Appendix F

Field Management Plan

Southern California Edison

EMF Field Management Plan

SCE TLRR Gorman-Kern River 66 kV Project

Issue 8 – February 01, 2022

GKR EMF Field Management Plan

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Acronyms and Abbreviations

A, Amps	Amperes, a unit of measure for electrical current
AC	Alternating current
AAC	All aluminum conductor, a type of overhead power line conductor
ACCC	Aluminum conductor composite core, a type of "high-temperature low-sag" overhead power line conductor
ACSR	Aluminum conductor steel reinforced, a type of overhead power line conductor
CDHS	California Department of Health Services
CPCN	Certificate of Public Convenience and Necessity
CPUC	California Public Utilities Commission
D/C	Double Circuit line construction
DI	Ductile Iron, a type of transmission structure
ELF	Extremely low frequency
EMF	Electric and magnetic fields
EPRI	Electric Power Research Institute
FMP	Field Management Plan
Ft	Feet, a unit of measure for distance
GO	General Order
GKR	Gorman-Kern River subtransmission line
HTLS	High-temperature low-sag, a type of overhead conductor
Hz	Hertz, a unit of measure for electrical frequency
IARC	International Agency for Research on Cancer
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
kcmil	Kilo (thousand) circular mils, a unit of conductor size and measurement
kV	Kilovolt, a unit of measure for electrical potential
LWS	Light weight steel, a type of transmission structure
mG	milliGauss, a unit of measure for magnetic fields
NIEHS	National Institute of Environmental Health Sciences (USA)
NRBB	National Radiological Protection Board (UK)
°	Degrees, a unit of measure for electric phasors

OHGW	Overhead ground wire
OPGW	Optical ground wire
PEA	Proponent's Environmental Assessment
PTC	Permit to Construct
PLS-CADD	A software program for transmission line design
ROW	Right of way
SCE	Southern California Edison
Str	Structure
TLRR	Transmission Line Rating and Remediation
T/L	Transmission Line
TSP	Tubular steel pole, a type of transmission structure
μT	Microtesla, a unit of measure for magnetic fields
WHO	World Health Organization

Executive Summary

The Field Management Plan (FMP) presented in this report describes the magnetic field reduction design options incorporated into the design of the Southern California Edison Company (SCE) Transmission Line Rating and Remediation (TLRR) Gorman-Kern River 66 kV Project (GKR Project) which consists of the following existing subtransmission circuits:

- Banducci-Kern River 1
- Frazier Park-Gorman
- Gorman-Kern River 1

Segments and Sections

The circuits included in the GKR Project are divided into separate segments as described below, and are further sub-categorized into multiple sections.

- Segment 1: Kern River 1 Hydroelectric Substation to Structure M20-T3
- Segment 2: Structure M20-T3 to Frazier Park Tap
- Segment 3: Frazier Park Tap to Gorman Substation
- Segment 4: Structure M20-T3 to X7666E
- Segment 5: Structure X7666E to Banducci Substation

The GKR Project is proposed to meet the following objectives: Comply with standards contained in CPUC GO 95; and address reliability concerns related to the age and the condition of existing infrastructure on the affected subtransmission lines.

Details pertaining to the GKR Project subtransmission line infrastructure are provided in the Proponent's Environmental Assessment (PEA).

Codes and Standards

The FMP for the GKR Project has been prepared in accordance with the California Public Utilities Commission (CPUC) Interim electric and magnetic fields (EMF) Decision No. 06-01-042 ("2006 CPUC Decision") and general recommendations supported by the U.S. National Institute of Environmental Health Sciences and also satisfies the CPUC approved EMF Design Guidelines as well as all national and state safety standards for reconductoring and new electric facilities.

Magnetic Field Reduction Measures

SCE provides this FMP to inform all interested parties of the evaluation of "no-cost and low-cost" magnetic field reduction design options being considered and the proposed application of these design options for the GKR Project. The FMP also provides a summary of background information regarding current scientific research related to possible health effects of EMF and the CPUC EMF Policy.

"No-Cost" Magnetic Field Reduction Design Options

The "no-cost" magnetic field reduction design options that are incorporated into the design of the GKR Project include the following utilization of structure types and characteristics which minimize EMF. Vertical and delta conductor configurations are used to reduce EMF in locations outside the Right of Way. Lastly, taller structure heights are used in areas with potential overhead discrepancies, increasing ground clearance and minimizing EMF.

"Low-Cost" Magnetic Field Reduction Design Options

The "no-cost and low-cost" magnetic field reduction design options implemented for this project are described in Table 1. Several portions of the project which are of specific interest for the EMF study are noted in the table below and will be further addressed in the EMF study for safety concerns. The most significant EMF conditions in each residential area will be modeled and graphed to address previous science studies.

Table 1 – "Low Cost and No Cost" Options Considered for Project

Segment	Start Structure	End Structure	EMF Reduction Design Options	Estimated Cost	Structures in Residential Area
Segment 1	Kern River 1 Hydroelectric Substation	Structure M20-T3	• Pole Head Configuration • Structure Heights	No cost No cost	1. 2241821E_2241822E-M6-T7, 2. M10-T2-M10-T3, 3. M17-T4-M17-T5, 4. M18-T3-M18-T4
Segment 2	Structure M20-T3	Frazier Park Tap	• Pole Head Configuration • Structure Heights	No cost No cost	N/A
Segment 3	Frazier Park Tap	Gorman Substation	• Pole Head Configuration • Structure Heights	No cost No cost	N/A
Segment 4	Structure M20-T3	Structure X7666E	• Pole Head Configuration • Structure Heights	No cost No cost	1. M9-T6-M9-T7
Segment 5	Structure X7666E	Banducci Substation	N/A	No cost No cost	N/A

1 EMF Background and Public Research

There are many sources of power frequency[1] electric and magnetic fields, including internal household and building wiring, electrical appliances, and electric power transmission and distribution lines. There have been numerous scientific studies about the potential health effects of EMF. After many years of research, the scientific community has been unable to determine if exposures to EMF cause health hazards. State and federal public health regulatory agencies have determined that setting numeric exposure limits is not appropriate.[2]

Many of the questions about possible connections between EMF exposures and specific diseases have been successfully resolved due to an aggressive international research program. However, potentially important public health questions remain about whether there is a link between EMF exposures and certain diseases, including childhood leukemia and a variety of adult diseases (e.g., adult cancers and miscarriages). As a result, some health authorities have identified magnetic field exposures as a possible human carcinogen. As summarized in greater detail below, these conclusions are consistent with the following published reports: the National Institute of Environmental Health Sciences (NIEHS) 1999[3], the National Radiation Protection Board (NRPB) 2001[4], the International Commission on non-Ionizing Radiation Protection (ICNIRP) 2001, the California Department of Health Services (CDHS) 2002[5], the International Agency for Research on Cancer (IARC) 2002[6] and the World Health Organization (WHO) 2007[7]. The federal government conducted EMF research as a part of a $45-million research program managed by the NIEHS. This program, known as the EMF RAPID (Research and Public Information Dissemination), submitted its final report to the U.S. Congress on June 15, 1999.

The report concluded that:

- "The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak."[8]
- "The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard."[9]
- "The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and

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1 In U.S., it is 60 Hertz (Hz).
2 CPUC Decision 06-01-042, p. 6, footnote 10.
3 National Institute of Environmental Health Sciences' Report on Health Effects from Exposures to Power-Line frequency Electric and Magnetic Fields, NIH Publication No. 99-4493, June 1999.
4 National Radiological Protection Board, Electromagnetic Fields and the Risk of Cancer, Report of an Advisory Group on Non-ionizing Radiation, Chilton, U.K. 2001.
5 California Department of Health Services, An Evaluation of the Possible Risks from Electric and Magnetic Fields from Power Lines, Internal Wiring, Electrical Occupations, and Appliances, June 2002.
6 World Health Organization / International Agency for Research on Cancer, IARC Monographs on the evaluation of carcinogenic risks to humans (2002), Non-ionizing radiation, Part 1: Static and extremely low frequency (ELF) electric and magnetic fields, IARC Press, Lyon, France: International Agency for Research on Cancer, Monograph, vol. 80, p. 338, 2002.
7 WHO, Environmental Health Criteria 238, EXTREMELY LOW FREQUENCY FIELDS, 2007.
8 National Institute of Environmental Health Sciences, NIEHS Report on Health Effects from Exposures to Power-Frequency Electric and Magnetic Fields, p. ii, NIH Publication No. 99-4493, 1999.
9 *Ibid.*, p. iii.

continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards."[10]

In 2001, Britain's NRPB arrived at a similar conclusion:

> "After a wide-ranging and thorough review of scientific research, an independent Advisory Group to the Board of NRPB has concluded that the power frequency electromagnetic fields that exist in the vast majority of homes are not a cause of cancer in general. However, some epidemiological studies do indicate a possible small risk of childhood leukemia associated with exposures to unusually high levels of power frequency magnetic fields."[11]

In 2002, three scientists for CDHS concluded:

> "To one degree or another, all three of the [CDHS] scientists are inclined to believe that EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's disease, and miscarriage. They [CDHS] strongly believe that EMFs do not increase the risk of birth defects, or low birth weight.
>
> They [CDHS] strongly believe that EMFs are not universal carcinogens, since there are a number of cancer types that are not associated with EMF exposure. To one degree or another they [CDHS] are inclined to believe that EMFs do not cause an increased risk of breast cancer, heart disease, Alzheimer's disease, depression, or symptoms attributed by some to a sensitivity to EMFs. However, all three scientists had judgments that were "close to the dividing line between believing and not believing" that EMFs cause some degree of increased risk of suicide. For adult leukemia, two of the scientists are 'close to the dividing line between believing or not believing' and one was 'prone to believe' that EMFs cause some degree of increased risk."[12]

In addition, in 2002, the World Health Organization's (WHO) IARC concluded:

> "EMF magnetic fields are possibly carcinogenic to humans"[13], based on consistent statistical associations of high-level residential magnetic fields with a doubling of risk of childhood leukemia...Children who are exposed to residential EMF magnetic fields less than 0.4 microTesla (4.0 milliGauss) have no increased risk for leukemia…. In contrast, "no consistent relationship has been seen in studies of childhood brain tumors or cancers at other sites and residential EMF electric and magnetic fields."[14]

In June of 2007, the WHO issued a report on their multi-year investigation of EMF and the possible health effects. After reviewing scientific data from numerous EMF and human health studies, they concluded:

> "Scientific evidence suggesting that every day, chronic low-intensity (above 0.3- 0.4 μT [3-4 mG]) power-frequency magnetic field exposure poses a health risk is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukemia."[15] "In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship

[10] *Ibid.*, p. 37 – 38
[11] NRPB, NRPB Advisory Group on Non-ionizing Radiation Power Frequency Electromagnetic Fields and the Risk of Cancer, NRPB Press Release May 2001.
[12] CDHS, An Evaluation of the Possible Risks From Electric and Magnetic Fields (EMFs) From Power Lines, Internal Wiring, Electrical Occupations and Appliances, p. 3, 2002.
[13] IARC, Monographs, Part I, Vol. 80, p. 338.
[14] *Ibid*., p. 332 – 334.
[15] WHO, Environmental Health Criteria 238, EXTREMELY LOW FREQUENCY FIELDS, p. 11 - 13, 2007.

between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern."[16]

"A number of other diseases have been investigated for possible association with ELF magnetic field exposure. These include cancers in both children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications, and neurological disease. The scientific evidence supporting a linkage between ELF magnetic fields and any of these diseases is much weaker than for childhood leukemia and in some cases (for example, for cardiovascular disease or breast cancer) the evidence is sufficient to give confidence that magnetic fields do not cause the disease"[17]

"Furthermore, given both the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukemia, and the limited impact on public health if there is a link, the benefits of exposure reduction on health are unclear. Thus, the costs of precautionary measures should be very low."[18]

2 Application of CPUC EMF Policy

Recognizing the scientific uncertainty over the connection between EMF exposures and health effects, the CPUC adopted a policy that addresses public concern over EMF with a combination of education, information, and precaution-based approaches. Specifically, Decision 93-11-013 established a precautionary based "no-cost and low-cost" EMF policy for California's regulated electric utilities based on recognition that scientific research had not demonstrated that exposures to EMF cause health hazards and that it was inappropriate to set numeric standards that would limit exposure.

In 2006, the CPUC completed its review and updated its EMF Policy in Decision 06-01-042. This decision reaffirmed the finding that state and federal public health regulatory agencies have not established a direct link between exposure to EMF and human health effects,[19] and the policy direction that (1) use of numeric exposure limits was not appropriate in setting utility design guidelines to address EMF,[20] and (2) existing "no-cost and low-cost" precautionary-based EMF policy should be continued for proposed electrical facilities. In addition, the decision also reaffirmed that EMF concerns brought up during Certificate of Public Convenience and Necessity (CPCN) and Permit to Construct (PTC) proceedings for electric transmission and substation facilities should be limited to the utility's compliance with the CPUC's "no-cost and low-cost" policies.[21]

[16] *Ibid*., p. 12.
[17] *Ibid*., p. 12.
[18] *Ibid*., p. 13.
[19] CPUC Decision 06-01-042, Conclusion of Law No. 5, mimeo. p. 19 ("As discussed in the rulemaking, a direct link between exposure to EMF and human health effects has yet to be proven despite numerous studies including a study ordered by this Commission and conducted by DHS.")
[20] CPUC Decision 06-01-042, mimeo. p. 17 - 18 ("Furthermore, we do not request that utilities include nonroutine mitigation measures, or other mitigation measures that are based on numeric values of EMF exposure, in revised design guidelines or apply mitigation measures to reconfigurations or relocations of less than 2,000 feet, the distance under which exemptions apply under GO 131-D. Non-routine mitigation measures should only be considered under unique circumstances.").
[21] CPUC Decision 06-01-042, Conclusion of Law No. 2, ("EMF concerns in future CPCN and PTC proceedings for electric and transmission and substation facilities should be limited to the utility's compliance with the Commission's low-cost/no-cost policies.").

The decision directed regulated utilities to hold a workshop to develop standard approaches for EMF Design Guidelines; such a workshop was held on February 21, 2006. Consistent design guidelines have been developed to describe the routine magnetic field reduction measures that regulate California electric utilities utilize for new and upgraded transmission line and transmission substation projects. SCE filed its revised EMF Design Guidelines with the CPUC on July 26, 2006.

"No-cost and low-cost" measures to reduce magnetic fields would be implemented for this Project in accordance with SCE's EMF Design Guidelines. In summary, the process of evaluating "no-cost and low-cost" magnetic field reduction measures and prioritizing within and between land usage classes considers the following:

1. SCE's priority in the design of any electrical facility is public and employee safety. Without exception, design and construction of an electric power system must comply with all applicable federal, state, and local regulations, applicable safety codes, and each electric utility's construction standards. Furthermore, transmission and subtransmission lines and substations must be constructed so that they can operate reliably at their design capacity. Their design must be compatible with other facilities in the area and the cost to operate and maintain the facilities must be reasonable.
2. As a supplement to Step 1, SCE follows the CPUC's direction to undertake "no-cost and low-cost" magnetic field reduction measures for new and upgraded electrical facilities. Any proposed "no-cost and low-cost" magnetic field measures, must, however, meet the requirements described in Step 1 above. The CPUC defines "no-cost and low-cost" measures as follows:
   - Low-cost measures, in aggregate, should:
     - Cost in the range of 4 percent of the total project cost.
     - Result in magnetic field reductions of "15% or greater at the utility R-O-W ([right-of-way] …"[22]

   The CPUC Decision stated,

   > "We direct the utilities to use 4 percent as a benchmark in developing their EMF mitigation guidelines. We will not establish 4 percent as an absolute cap at this time because we do not want to arbitrarily eliminate a potential measure that might be available but costs more than the 4 percent figure. Conversely, the utilities are encouraged to use effective measures that cost less than 4 percent."[23]

3. The CPUC provided further policy direction in Decision 06-01-042, stating that, "although equal mitigation for an entire class is a desirable goal, we will not limit the spending of EMF mitigation to zero on the basis that not all class members can benefit."[24] While Decision 06-01-042 directs the utilities to favor schools, day-care facilities and hospitals over residential areas when applying low-cost magnetic field reduction measures, prioritization within a class can be difficult on a project case-by-case basis because schools, day-care facilities, and hospitals are often integrated into residential areas, and many licensed day-care facilities are housed in private homes, and can be easily moved from one location to another. Therefore, it may be practical for public schools, licensed day-care centers, hospitals, and residential land uses to be grouped together to receive highest prioritization for low-cost magnetic field reduction measures. Commercial and industrial areas may be grouped as a second priority group, followed by recreational and agricultural areas as the third group. Low-cost magnetic field reduction measures will not be considered for undeveloped land, such as open space, state and national parks, and Bureau of Land Management and U.S. Forest Service

[22] CPUC Decision 06-01-042, p. 10.
[23] CPUC Decision 93-11-013, § 3.3.2, p.10.
[24] CPUC Decision 06-01-042, p. 10.

lands. When spending for low-cost measures would otherwise disallow equitable magnetic field reduction for all areas within a single land-use class, prioritization can be achieved by considering location and/or density of permanently occupied structures on lands adjacent to the projects, as appropriate.

This FMP contains descriptions of various magnetic field models and the calculated results of magnetic field levels based on those models. These calculated results are provided only for purposes of identifying the relative differences in magnetic field levels among various transmission or subtransmission line design alternatives under a specific set of modeling assumptions and determining whether design alternatives can achieve magnetic field level reductions of 15 percent or more at the edges of the right-of-way. The calculated results are not intended to be predictors of the actual magnetic field levels at any given time or at any specific location if and when the Project is constructed. This is because magnetic field levels depend upon a variety of variables, including load growth, customer electricity usage, and other factors beyond SCE's control. The CPUC affirmed this in Decision 06-01-042 stating:

> "Our [CPUC] review of the modeling methodology provided in the utility [EMF] design guidelines indicates that it accomplishes its purpose, which is to measure the relative differences between alternative mitigation measures. Thus, the modeling indicates relative differences in magnetic field reductions between different transmission line construction methods but does not measure actual environmental magnetic fields."[25]

2.1 Project Description

The GKR Project is proposed to meet the following objectives: Comply with standards contained in CPUC GO 95; and address reliability concerns related to the age and the condition of existing infrastructure on the affected subtransmission lines.

To meet these objectives, the GKR Project proposes to replace structures, to install new conductor, and to install OPGW for improved grounding and substation communications. The existing line is approximately 83.6 miles long and is comprised mainly of steel lattice towers (63%) and wood monopoles (35%), with several wooden H-Frames (2%). The original line was constructed in 1903, but many structure replacements have occurred since then. The existing conductor consists of 336.4 ACSR 30/7 "Oriole", 336.4 ACSR 18/1 "Merlin", and 4/0 7-strand copper. The existing line is designed to carry an emergency 4-hour ampacity of 680 amps but only a normal operation ampacity of 540 Amps.

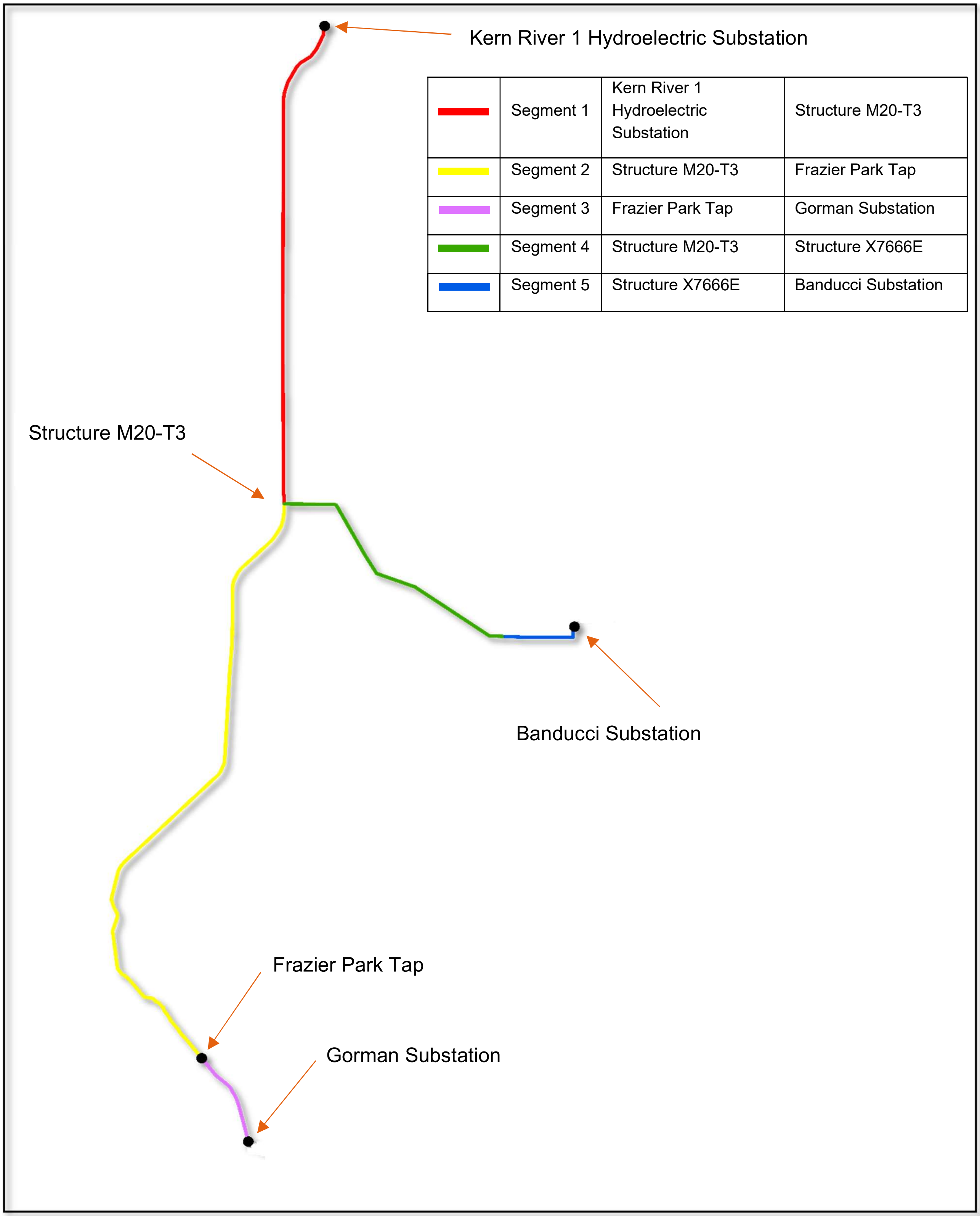
2.2 Geographic Segments

The Project has been divided into the following geographic segments in the PEA report submittal:

Segment	Start Structure	End Structure	Approx. Length
Segment 1	Kern River 1 Hydroelectric Substation	Structure M20-T3	20.3 mi.
Segment 2	Structure M20-T3	Frazier Park Tap	26.9 mi.
Segment 3	Frazier Park Tap	Gorman Substation	4.0 mi.
Segment 4	Structure M20-T3	Structure X7666E	11.1 mi.
Segment 5	Structure X7666E	Banducci Substation	3.0 mi.

[25] CPUC Decision 06-01-042, p. 11.

Figure 1 – Gorman-Kern River 66 kV Subtransmission Line Route and Segments



	Segment 1	Kern River 1 Hydroelectric Substation	Structure M20-T3
	Segment 2	Structure M20-T3	Frazier Park Tap
	Segment 3	Frazier Park Tap	Gorman Substation
	Segment 4	Structure M20-T3	Structure X7666E
	Segment 5	Structure X7666E	Banducci Substation

3 Summary of Project Components by Segment

Segment 1 Proposed Construction Activities

The majority of existing structures and all conductors would be removed and new structures and conductor would be installed along the length of Segment 1. Some existing structures would be modified and remain in-place. OPGW would be installed on the new structures.

Segment 2 Proposed Construction Activities

The existing structures and conductor would be removed, and new structures and conductor would be installed along the length of Segment 2. OPGW would be installed on the new structures.

Segment 3 Proposed Construction Activities

The existing structures and conductor would be removed and new structures and conductor would be installed along the length of Segment 3. OPGW would be installed on the new structures.

Segment 4 Proposed Construction Activities

The existing structures and conductor would be removed and new structures and conductor would be installed along the length of Segment 4. OPGW would be installed on the new structures.

Segment 5 Proposed Construction Activities

Some existing poles would be removed, and replacement poles would be installed, and other structures would be modified. The existing conductor and cable attached to the existing poles would be transferred to the new poles. Third-party infrastructure may be transferred or left in-place on existing poles. Insulators and other hardware on adjoining poles may be modified to accommodate the taller new poles. ADSS fiber optic cable would be installed along the length of Segment 5.

The EMF analysis is broken into two evaluations. The first is a segment evaluation, which estimates a typical calculated magnetic field for each segment. The second is a residential evaluation which identifies potential EMF exposure locations and estimates a calculated magnetic field for those locations.

4 Segment Evaluation

A series of EMF analyses were completed on the GKR Project, and a calculated typical EMF profile is shown for each segment as well as an existing conditions calculation. Values shown in this report are not meant to be predictive of any date or any time but are to be used for a comparison of structure arrangements.

Segment 1: Kern River 1 Hydroelectric Substation to Structure M20-T3

The portion from Kern River 1 Hydroelectric Substation to Structure M20-T3 represents Segment 1. The calculated magnetic fields for Segment 1 can be found in Figure 3 and Table 2. The magnetic field calculations were obtained using a PLS-CADD model line and a normal amperage. The calculations exceed the assumed ROW by 25% or more on either side for display and informational purposes only. For the line graphs and data, the proposed amperage is 540 amps, and the existing normal amperage is 540 Amps.

Segment 2: Structure M20-T3 to Frazier Park Tap

The portion from Structure M20-T3 to Frazier Park Tap represents Segment 2. The calculated magnetic fields for Segment 2 can be found in Figure 5 and Table 3. The magnetic field calculations were obtained using a PLS-CADD model line and a normal amperage. The calculations exceed the assumed ROW by 25% or more on either side for display and informational purposes only. For the line graphs and data, the proposed amperage is 540 amps, and the existing normal amperage is 540 Amps.

Segment 3: Frazier Park Tap to Gorman Substation

The portion from Frazier Park Tap to Gorman Substation represents Segment 3. A series of EMF analyses were completed on the Gorman-Kern River (GKR) 66 kV project and a calculated typical EMF profile is shown for each segment. The calculated magnetic fields for Segment 3 can be found in Figure 7 and Table 4. The magnetic field calculations were obtained using a PLS-CADD model line and a normal amperage. The calculations exceed the assumed ROW by 25% or more on either side for display and informational purposes only. For the line graphs and data, the proposed amperage is 540 amps, and the existing normal amperage is 540 Amps.

Segment 4: Structure M20-T3 to Structure X7666E

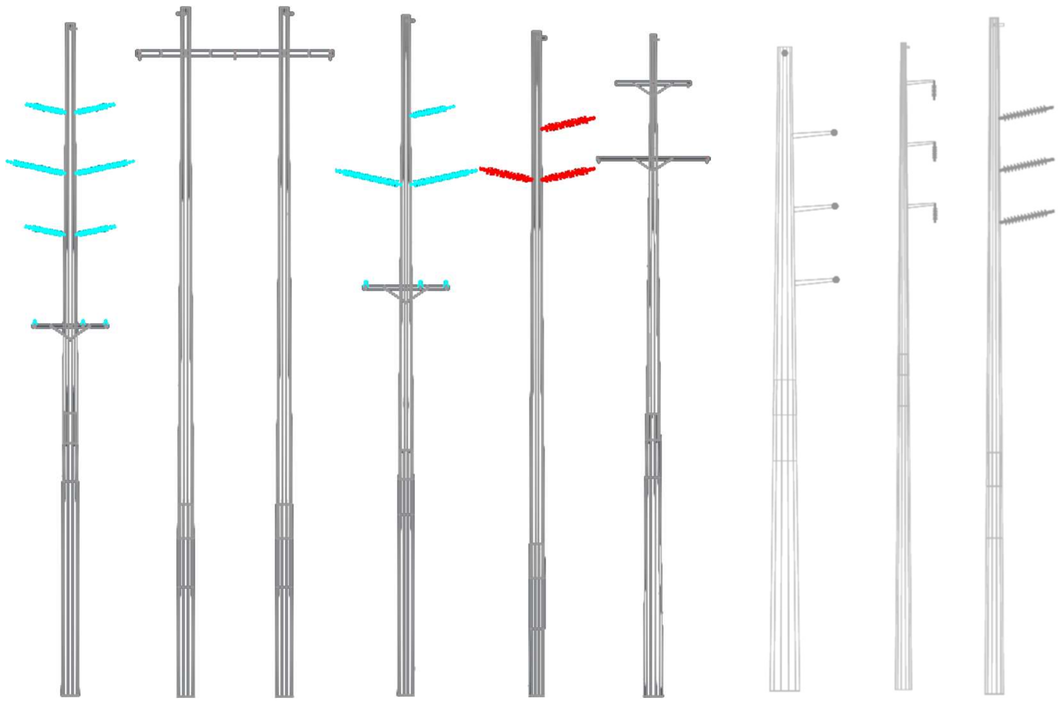
The portion from Structure M20-T3 to Banducci Substation represents Segment 4. The calculated magnetic fields for Segment 4 can be found in Figure 9 and Table 5. The magnetic field calculations were obtained using a PLS-CADD model line and a normal amperage. The calculations exceed the assumed ROW by 25% or more on either side for display and informational purposes only. For the line graphs and data, the proposed amperage is 540 amps, and the existing normal amperage is 540 Amps.

Segment 5: Structure X7666E to Banducci Substation

The portion from Structure M20-T3 to Banducci Substation represents Segment 5The calculated magnetic fields for Segment 5 can be found in Figure 11 and Table 6. The magnetic field calculations were obtained using a PLS-CADD model line and a normal amperage. The calculations exceed the assumed ROW by 25% or more on either side for display and informational purposes only. For the line graphs and data, the proposed amperage is 540 amps, and the existing normal amperage is 540 Amps.

5 Proposed Structures

Figure 2 – Proposed Typical Structure Designs – GKR Project



6 Final Recommendations for Magnetic Field Reduction Design

The GKR Project design can benefit from vertical and delta pole head configuration. Implementing both low cost and no cost measures significantly reduces the magnetic field and potential exposure risk well below CPUC approved EMF Design Guidelines as well as all national and state safety standards for reconductoring or new electric facilities.

Reduction Measures:

1. Configure pole head in a vertical or delta of subtransmission lines for magnetic field reduction. This is considered a no cost measure as the entire line maintains the recommended phase arrangement.
2. Utilize structure heights that meet or exceed EMF preferred design criteria of SCE.
3. Change the phase arrangement as the circuit enters the substation thereby changing the final phasing to further reduce the magnetic field.

7 Segment Graphs

The following graphs show the results from calculations done on the lowest spans within each section.

7.1 Segment 1

Figure 3 – Typical Magnetic Field Levels for Segment 1, Kern River 1 Hydroelectric Substation to Structure M20-T3: Structure M15T1 to M15T2 (Looking South)

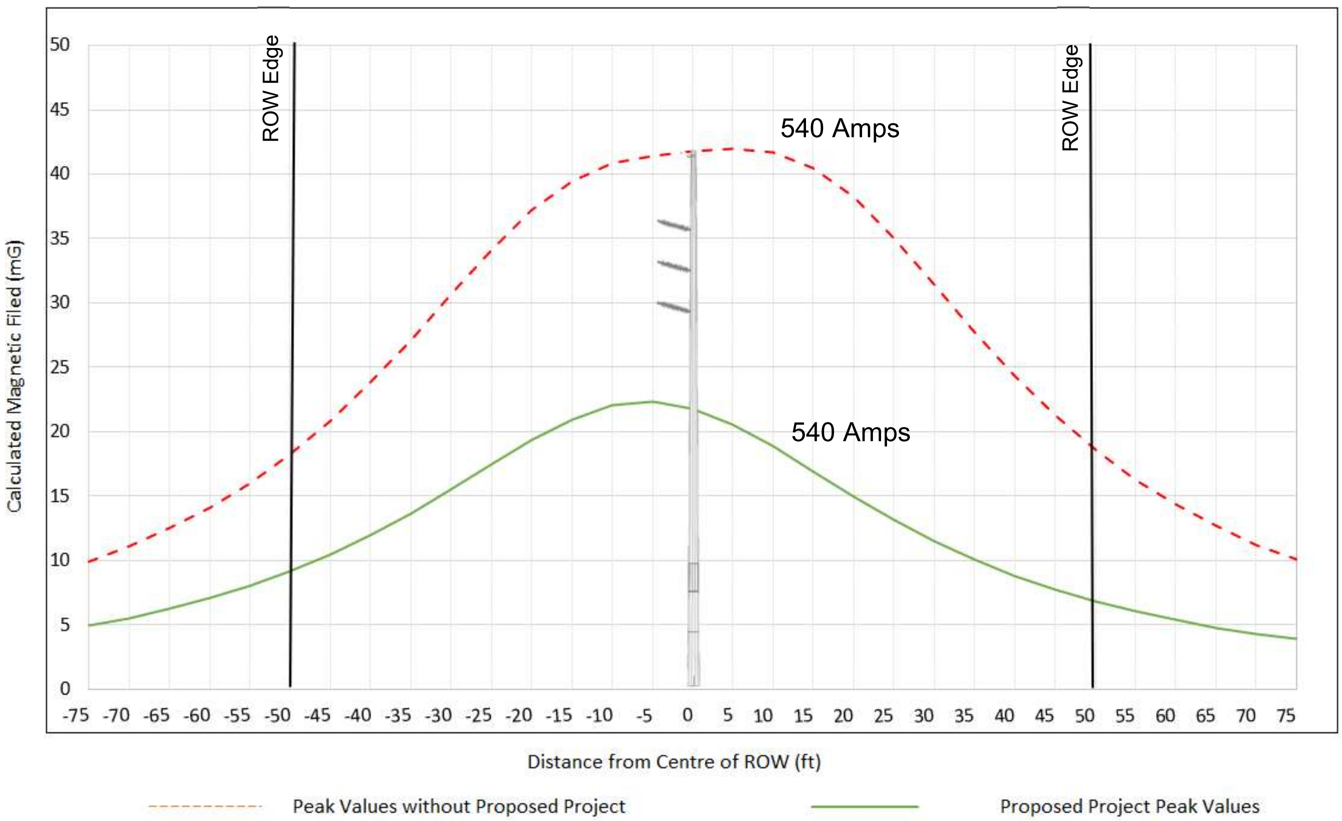


Table 2 – Comparison of Magnetic Fields at Edge of ROW for Segment 1, Structure M15T1 to M15T2

Design Options	Left Edge (mG)	% Change[26]	Right Edge (mG)	% Change[26]
Projected Peak Values without GKR Project 66 kV T/L	18.245	N/A	18.591	N/A
GKR Project Peak Values 66 kV T/L *	9.108	50% Reduced	6.807	63% Reduced

*The GKR Project alignment is shifted to the left an average of 12 feet transversely and 9 feet longitudinally in either direction in relation to the existing alignment.

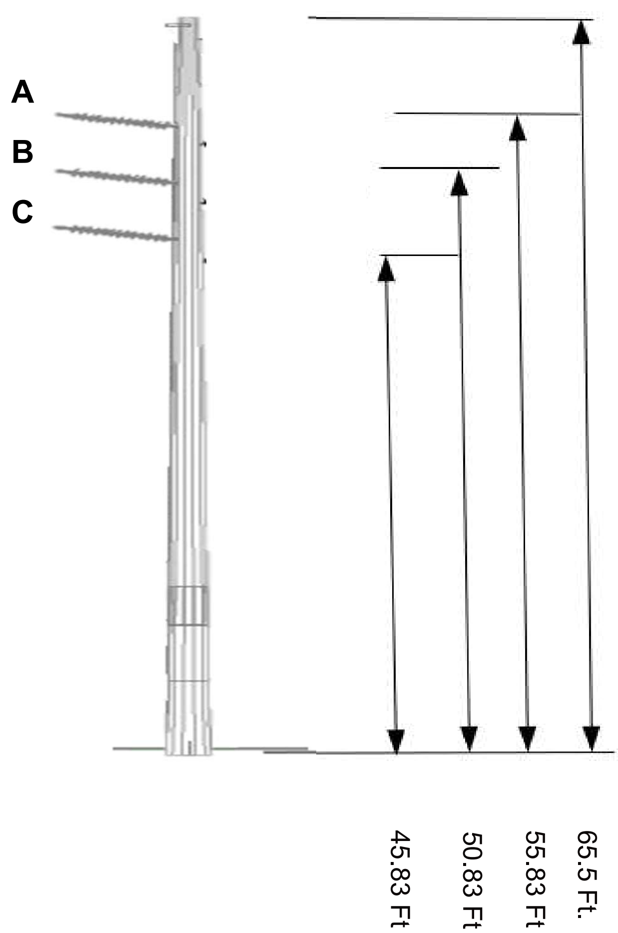
[26] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

All calculations were made at a height of 3 feet across the ROW.

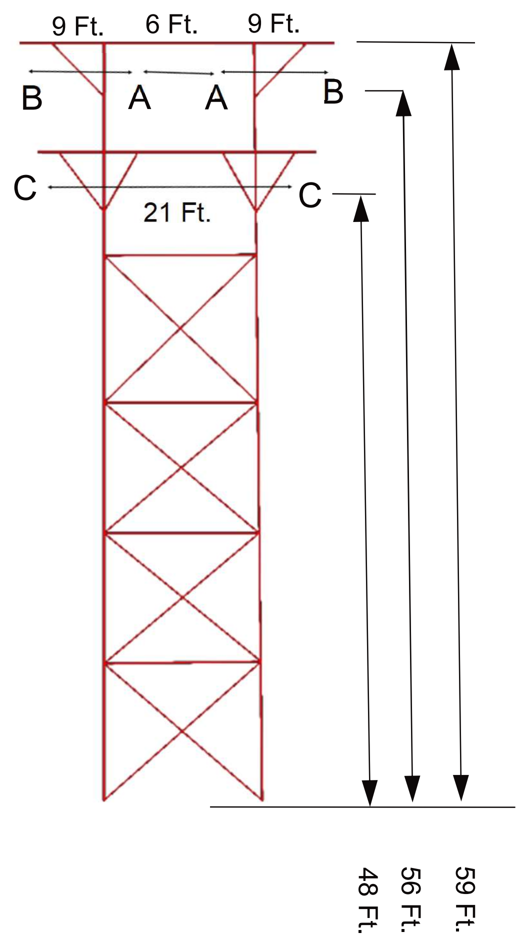
Existing Height and Insulator Length
Height – 59 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length
Height – 65.5 Ft. Length – 5.2 Ft.

Figure 4 – Tower and Insulator Dimensions and Phasing for a structure in Segment 1, Kern River 1 Hydroelectric Substation to Structure M20-T3



Proposed:
Single Circuit – Monopole
Figure Not to Scale
Structure M15-T1



Existing:
Double Circuit – Lattice Tower
Figure Not to Scale
Structure M15-T1

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

7.2 Segment 2

Figure 5 – Typical Magnetic Field Levels for Segment 2, Structure M20-T3 to Frazier Park Tap: Structure M33-T1 to M33-T2 (Looking South)

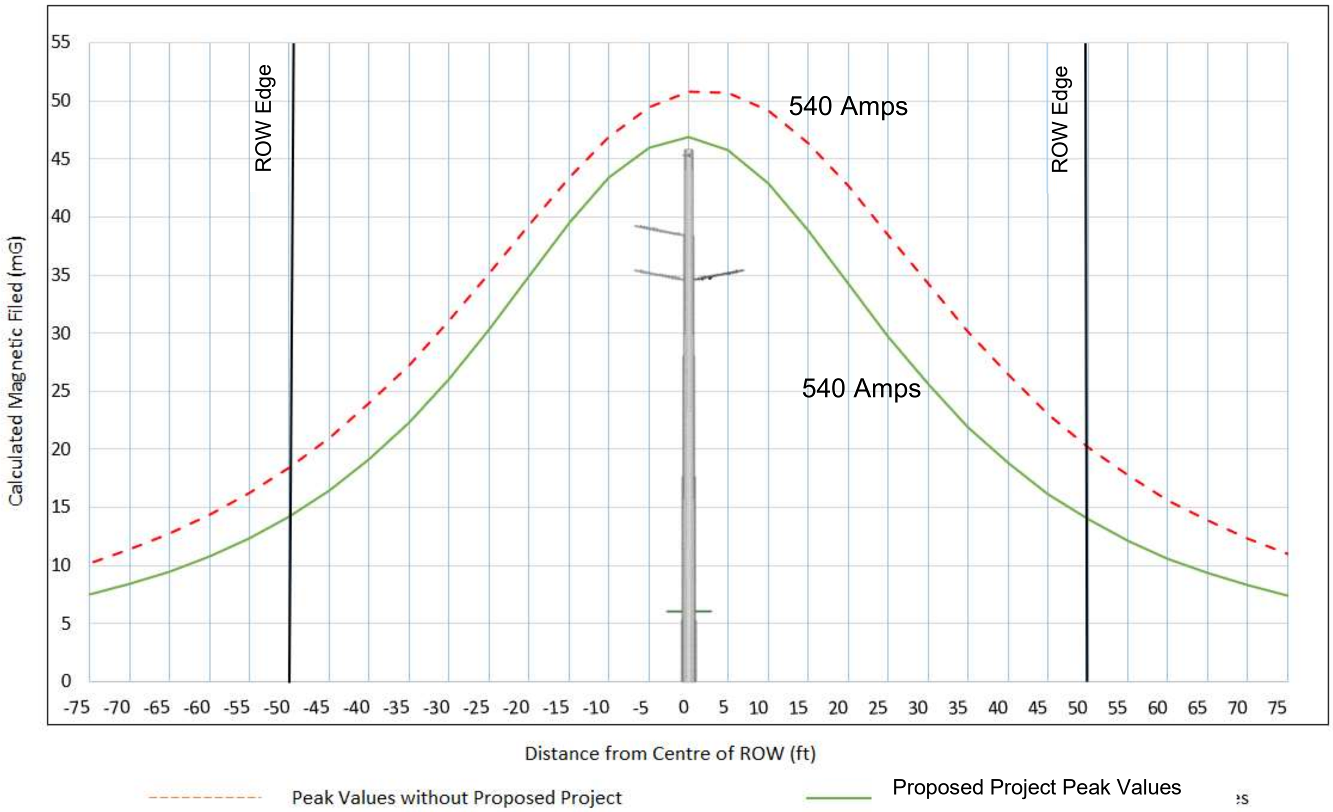


Table 3 – Comparison of Magnetic Fields at Edge of ROW for Segment 2, Structure M33-T1 to M33-T2

Design Options	Left Edge (mG)	% Change[27]	Right Edge (mG)	% Change[27]
Projected Peak Values without GKR Project 66 kV T/L	18.409	N/A	20.185	N/A
GKR Project Peak Values 66 kV T/L	14.179	23% Reduced	13.942	31% Reduced

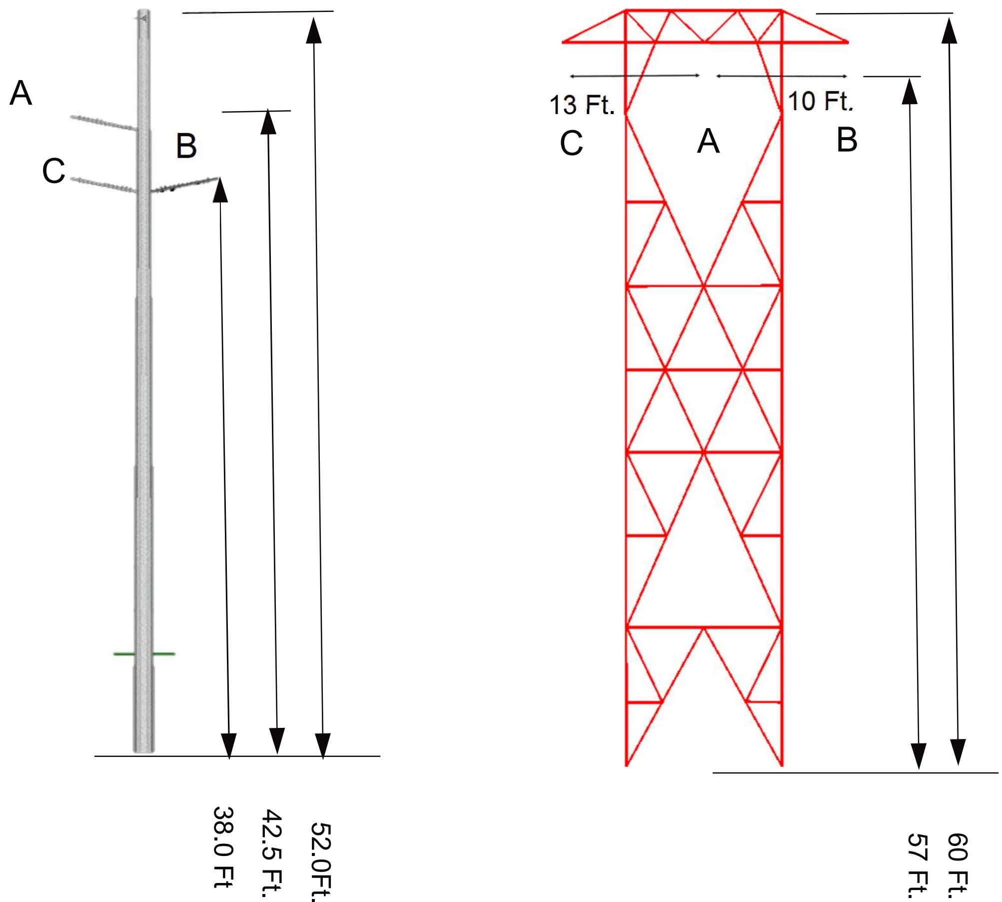
All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 60 Ft. Length – 3.0 Ft.

Proposed Construction and Insulator Length
Height – 56.5 Ft. Length – 3.0 Ft.

[27] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Figure 6 – Tower and Insulator Dimensions and Phasing for a structure in Segment 2, Structure M20-T3 to X7666E



Proposed:
Single Circuit – H-Frame
Figure Not to Scale
Structure M33-T2

Existing:
Single Circuit – Lattice Tower
Figure Not to Scale
Structure M33-T2

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

7.3 Segment 3

Figure 7 – Typical Magnetic Field Levels for Segment 3, Frazier Park Tap to Gorman Substation: Structure M49-T3 to M49-T4 (Looking South)

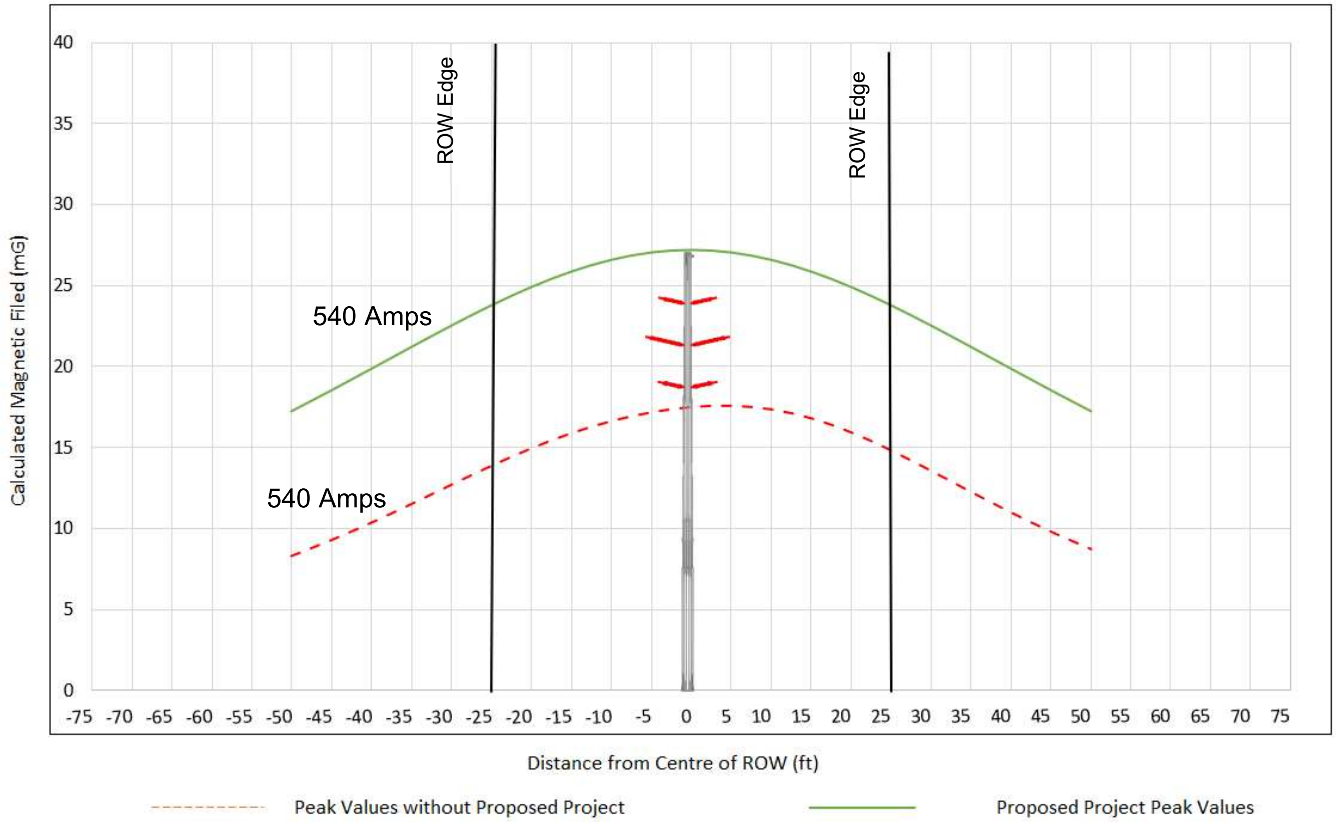


Table 4 – Comparison of Magnetic Fields at Edge of ROW for Segment 3, Structure M49-T3 to M49-T4

Design Options	Left Edge (mG)	% Change[27]	Right Edge (mG)	% Change[28]
Projected Peak Values without GKR Project 66 kV T/L	13.841	N/A	14.791	N/A
GKR Project Peak Values 66 kV T/L	23.781	72% Increased	23.781	61% Increased

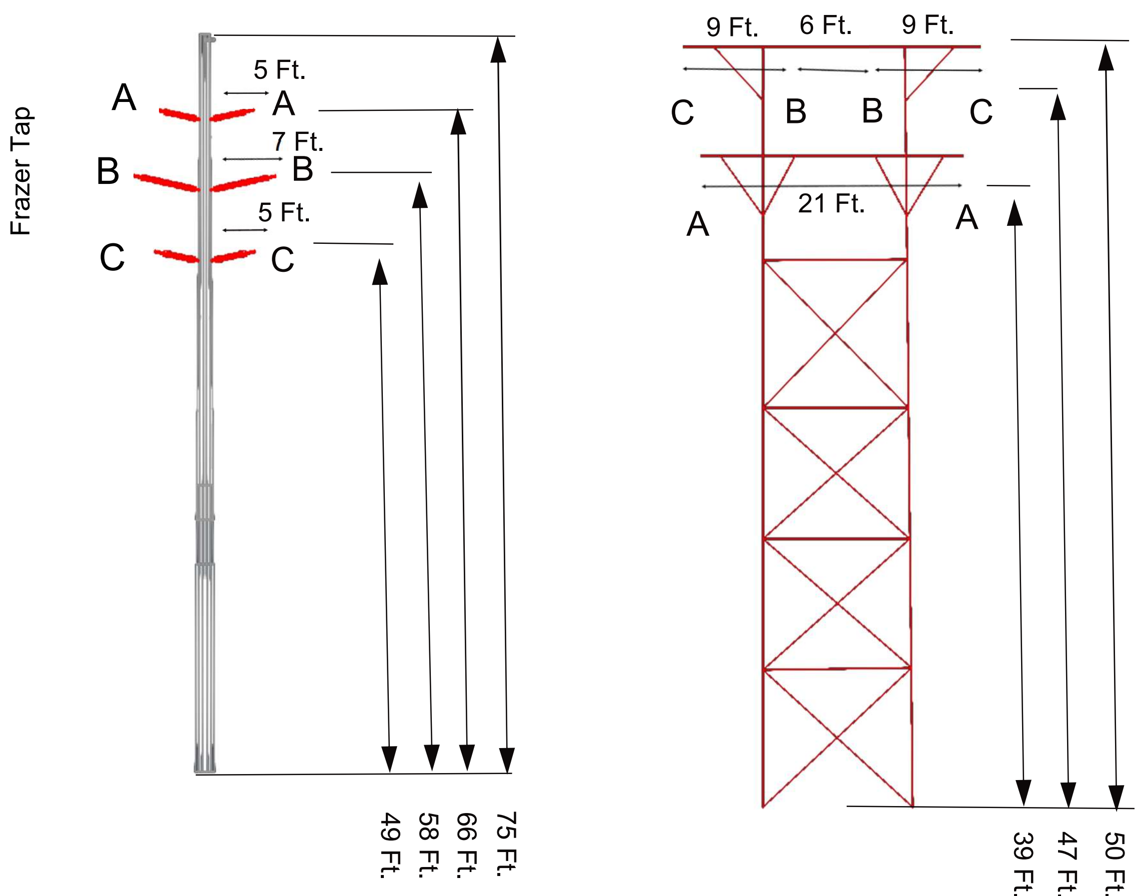
All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 50 Ft. Length – 2.9 Ft.

Proposed Construction and Insulator Length
Height – 75 Ft. Length – 5.2 Ft.

[28] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Figure 8 – Tower and Insulator Dimensions and Phasing for a structure in Segment 3, Frazier Park Tap to Gorman Substation



Proposed:
Single Circuit – Monopole
Figure Not to Scale
Structure M49-T3

Existing:
Double Circuit – Lattice Tower
Figure Not to Scale
Structure M49-T3

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

7.4 Segment 4

Figure 9 – Typical Magnetic Field Levels for Segment 4, Structure M20-T3 to X7666E: Structure M5-T3 to M5-T4 (Looking East)

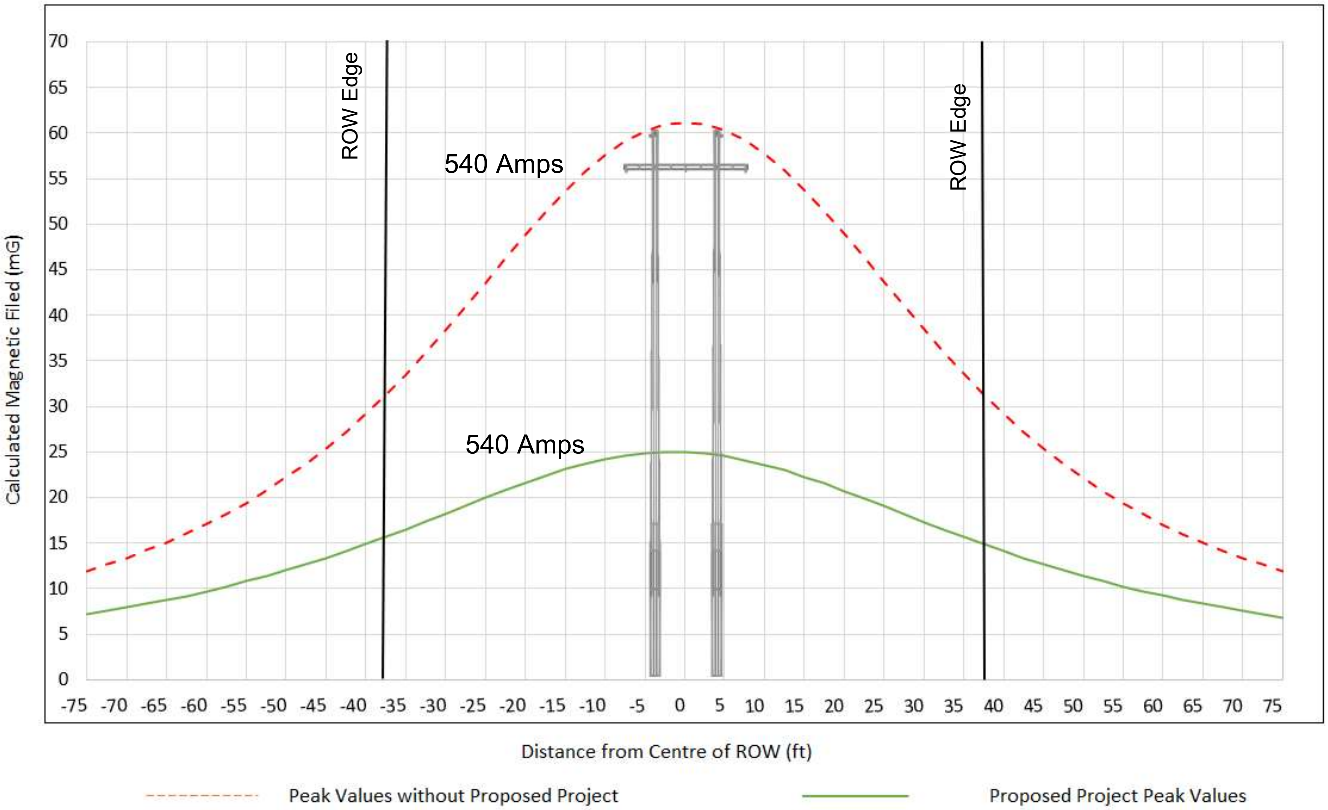


Table 5 – Comparison of Magnetic Fields at Edge of ROW for Segment 4, Structure M5-T3 to M5-T4

Design Options	Left Edge (mG)	% Change[29]	Right Edge (mG)	% Change[29]
Projected Peak Values without GKR Project 66 kV T/L	31.3	N/A	31.303	N/A
GKR Project Peak Values 66 kV T/L	15.670	50% Reduced	14.843	53% Reduced

All calculations were made at a height of 3 feet across the ROW.

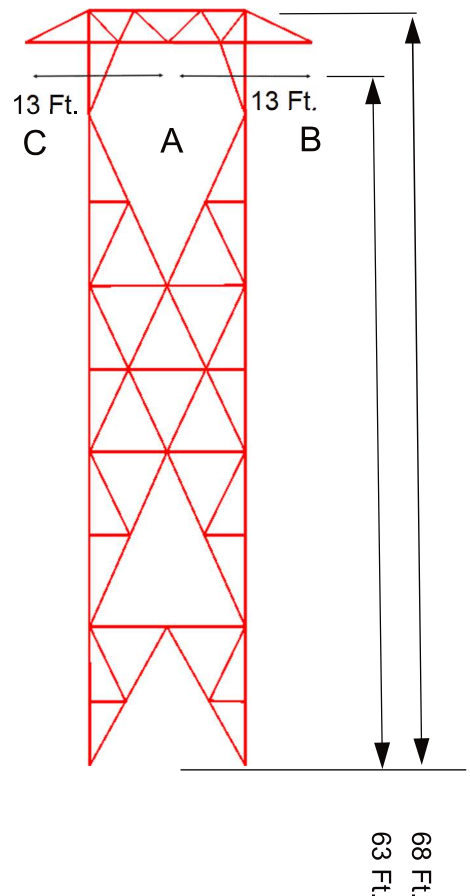
Existing Height and Insulator Length
Height – 68 Ft. Length – 3.0 Ft.

Proposed Construction and Insulator Length
Height – 65 Ft. Length – 3.0 Ft.

[29] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Figure 10 – Tower and Insulator Dimensions and Phasing for a structure in Segment 4, Structure M20-T3 to X7666E

Proposed:
Single Circuit – H-Frame
Figure Not to Scale
Structure M5-T3

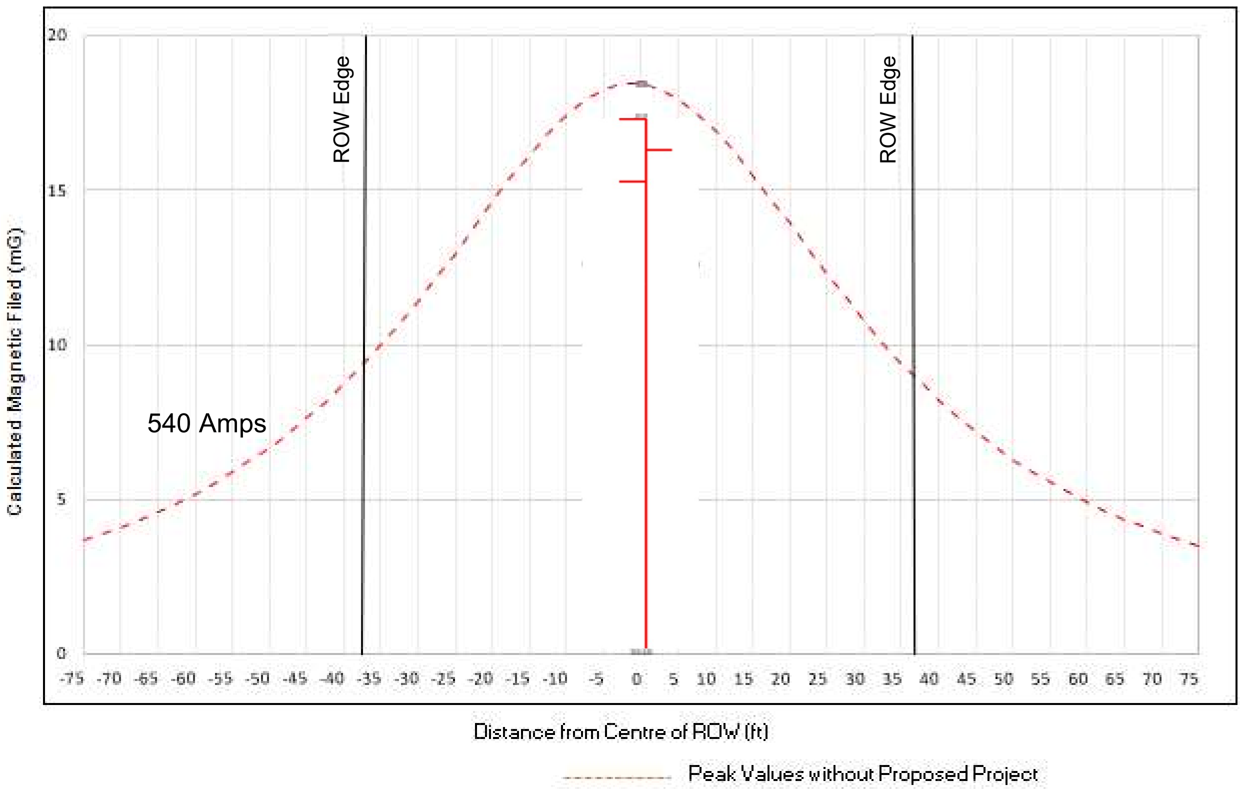


Existing:
Single Circuit – Lattice Tower
Figure Not to Scale
Structure M5-T3

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

7.5 Segment 5

*Figure 11 – Typical Magnetic Field Levels for Segment 5, Structure X7666E to Banducci Substation: Structure X7656E to X7655E (Looking East) **



**Note: Graph of GKR Project peak values is not shown in Figure 11 since there will not be any changes to the relevant span or structures.*

Table 6 – Comparison of Magnetic Fields at Edge of ROW for Segment 5, Structure X7656E to X7655E

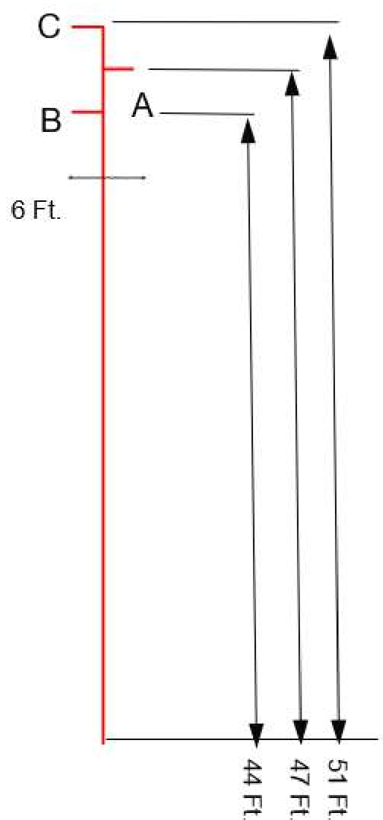
Design Options	Left Edge (mG)	% Change[29]	Right Edge (mG)	% Change[30]
Existing (As Surveyed) Project Peak Values with 4-o_7_copper 66 kV T/L	9.329	N/A	8.784	N/A

All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 51 Ft. Length – 3.0 Ft.

[30] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Figure 12 – Tower and Insulator Dimensions and Phasing for a structure in Segment 5, Structure X7666E to Banducci Substation



Existing:
Single Circuit – Wood Pole
Figure not to Scale
(Note: Proposed structures not shown because there will not be new proposed project on this span of Segment 5)
Structure X7655E

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

8 Residential Evaluation

The graphs below show the results obtained from calculations done on the lowest spans near residential areas. The magnetic field created by these spans are less in magnitude than the worst span in each segment, but these are more of a concern for the residents that live near the ROW.

8.1 Segment 1, Structure 2241821E_2241822E to M8-T7 Span

Figure 13 – Typical Magnetic Field Levels for Segment 1, Span 2241821E_2241822E – M8-T7 (Looking South)

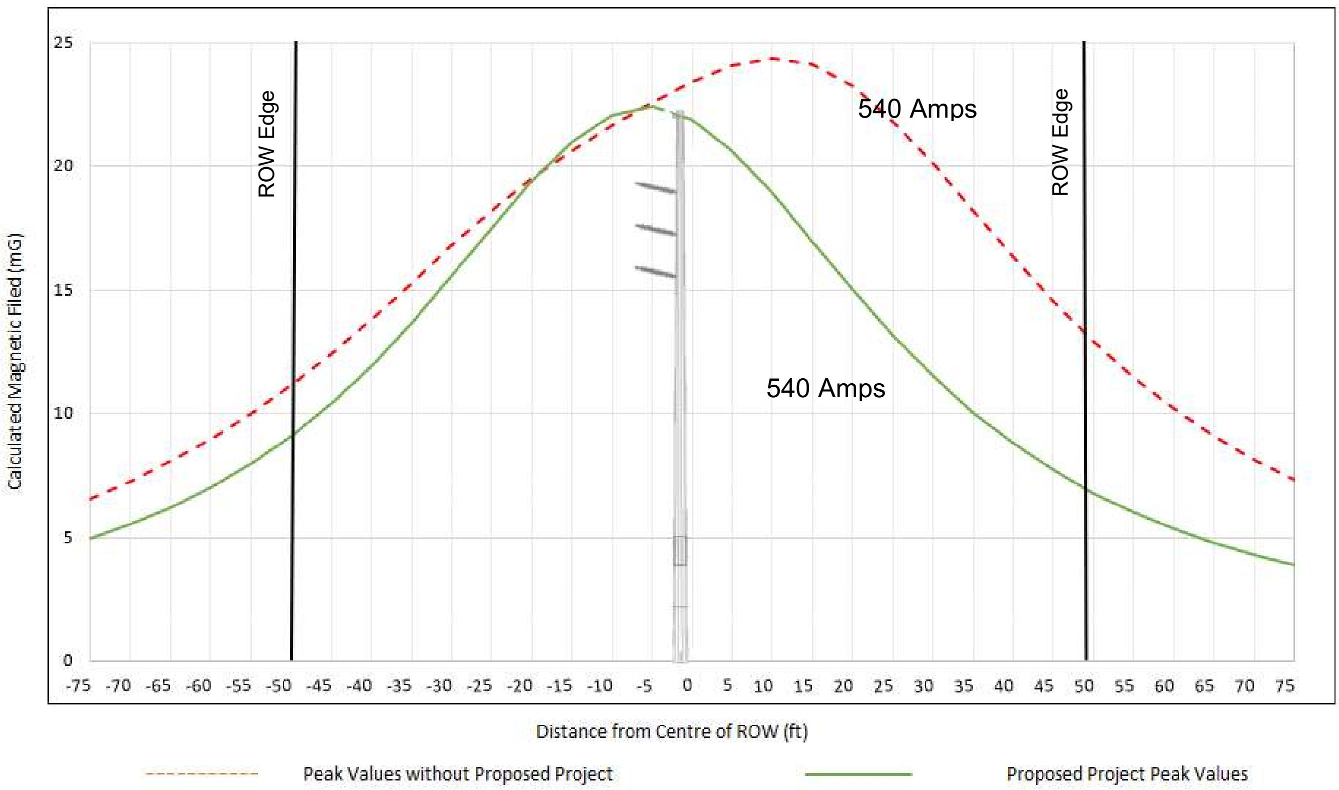


Table 7 – Comparison of Magnetic Fields at Edge of ROW for Segment 1, Structure 2241821E_2241822E to M8-T7

Design Options	Left Edge (mG)	% Change[30]	Right Edge (mG)	% Change[31]
Projected Peak Values without GKR Project 66 kV T/L	11.155	N/A	12.936	N/A
GKR Project Peak Values 66 kV T/L*	9.122	18% Reduced	6.814	47% Reduced

[31] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

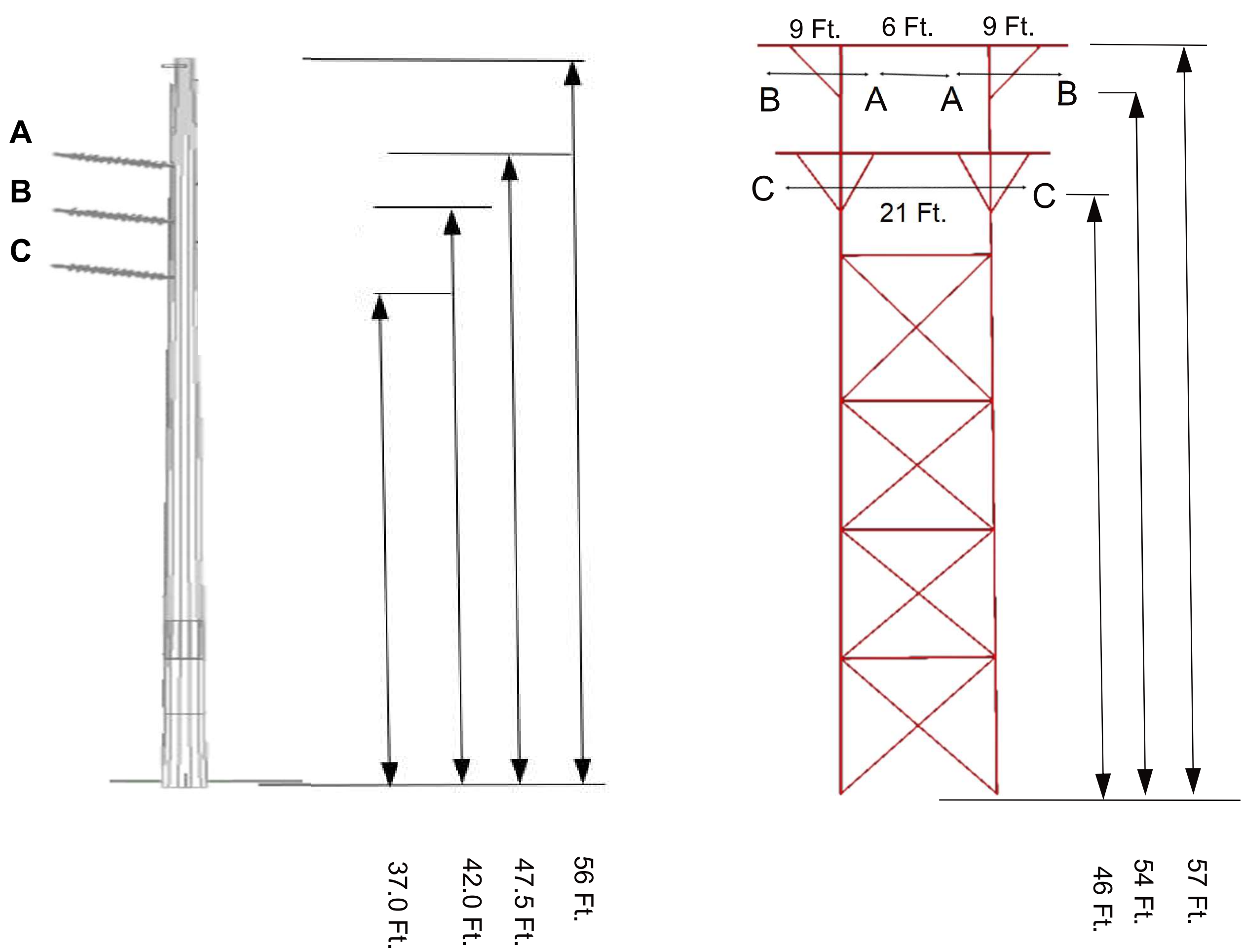
*The GKR Project alignment is shifted to the left an average of 12 feet transversely and 9 feet longitudinally in either direction in relation to the existing alignment.

All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 57 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length
Height – 61 Ft. Length – 5.2 Ft.

Figure 14 – Tower and Insulator Dimensions and Phasing for a structure in Segment ,1 Kern River 1 Hydroelectric Substation to Structure M20-T3



Proposed:
Single Circuit – Monopole
Figure not to Scale
Structure M8 -T7

Existing:
Double Circuit – Lattice Tower
Figure not to Scale
Structure M8 -T7

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

8.2 Segment 1, Structure M10-T2 to M10-T3 Span

Figure 15 – Typical Magnetic Field Levels for Segment 1, Span M10-T2 – M10T3 (Looking South)

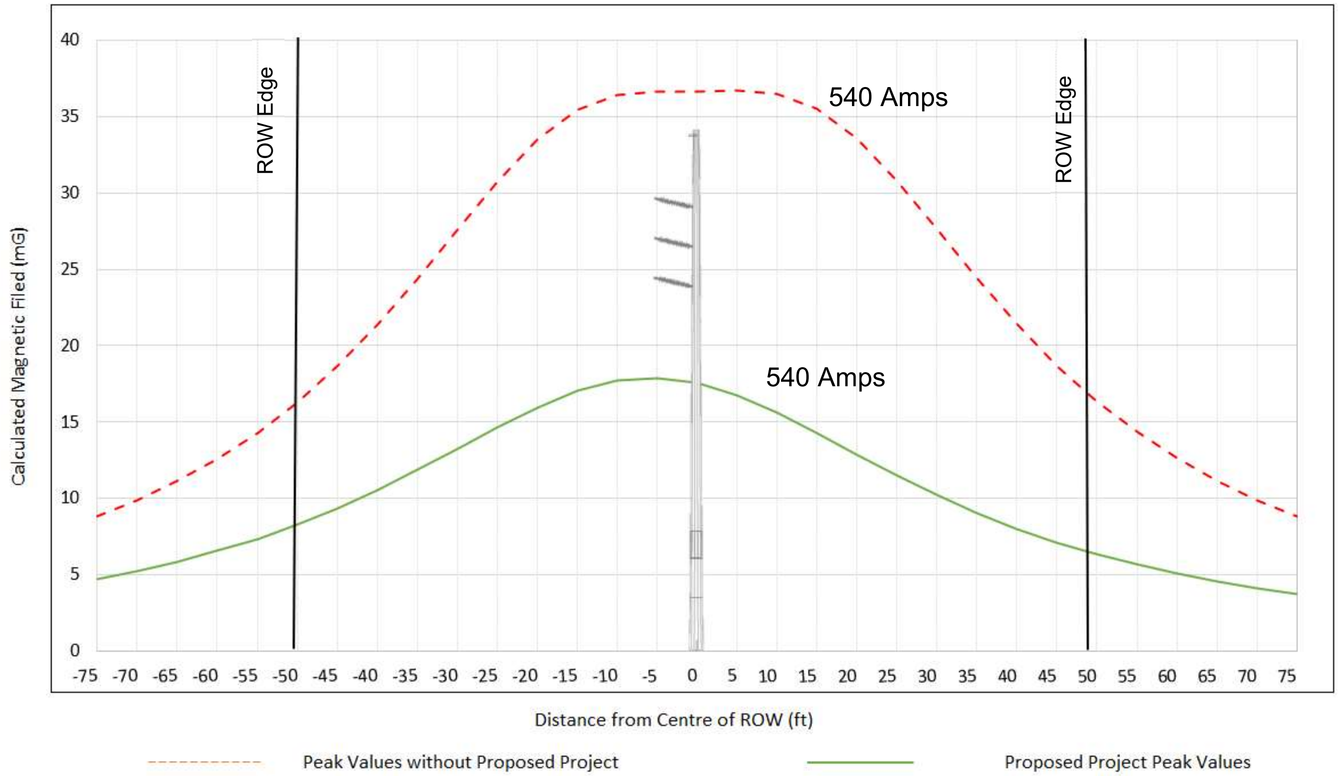


Table 8 – Comparison of Magnetic Fields at Edge of ROW for Segment 1, Structure M10-T2 to M10T3

Design Options	Left Edge (mG)	% Change[32]	Right Edge (mG)	% Change[31]
Projected Peak Values without GKR Project 66 kV T/L	16.314	N/A	16.356	N/A
GKR Project Peak Values 66 kV T/L *	8.280	49% Reduced	6.333	61% Reduced

*The GKR Project alignment is shifted to the left an average of 12 feet transversely and 9 feet longitudinally in either direction in relation to the existing alignment.

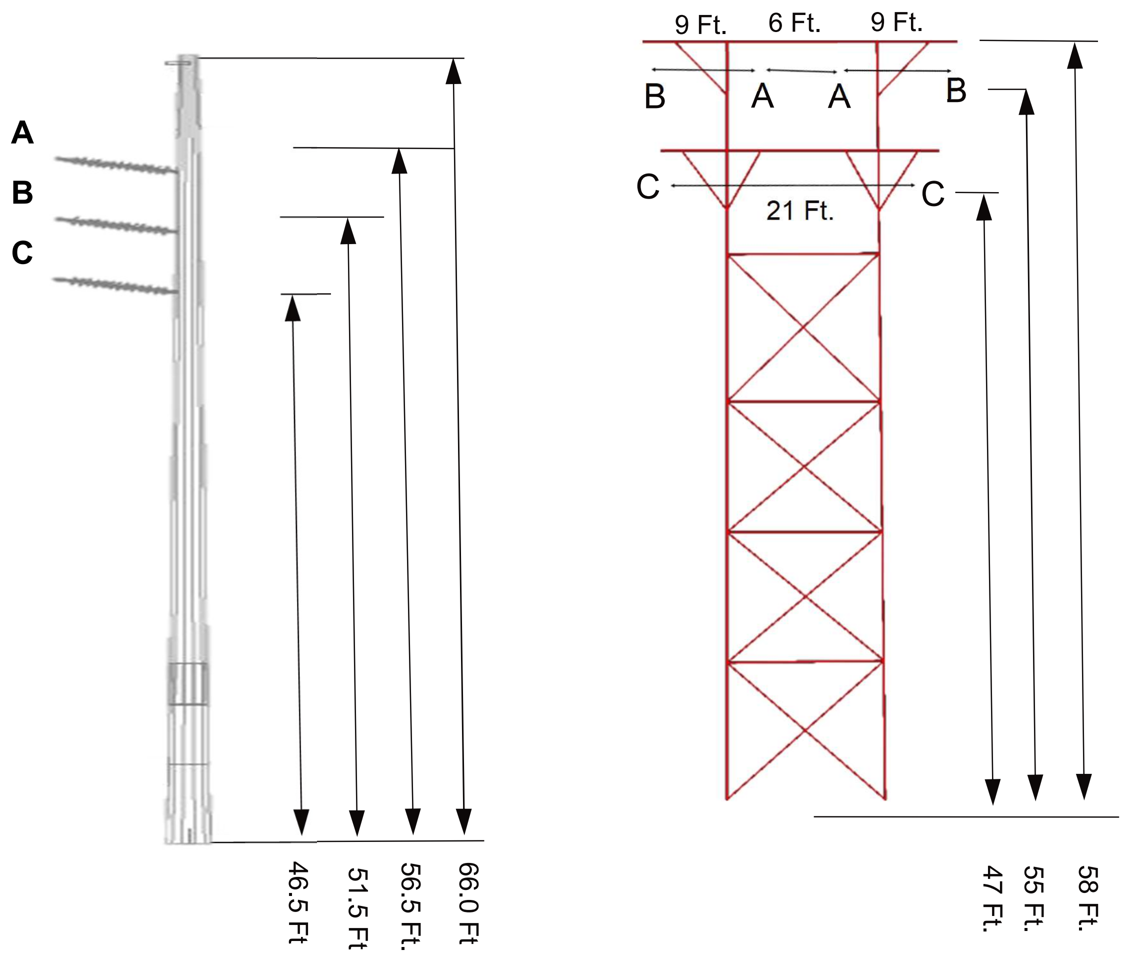
[32] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project.

All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 58 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length
Height – 70 Ft. Length – 5.2 Ft.

Figure 16 – Tower and Insulator Dimensions and Phasing for a structure in Segment 1, Kern River 1 Hydroelectric Substation to Structure M20-T3



Proposed:
Single Circuit – Monopole
Figure not to Scale
Structure M10 – T3

Existing:
Double Circuit – Lattice Tower
Figure not to Scale
Structure M10 – T3

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

8.3 Segment 1, Structure M17-T4 to M17-T5 Span

Figure 17 – Typical Magnetic Field Levels for Segment 1, Span M17-T4 to M17-T5 (Looking South)

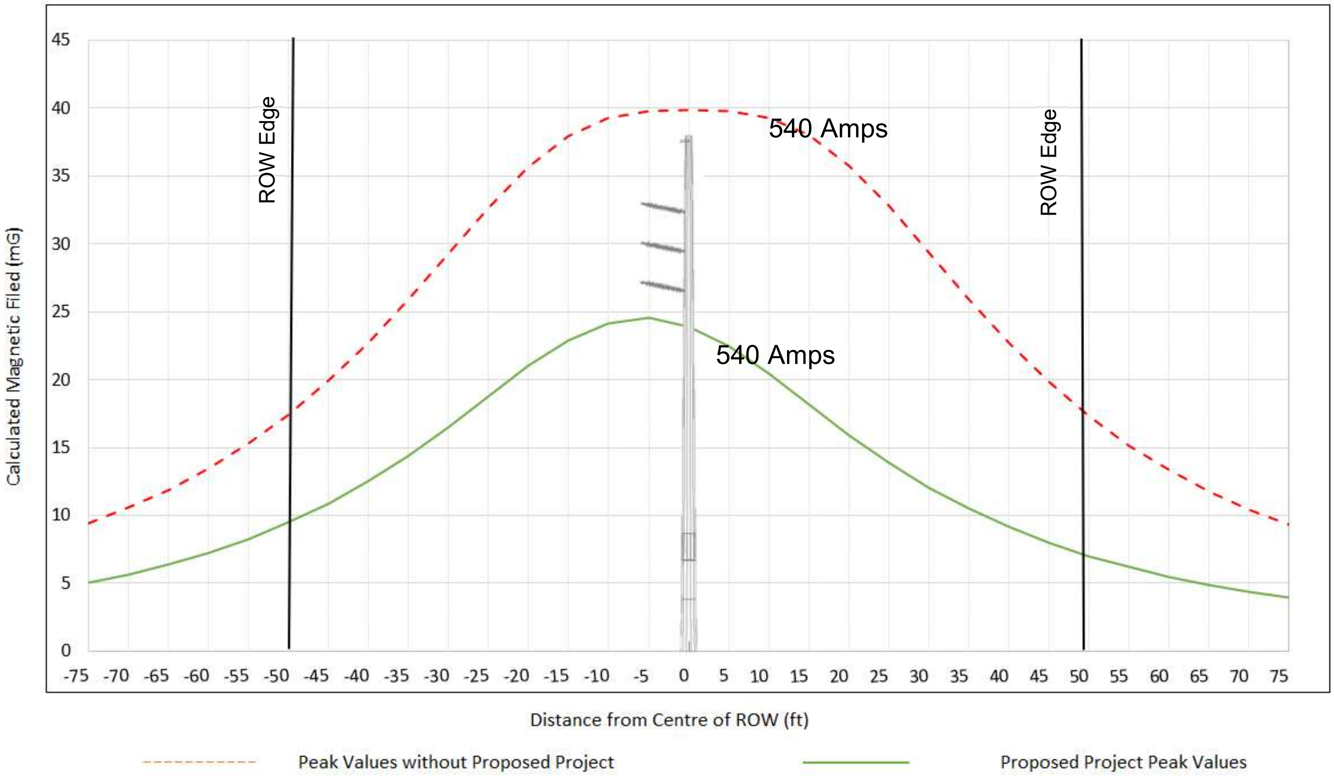


Table 9 – Comparison of Magnetic Fields at Edge of ROW for Segment 1, Structure M17-T4 to M17-T5

Design Options	Left Edge (mG)	% Change[33]	Right Edge (mG)	% Change[32]
Projected Peak Values without GKR Project 66 kV T/L	17.4	N/A	17.313	N/A
GKR Project Peak Values 66 kV T/L*	9.453	46% Reduced	6.998	60% Reduced

*The GKR Project alignment is shifted to the left an average of 12 feet transversely and 9 feet longitudinally in either direction in relation to the existing alignment.

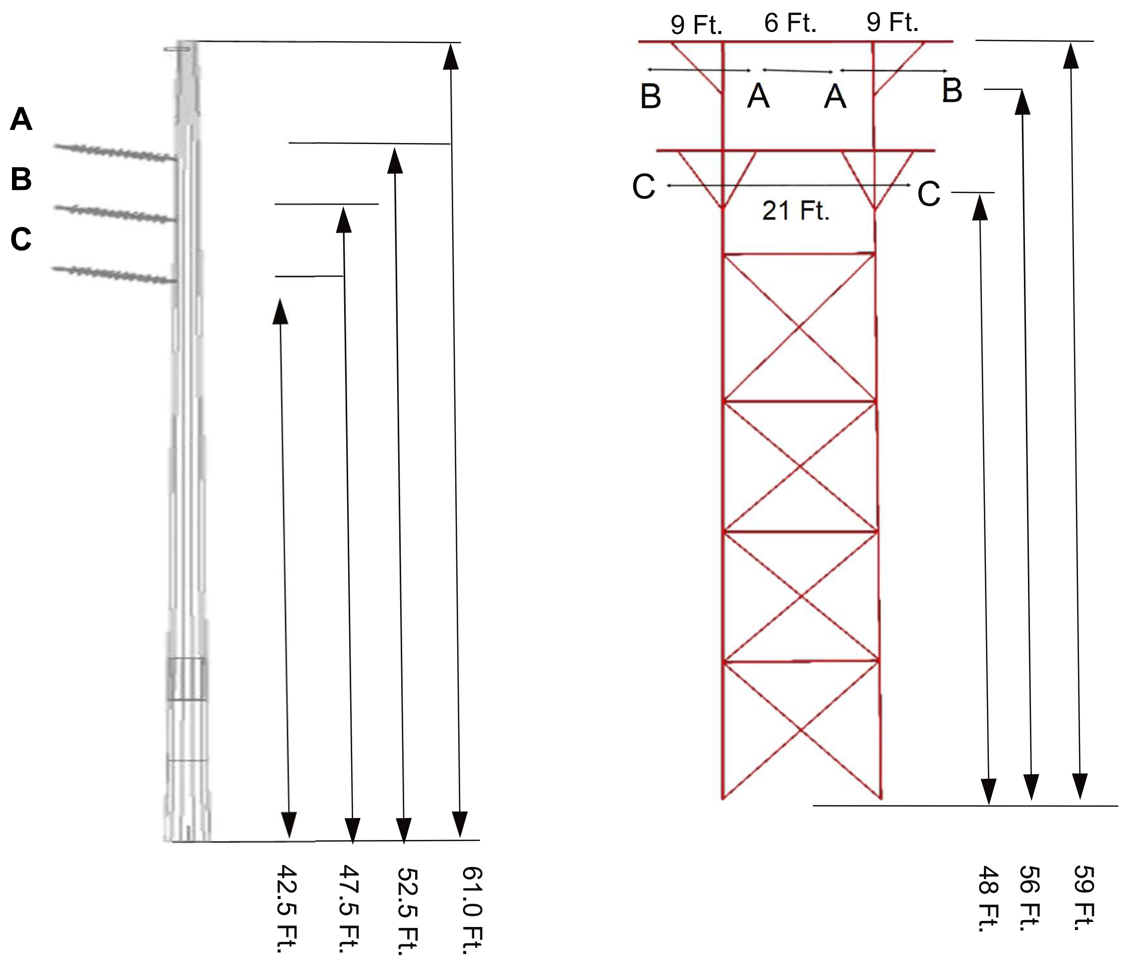
33 All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 59 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length
Height – 65.5 Ft. Length – 5.2 Ft.

Figure 18 – Tower and Insulator Dimensions and Phasing for a structure in Segment 1, Kern River 1 Hydroelectric Substation to Structure M20-T3



Proposed:
Single Circuit – Monopole
Figure not to Scale
Structure M17-T5

Existing:
Double Circuit – Lattice Tower
Figure not to Scale
Structure M17-T5

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

8.4 Segment 1, Structure M18-T3 to M18-T4 Span

Figure 19 – Typical Magnetic Field Levels for Segment 1, Span M18-T3 to M18-T4 (Looking South)

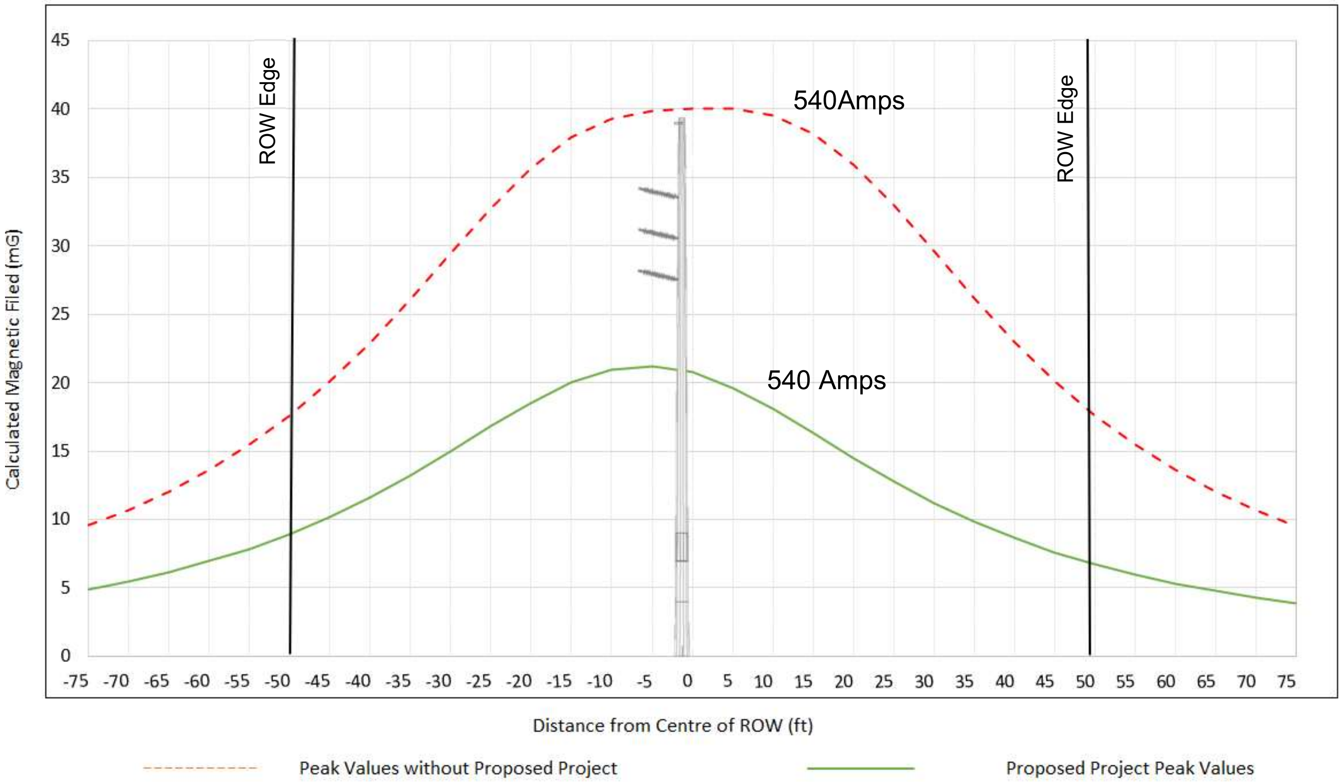


Table 10 – Comparison of Magnetic Fields at Edge of ROW for Segment 1, Structure M18-T3 to M18-T4

Design Options	Left Edge (mG)	% Change[34]	Right Edge (mG)	% Change[33]
Projected Peak Values without GKR Project 66 kV T/L	17.6	N/A	17.592	N/A
GKR Project Peak Values 66 kV T/L*	8.921	49% Reduced	6.702	62% Reduced

*The GKR Project alignment is shifted to the left an average of 12 feet transversely and 9 feet longitudinally in either direction in relation to the existing alignment.

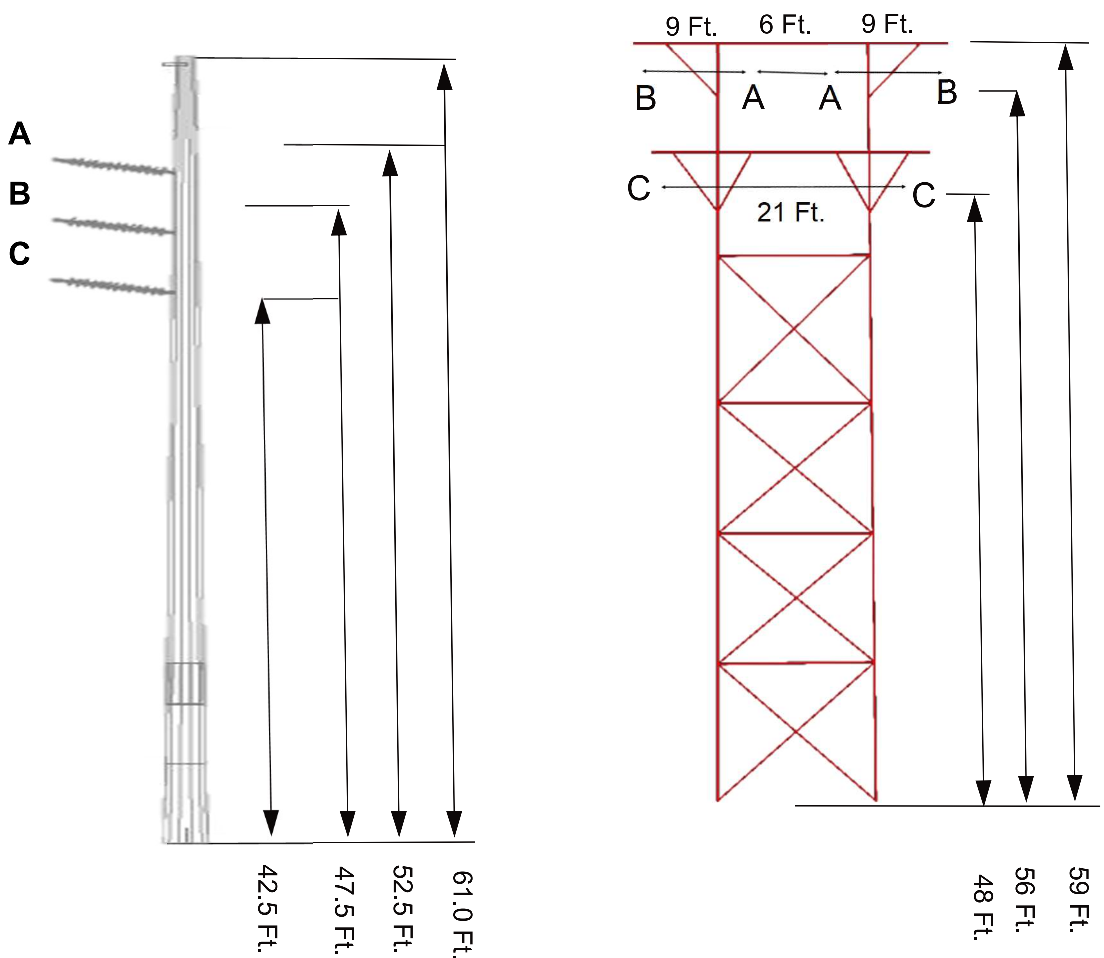
All calculations were made at a height of 3 feet across the ROW.

Existing Height and Insulator Length
Height – 59 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length
Height – 70 Ft. Length – 5.2 Ft.

[34] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Figure 20 – Tower and Insulator Dimensions and Phasing for a structure in Segment 1, Kern River 1 Hydroelectric Substation to Structure M20-T3



Proposed:
Single Circuit – Monopole
Figure not to Scale
Structure M18-T4

Existing:
Double Circuit – Lattice Tower
Figure not to Scale
Structure M18 – T4

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

8.5 Segment 4, Structure M9-T6 to M9-T7 Span

Figure 21 – Typical Magnetic Field Levels for Segment 4, Span M9-T6 to M9-T7 (Looking East)

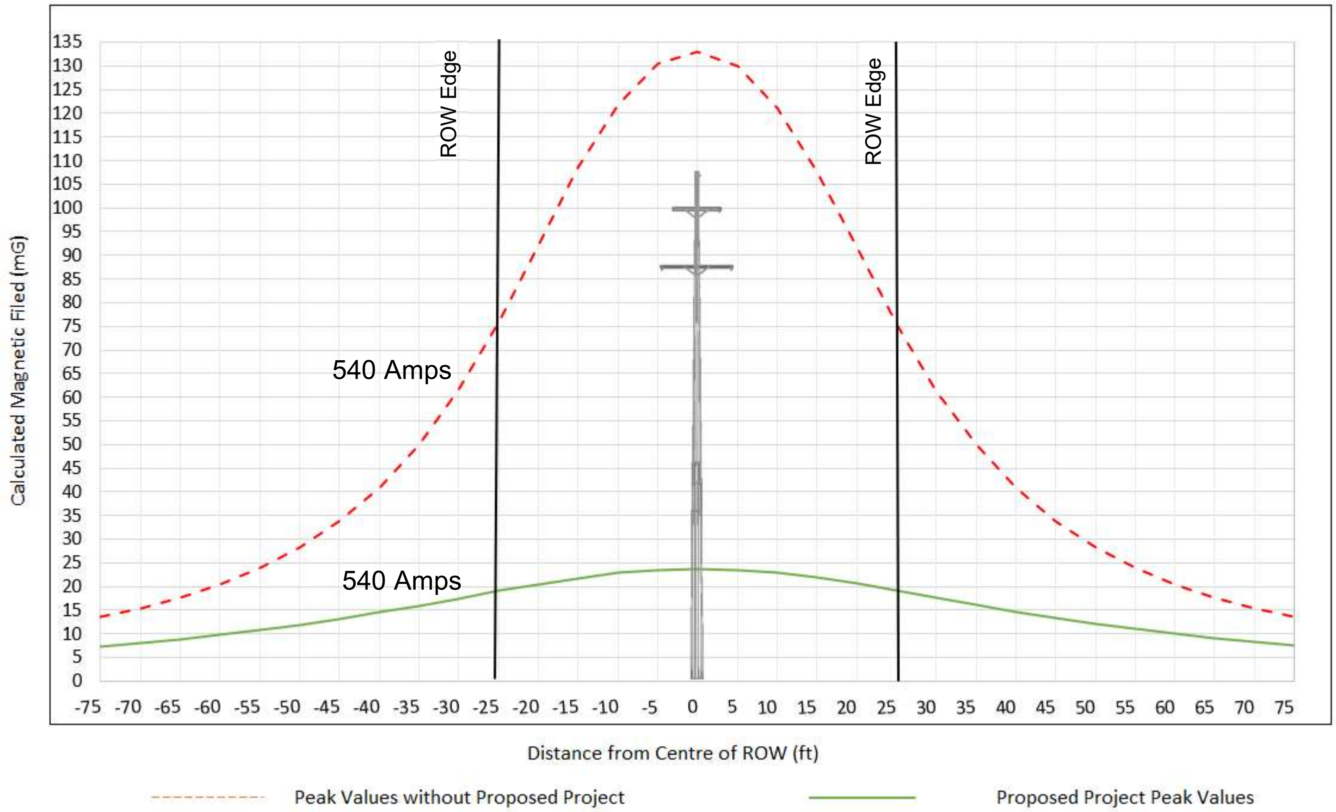


Table 11 – Comparison of Magnetic Fields at Edge of ROW for Segment 4, M9-T6 to M9-T7

Design Options	Left Edge (mG)	% Change[35]	Right Edge (mG)	% Change[34]
Projected Peak Values without GKR Project 66 kV T/L	75.888	N/A	75.478	N/A
GKR Project Peak Values 66 kV T/L	19.005	75% Reduced*	19.159	75% Reduced*

*The high reduction in the magnetic field is due to the significant height increase of structure M9-T7 when compared to the existing structure.

All calculations were made at a height of 3 feet across the ROW.

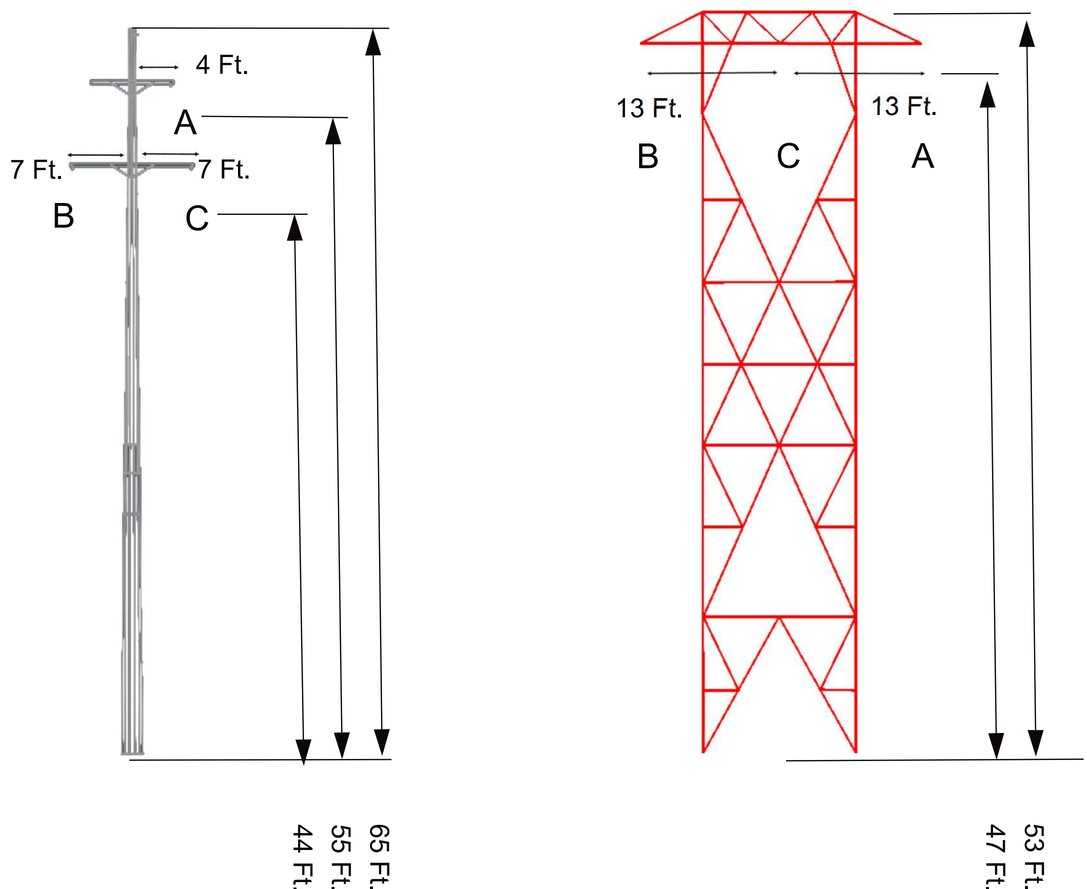
Existing Height and Insulator Length
Height – 53 Ft. Length – 3.1 Ft.

Proposed Construction and Insulator Length

[35] All data in Percent Change column is compared to the Projected Peak Values without the GKR Project

Height – 64 Ft. Length – 3.0 Ft. for structure M9-T6 and 106 Ft. Length – 3.0 Ft for structure M9-T7.

Figure 22 – Tower and Insulator Dimensions and Phasing for a structure in Segment 4, Structure M20-T3 to X7666E



Proposed:
Single Circuit – Monopole
Figure not to Scale
Structure M9-T6

Existing:
Single Circuit – Lattice Tower
Figure not to Scale
Structure M9-T6

Dimensions are for the shorter structure, phase angles were assumed and based on approved PLS-CADD models.

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