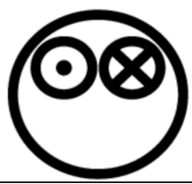
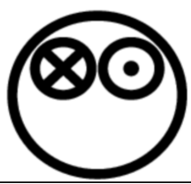


Figure C-11. Compass deflection (degrees) from magnetic north for the Onshore Transmission Cable in the DC duct bank configuration, oriented in an east-west direction for average loading and calculated at a height of 3.3 ft (1 m) above ground.

The figure insets depict two current flow scenarios. For (a), the cables are modeled with current flowing out of the page on the left conduit and into the page on the right conduit, while for (b), the cables are modeled with current flowing out of the page on the right conduit and into the page on the left conduit.

Table C-8. Compass deflection (degrees) from magnetic north for an east-west cable orientation, evaluated at various horizontal distances 3.3 ft (1 m) above ground at average loading

Installation Type	Configuration†	Compass deflection (degrees) from magnetic north			
		–10 ft (–3 m)	**(+) Max**	**(–) Max**	**+10 ft (+3 m)**
DC Duct Bank		-2.6	12	-4.4	4.2
		4.2	12	-4.4	-2.6
	east-west summary	-2.6 to 4.2	12	-4.4	-2.6 to 4.2
DC Trenchless†		-1.4	2.2	-1.7	1.7
		1.7	2.2	-1.7	-1.4
	east-west summary	-1.4 to 1.7	2.2	-1.7	-1.4 to 1.7

* Figures depict direction of current flow.

† Trenchless configuration shown is representative of the intracoastal waterway. Compass deflections for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-9. Compass deflection (degrees) from magnetic north for each of the six geographic orientations, evaluated at various horizontal distances 3.3 ft (1 m) above ground at average loading

Installation Type	Cable Route	Compass deflection (degrees) from magnetic north			
		–10 ft (–3 m)	**(+) Max**	**(–) Max**	**+10 ft (+3 m)**
DC Duct Bank	north-south	-14 to 12	22	-27 to -27	-14 to 12
	east-west	-2.6 to 4.2	12 to 12	-4.4	-2.6 to 4.2
	30° north of east	-5 to 3.1	5.1	-13	-5 to 3.1
	75° north of east	-13 to 11	19	-28	-13 to 11
	110° north of east	-13 to 14	26	-24	-13 to 14
	155° north of east	-7.2 to 10	25	-12	-7.2 to 10
DC Trenchless*	north-south	-6.5 to 6.1	7.5	-8.1	-6.5 to 6.1
	east-west	-1.4 to 1.7	2.2	-1.7	-1.4 to 1.7
	30° north of east	-2 to 1.6	2	-2.6	-2 to 1.6
	75° north of east	-6 to 5.4	6.6	-7.6	-6 to 5.4
	110° north of east	-6.4 to 6.5	8.1	-7.9	-6.4 to 6.5
	155° north of east	-3.7 to 4.5	5.7	-4.6	-3.7 to 4.5

* Trenchless configuration shown is representative of the intracoastal waterway. Compass deflections for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-10. Compass deflection (degrees) from magnetic north for each of the six geographic orientations, evaluated at various horizontal distances 3.3 ft (1 m) above ground at peak loading

Installation Type	Cable Route	Compass deflection (degrees) from magnetic north			
		–10 ft (–3 m)	**(+) Max**	**(–) Max**	**+10 ft (+3 m)**
DC Duct Bank	north-south	-12 to 21	35 to 60	-47 to -18	-26 to 23
	east-west	-26 to -4.2	35 to 53	-47 to -6.4	11 to 21
	30° north of east	5.0	7.5	-56	-12
	75° north of east	-12 to 18	7.5 to 28	-56 to -53	-26 to 5
	110° north of east	-26 to 25	28 to 44	-53 to -38	-23 to 18
	155° north of east	-23 to 23	44 to 60	-38 to -18	-12 to 25
DC Trenchless*	north-south	-12 to 11	14	-15	-12 to 11
	east–west	-2.4 to 3.6	4.8	-2.9	-2.4 to 3.6
	30° north of east	-4.2 to 2.8	3.3	-5.6	-4.2 to 2.8
	75° north of east	-12 to 9.6	12	-15	-12 to 9.6
	110° north of east	-12 to 12	15	-14	-12 to 12
	155° north of east	-6.5 to 9	12	-7.8	-6.5 to 9

* Trenchless configuration shown is representative of the intracoastal waterway. Compass deflections for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-11. Compass deflection (degrees) from magnetic north, evaluated for average loading and 3.3 ft (1 m) above ground, where SRWEC is guided via a transition duct between the HDD and the TJB along a geographic direction of 161 degrees north of east

Configuration	**Cable Orientation**	**Compass deflection (degrees) from magnetic north**			
		-10 ft (-3 m)	**(+) Max**	**(-) Max**	**+10 ft (+3 m)**
Transition Duct	⊙ ⊗	9.2	23	-10	-6.2
	⊗ ⊙	-6.2	23	-10	9.2
	161° north of east Summary	-6.2 to 9.2	23	-10	-6.2 to 9.2

Table C-12. Compass deflection from magnetic north, evaluated at average loading and 3.3 ft (1 m) above ground, where SRWEC is installed at the TJB along a geographic direction of 161 degrees north of east

Configuration	**Cable Orientation**	**Compass deflection (degrees) from magnetic north**			
		-10 ft (-3 m)	**(+) Max**	**(-) Max**	**+10 ft (+3 m)**
Onshore TJB (Option 1)	⊗ ⊙	-2	87	-3.9	-2
	⊙ ⊗	2.3	4.9	-18	2.3
	161° north of east Summary	-2 to 2.3	4.9 to 87	-18 to -3.9	-2 to 2.3
Onshore TJB (Option 2)	⊙ ⊗	70	86	-18	-16
	⊗ ⊙	-16	86	-18	70
	161° north of east Summary	-16 to 70	86	-18	-16 to 70

Table C-13. Summary of compass deflection (degrees) at various horizontal distances 3.3 ft (1 m) above ground at average loading

Evaluation Height	Compass deflection (degrees) from magnetic north											
	–75 ft (–23 m)	**–50ft (–15 m)**	**–25 ft (–18 m)**	**–10ft (–3 m)**	**–5 ft (–1.5 m)**	**(+) Max**	**(–) Max**	**+5 ft (+1.5 m)**	**+10 ft (+3 m)**	**+25 ft (+18 m)**	**+50 ft (+15 m)**	**+75 ft (+23 m)**
DC Duct Bank	-0.1 to 0.1	-0.2 to 0.2	-1.7 to 1.7	-14 to 14	-27 to 26	5.1 to 26	-28 to -4.4	-27 to 26	-14 to 14	-1.7 to 1.7	-0.2 to 0.2	-0.1 to 0.1
DC Trenchless*	-0.1 to 0.1	-0.2 to 0.2	-1.3 to 1.3	-6.5 to 6.5	-7.9 to 7.9	2 to 8.1	-8.1 to -1.7	-7.9 to 7.9	-6.5 to 6.5	-1.3 to 1.3	-0.2 to 0.2	-0.1 to 0.1
Transition Duct	<0.1	-0.1 to 0.1	-0.9 to 1	-6.2 to 9.2	-10 to 22	23 to 23	-10	-10 to 22	-6.2 to 9.2	-0.9 to 1	-0.1 to 0.1	<0.1
Onshore TJB (Option 1)	-0.4 to 0.5	-0.9 to 1	-2.7 to 3.2	-2 to 2.3	-9.5 to 19	4.9 to 87	-18 to -3.9	-9.5 to 19	-2 to 2.3	-2.7 to 3.2	-0.9 to 1	-0.4 to 0.5
Onshore TJB (Option 2)	-0.3 to 0.3	-0.9 to 1	-5.2 to 7.3	-16 to 70	-17 to 80	86	-18	-17 to 80	-16 to 70	-5.2 to 7.3	-0.9 to 1	-0.3 to 0.3

* Trenchless configuration shown is representative of the intracoastal waterway. Compass deflections for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

Table C-14. Summary of compass deflection (degrees) at various horizontal distances 3.3 ft (1 m) above ground at peak loading

Evaluation Height	Compass deflection (degrees) from magnetic north											
	–75 ft (–23 m)	–50ft (–15 m)	–25 ft (–18 m)	–10ft (–3 m)	–5 ft (–1.5 m)	(+) Max	(–) Max	+5 ft (+1.5 m)	+10 ft (+3 m)	+25 ft (+18 m)	+50 ft (+15 m)	+75 ft (+23 m)
DC Duct Bank	-0.1 to 0.1	-0.5 to 0.5	-3.2 to 3.2	-26 to 25	-53 to 58	7.5 to 60	-56 to -6.4	-53 to 58	-26 to 25	-3.2 to 3.2	-0.5 to 0.5	-0.1 to 0.1
DC Trenchless*	-0.1 to 0.1	-0.4 to 0.4	-2.4 to 2.5	-12 to 12	-15 to 15	3.3 to 15	-15 to -2.9	-15 to 15	-12 to 12	-2.4 to 2.5	-0.4 to 0.4	-0.1 to 0.1
Transition Duct	-0.1 to 0.1	-0.2 to 0.2	-1.7 to 1.8	-10 to 21	-15 to 59	61 to 61	-15 to -15	-15 to 59	-10 to 21	-1.7 to 1.8	-0.2 to 0.2	-0.1 to 0.1
Onshore TJB (Option 1)	-0.8 to 0.9	-1.7 to 1.9	-4.8 to 6.5	-3.6 to 4.4	-14 to 51	10 to 125	-23 to -6.6	-14 to 51	-3.6 to 4.4	-4.8 to 6.5	-1.7 to 1.9	-0.8 to 0.9
Onshore TJB (Option 2)	-0.5 to 0.6	-1.7 to 1.9	-8.7 to 16	-21 to 118	-22 to 122	124 to 124	-22	-22 to 122	-21 to 118	-8.7 to 16	-1.7 to 1.9	-0.5 to 0.6

* Trenchless configuration shown is representative of the intracoastal waterway. Compass deflections for a jack and bore configuration will be similar to or lower than those reported for the DC Duct Bank.

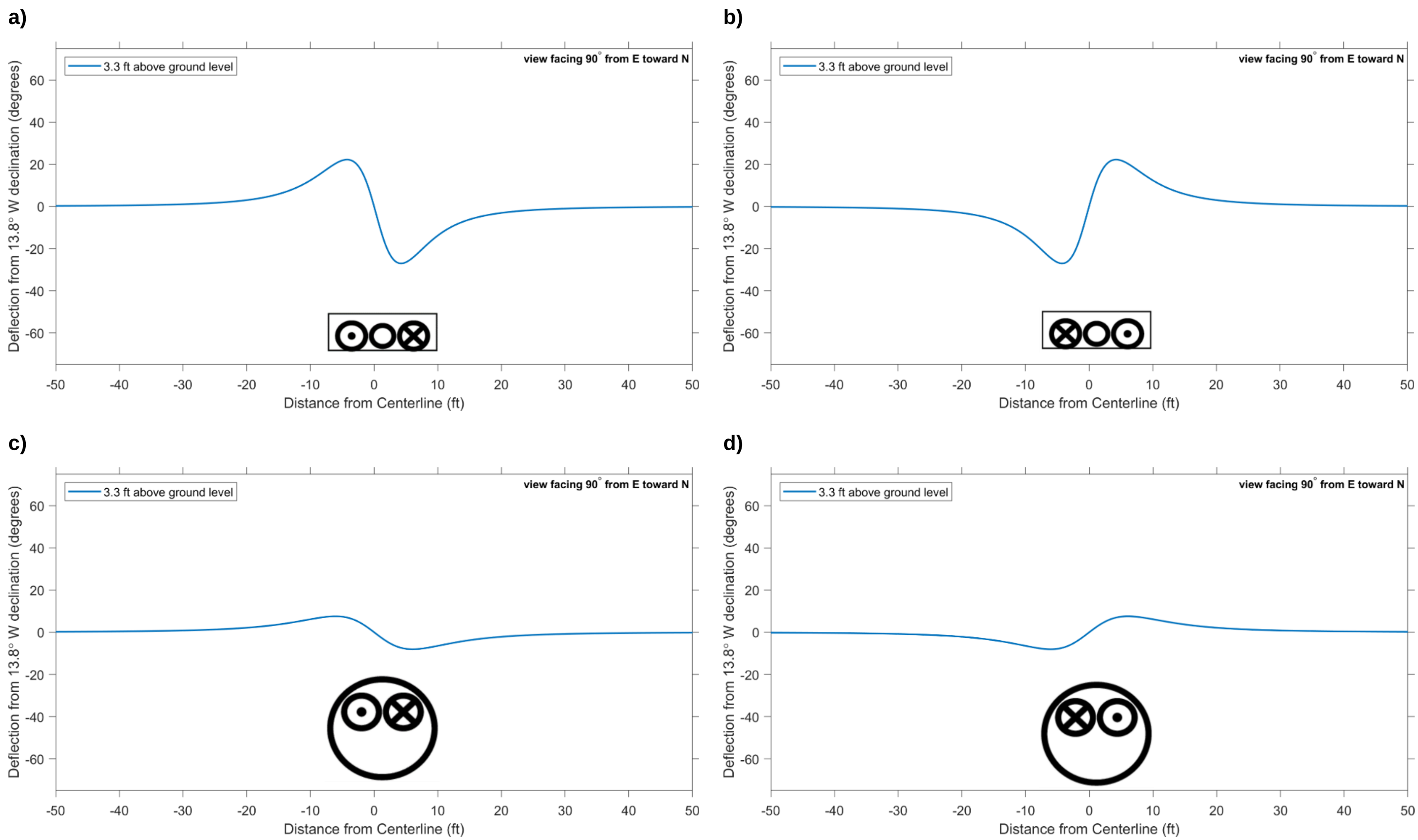


Figure C-12. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented in a north-south direction, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

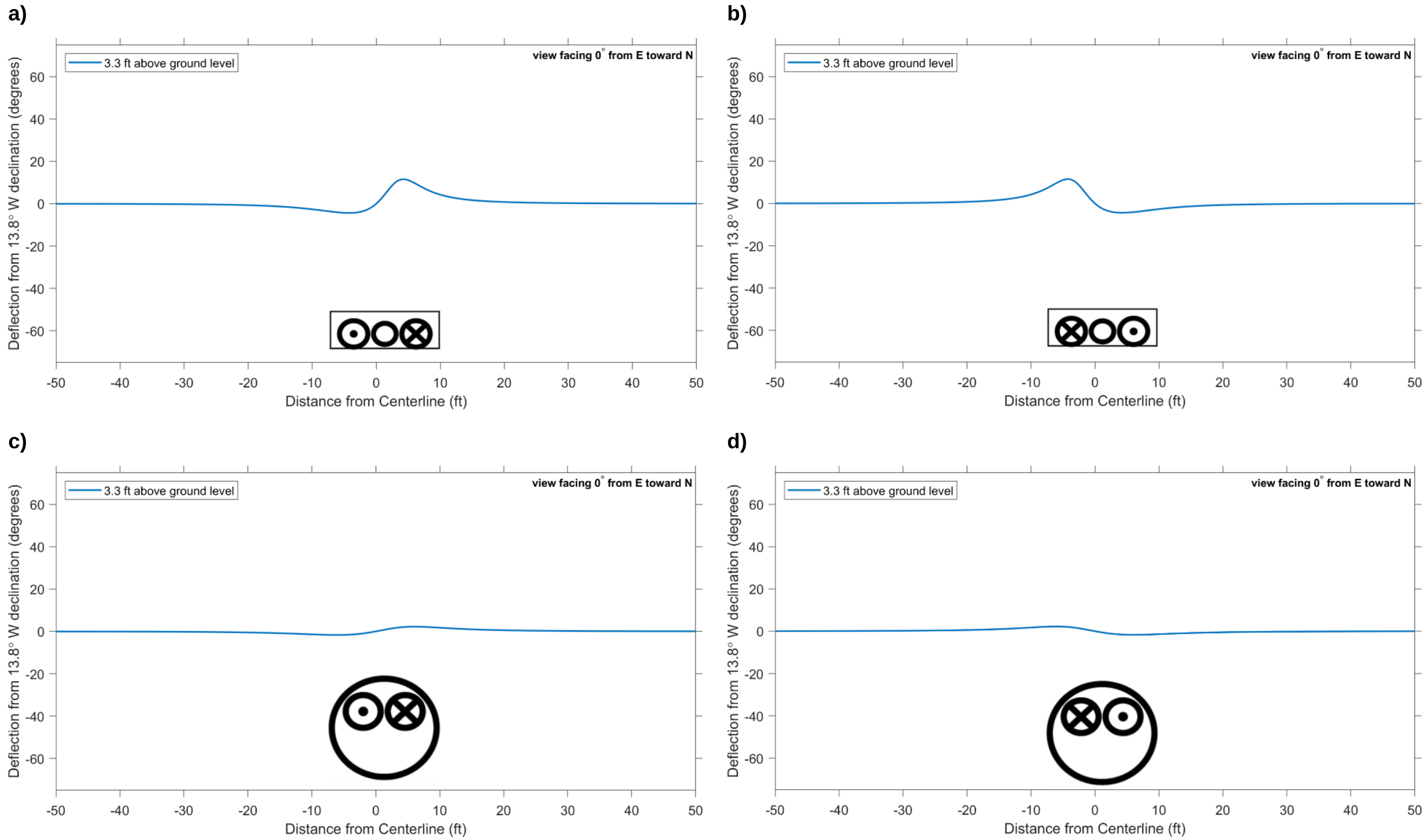


Figure C-13. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented along an east-west direction, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot). Note that plots a and b are repeated from Figure C-12.

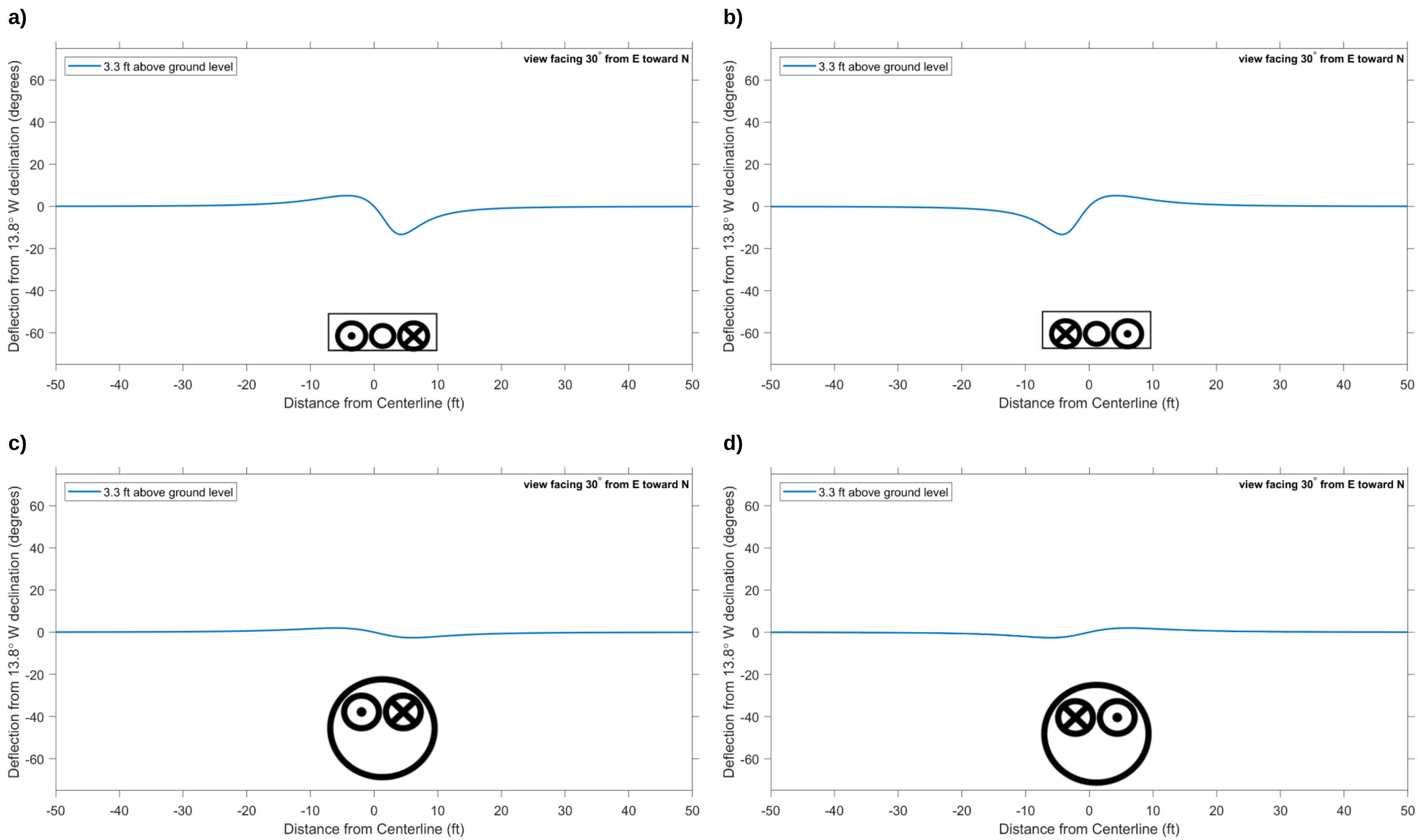


Figure C-14. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented 30 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

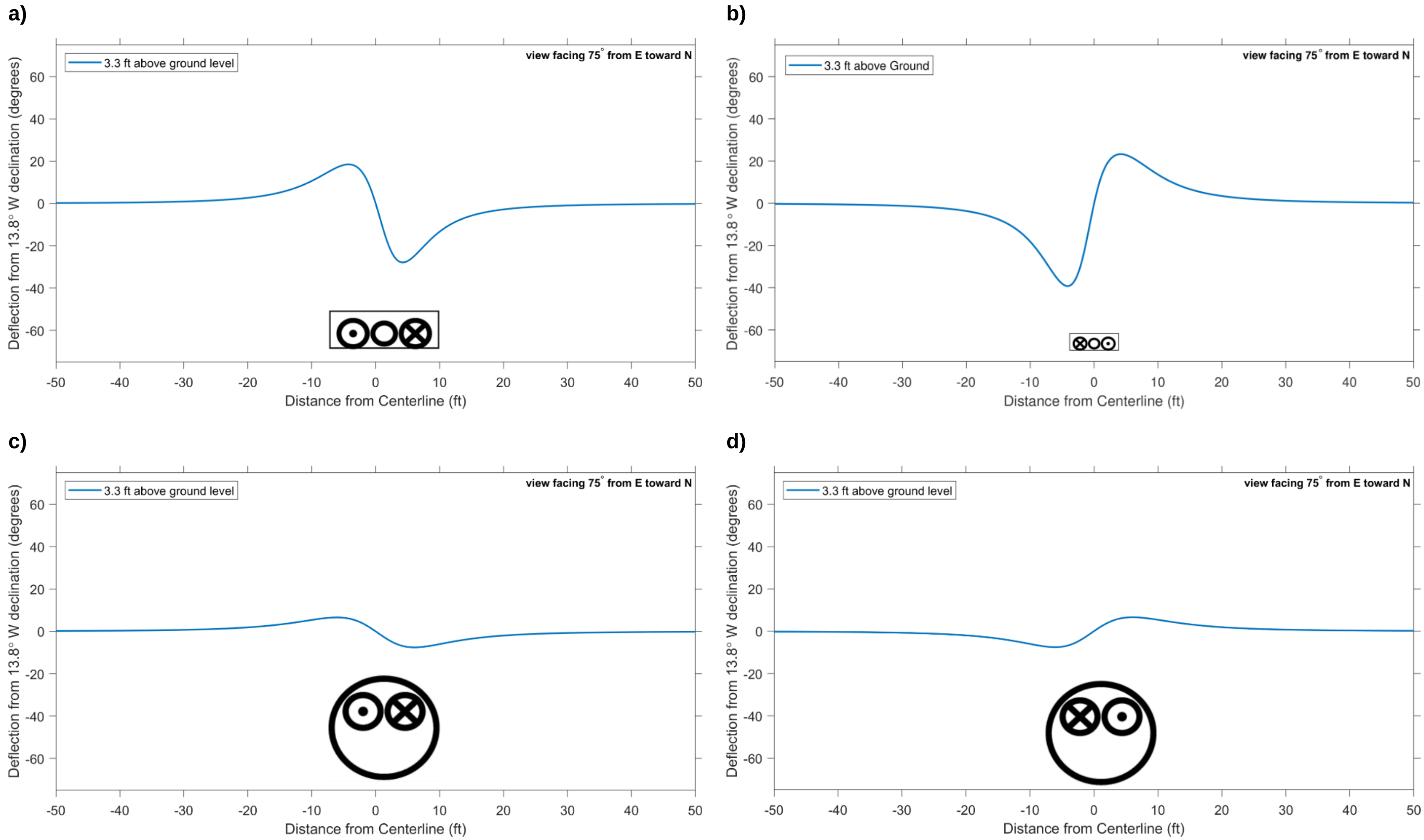


Figure C-15. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented 75 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

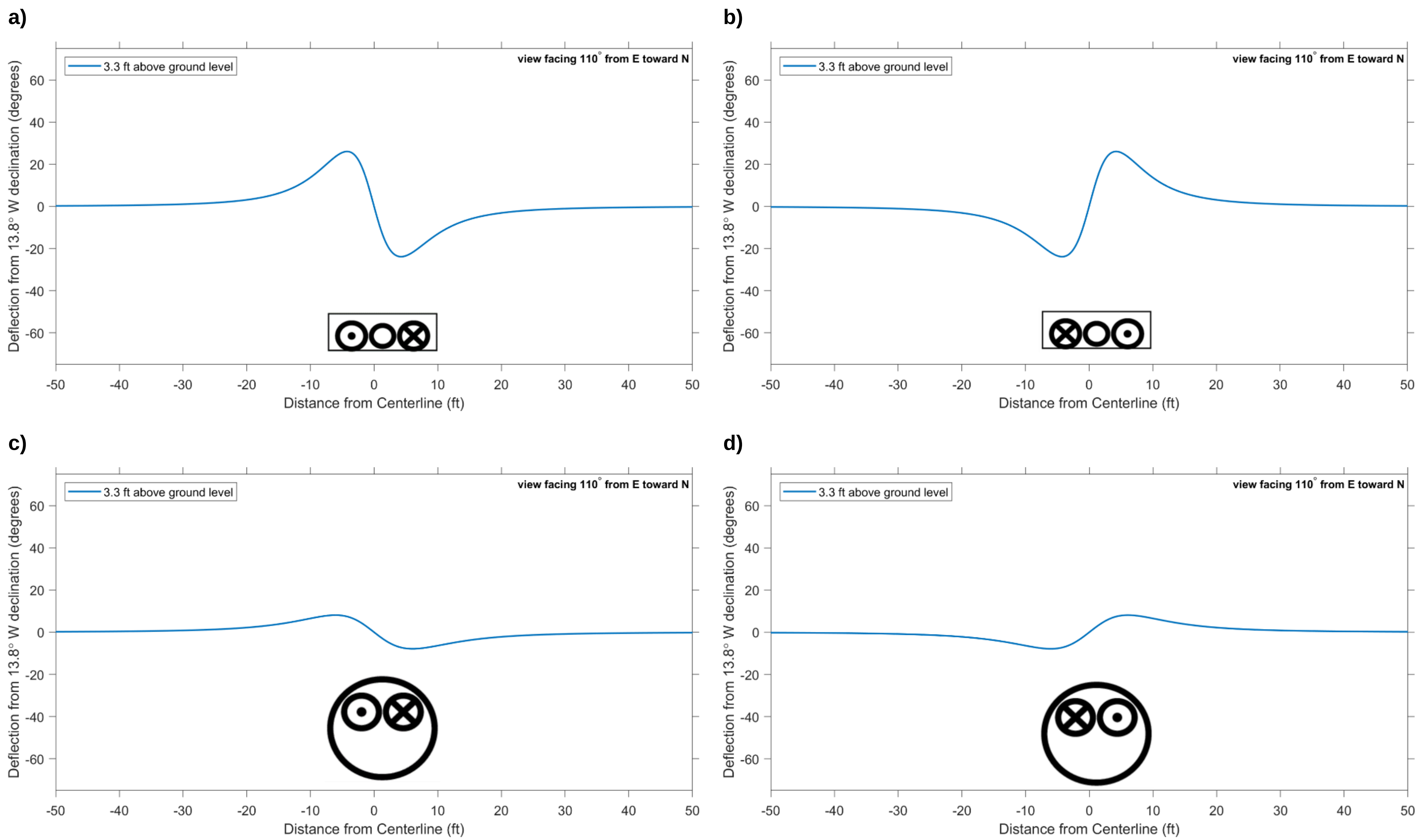


Figure C-16. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented 110 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

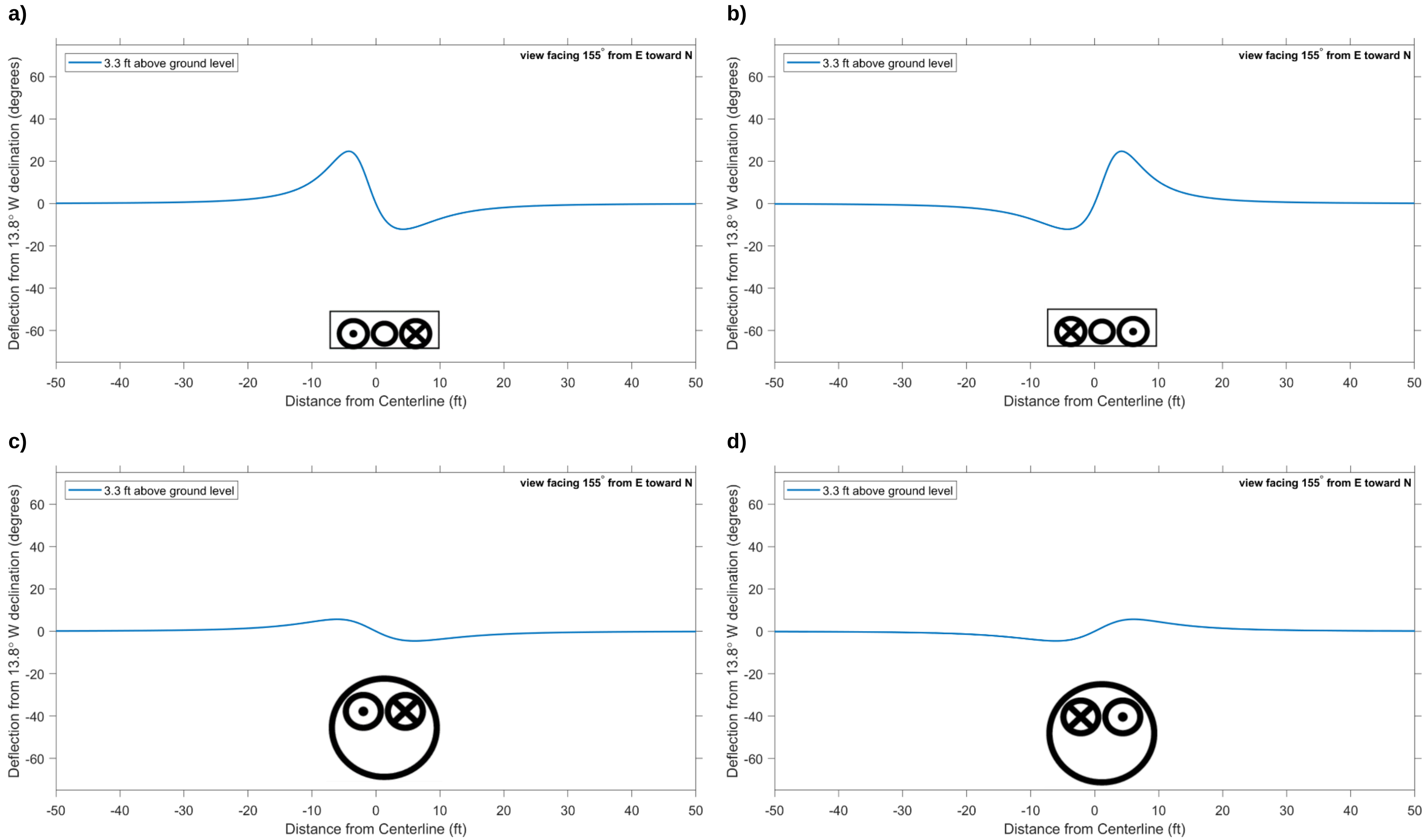


Figure C-17. Compass deflection (degrees) from magnetic north at average loading for the Onshore Transmission Cable oriented 155 degrees north of east, calculated at a height of 3.3 ft (1 m) above ground for both DC duct bank (a and b) and DC trenchless (c and d) configurations. Each evaluated for two different current flow scenarios (indicated by the inset figure at the bottom-center of each plot).

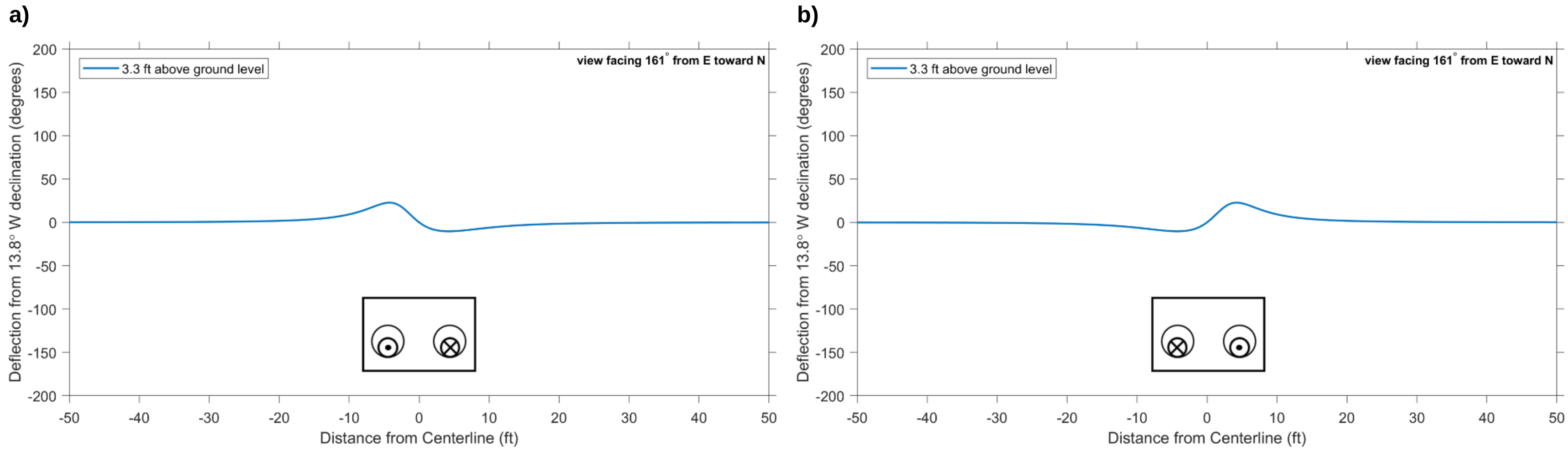


Figure C-18. Compass deflection (degrees) from magnetic north at average loading for SRWEC cables installed in a transition duct bank and buried to a depth of 3 ft (0.9 m), evaluated at 3.3 ft (1 m) above the ground and oriented 161° north of east for two different installation scenarios, indicated by the figure at the bottom center of each plot.

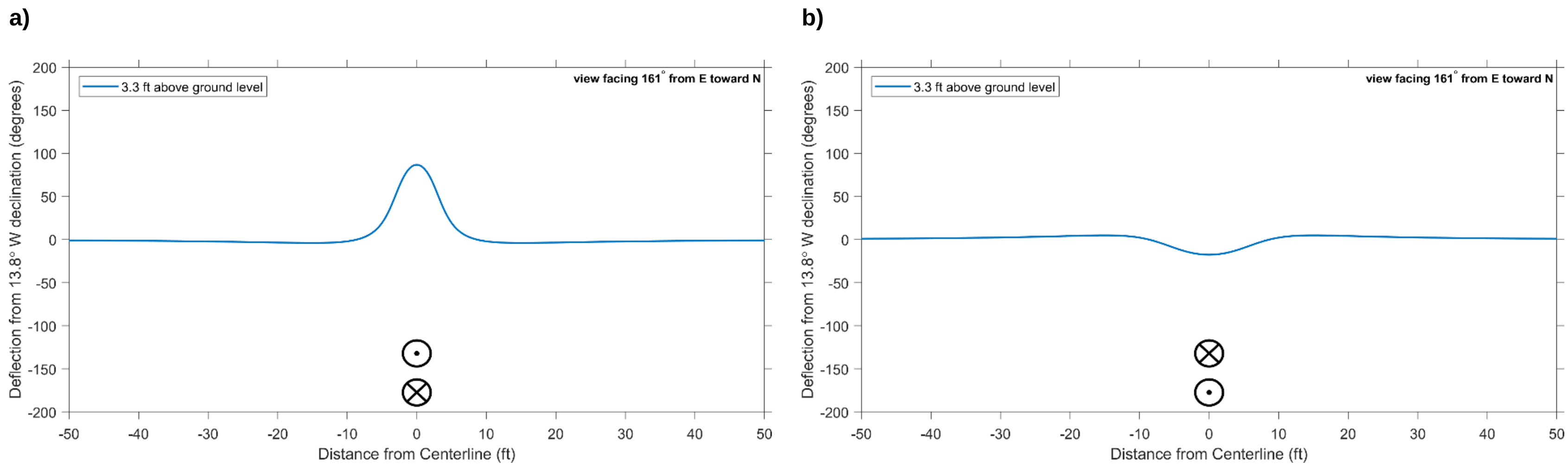


Figure C-19. Compass deflection (degrees) from magnetic north for SRWEC at average loading in which cables are installed vertically separated at the TJB (TJB Option 1) and buried to a minimum depth of 4 ft (1.2 m) at WNC loading 3.3 ft (1 m) above the ground oriented 161 degrees north of east for two different current flow direction scenarios, indicated by the figure at the bottom center of each plot.

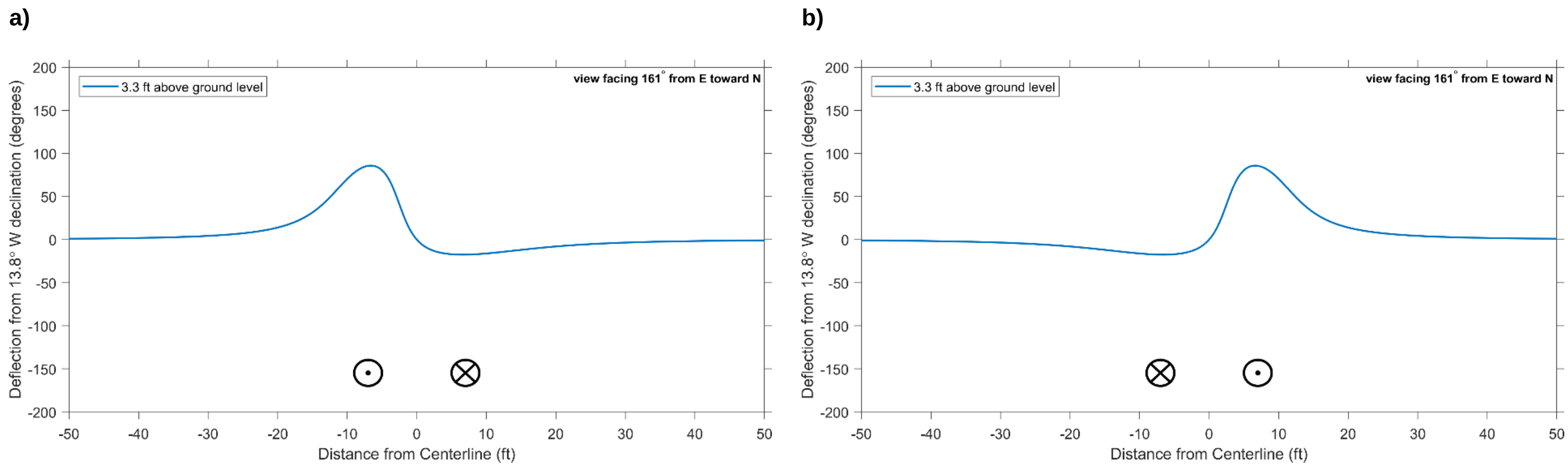


Figure C-20. Total DC magnetic field for SRWEC at average loading in which cables are installed horizontally separated at the TJB (TJB Option 2) and buried to a minimum depth of 7 ft (2.1 m) at WNC loading 3.3 ft (1 m) above the ground oriented 161 degrees north of east for two different current flow direction scenarios, indicated by the figure at the bottom center of each plot.

AC Onshore Interconnection Cables

AC Magnetic Field

The calculated AC magnetic field for the Onshore Interconnection Cable configuration installed in two duct banks depicted in Figure A-5 is shown in Figure 3 in the main body of the report and tabular results are summarized below in Table C-15.

Table C-15 Calculated AC magnetic-field levels (mG) at various horizontal distances from the nearest duct bank centerline 3.3 ft (1m) above ground at average and peak loading

Configuration	Loading	AC Magnetic Field (mG)*										
		–100 ft (–30 m)	**–75 ft (–23 m)**	**–50 ft (–15 m)**	**–25 ft (–7.6 m)**	**–10 ft (–3 m)**	**Max**	**+10 ft (+3 m)**	**+25 ft (+7.6 m)**	**+50 ft (+15 m)**	**+75 ft (+23 m)**	**+100 ft (+30 m)**
AC Interconnection	Average	1.1	1.4	2.1	4	12	60	21	5.4	2.2	1.4	1.1
	Peak	1.8	2.3	3.5	6.8	21	101	36	9.1	3.7	2.4	1.8

* As shown in Attachment A, Figure A-5, for the Onshore Interconnection Cable configuration the phase cables are divided into two groups (separated by 20 ft [6 m]). The ± horizontal distance is measured from the centerline above the left and right duct bank, respectively