APPENDIX B
Field Management Plan

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Detailed Magnetic Field Management Plan:

Artesian 230 kV Substation Expansion

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Project Designer: **P. Martinez**

Work Order No.: **WO: 5984695**
In-Service Date: **1/31/2020**

Power & Distribution Lines: **TL 616 & TL 6939**

Central File No.: **ELA 140.B.116**

Prepared by: Steve Rehr Date: 7/14/2016

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I. Proposed Project Scope

In an effort to address anticipated growth in the Poway area and alleviate congestion at the existing Sycamore Canyon Substation, SDG&E proposes to expand the existing Artesian Substation. Specifically, the existing 69/12 kilovolt (kV) Artesian Substation will be expanded to enable an addition of a 230/69kV yard to alleviate the existing 69kV congestion at the existing Sycamore Canyon Substation. In addition, the Artesian Substation expansion will increase reliability to the Poway Area Load Pocket which is expected to grow by as much as 12 percent in the next 10 years.

II. Magnetic Field Management Design Guidelines

The California Public Utilities Commission ("CPUC") requires SDG&E to apply its *EMF*[1] *Design Guidelines for Electrical Facilities* ("Guidelines") to all new and upgraded electric power and transmission projects to reduce public exposure to magnetic fields. SDG&E filed its Guidelines with the CPUC in accordance with CPUC Decision 93-11-013 and updated them in accordance with the 2006 CPUC Decision 06-01-042.

Consistent with SDG&E's Guidelines and with the CPUC order, magnetic fields and possible magnetic field management measures were evaluated along the power line locations associated with the proposed Project. The results of this evaluation are contained in this Detailed Magnetic Field Management Plan ("FMP").

This FMP deals solely with magnetic fields. Moreover, reducing the magnetic field strength is but one of many factors to be considered in planning and designing a transmission system, along with other issues such as safety, environmental concerns, reliability, insulation and electrical clearance requirements, aesthetics, cost, operations and maintenance.

The scope of magnetic field analysis for this FMP does not include the distribution lines, per SDG&E's Guidelines, which state, "For distribution facilities, utilities would apply no-cost and low-cost measures by integrating reduction measures into construction and design standards, rather than evaluating no-cost and low-cost measures for each project." Thus, for purposes of this FMP, the term "Project" includes only the 69 kV wood-to-steel pole conversions.

III. Magnetic Field Management Methodology

In Decision 06-01-042, the CPUC noted that "Utility modeling methodology is intended to compare differences between alternative EMF mitigation measures and not determine actual EMF amounts."[2] The CPUC also noted that "modeling indicates relative differences in magnetic field reductions between different transmission line construction methods, but does not measure actual environmental magnetic fields."[3]

In accordance with its Guidelines, SDG&E will take the following measures for the proposed Project:

- Apply its EMF Guidelines to the proposed Project design.

[1] EMF refers to electric and magnetic fields.
[2] CPUC Decision D.06-01-042, Finding of Fact 14, p. 20.
[3] Ibid, p.11.

- Identify and implement appropriate "no-cost" measures, i.e., those that will not increase overall project costs but will reduce the magnetic field levels.
- Identify and implement appropriate "low-cost" measures, i.e., those measures costing in the range of 4% of the total budgeted project cost that will reduce the magnetic field levels by 15% or more at the edge of the right-of-way (ROW).
- When a sufficiency of "low-cost" measures is available to reduce magnetic field levels, such that it is difficult to stay within the 4% cost guideline, apply these "low-cost" measures by priority of adjacent land uses.

The 15% minimum reduction required for low-cost measures is in addition to any field reduction due to "no-cost" measures. It is not cumulative. Since the proposed Project requires permitting under General Order 131-D, a Detailed FMP will be used.

This FMP consists of a project description, a checklist table showing evaluation of magnetic field reduction measures adopted or rejected per transmission line, and a summary with recommendations.

IV. Project Description

Segment 1 – Artesian Substation – Ten wooden poles will be removed and be replaced by two steel cable poles which will route approximately 1000 feet of 3000 kcmil (XLPE) copper underground cable into the substation. A third cable pole will be installed west of the substation to route approximately 800 feet of underground cable out of Artesian to the north (TL616).

New equipment being installed in the Artesian substation:

- Two additional 69/12kV, 30 MVA transformers will be installed with oil containment basins.
- Two additional 12kV capacitors will be installed in the east yard.
- Two additional ¼ section of 12kV switchgear will be installed with four 12kV circuit positions terminating inside the switchgear. This switchgear will be installed in the east yard.

All additional relay and protection equipment will be housed inside masonry block control shelters.

Segment 2 – Overhead Section - This section of the project includes upgrades of 2.31 miles of TL 695 & TL 6939. Both tielines will be replaced from 1033 kcmil steel reinforced (ACSR) conductor to 636 kcmil heat resistant aluminum alloy conductor invar reinforced (ZTACIR). Eight wooden poles will be removed and be replaced by taller, stronger steel poles, and an additional 4 wooden poles will be removed completely.

Segment 3 – Bernardo Substation - Five wooden poles will be removed and be replaced by two cable poles which will route approximately 300 feet of 3000 kcmil (XLPE) copper underground cable into the Bernardo substation.

V. Magnetic Field Reduction Measures Considered for the Proposed Project

Per Table 3-1 of SDG&E's Guidelines, all portions of power lines within scope of the proposed Project were reviewed for suitable application of magnetic field reduction measures, as listed in *Table 1* below.

Table 1: Magnetic Field Reduction Measures Adopted or Rejected

Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
1, 2, 3	TL 616 TL 6939	Residential	**Phase Reconfiguration**	Yes	No-Cost
	Reduction of EMF through phasing techniques was considered and modeled for the Project for Segments 1, 2, & 3. Calculations for phase reconfiguration show that the magnetic values are reduced by an average of 83% at the edge of the right-of-way (ROW). Current phasing for TL616 is A-C-B & TL6939 A-B-C. The new planned configuration of TL616 A-B-C & TL6939 A-B-C.				
2	TL 616 TL 6939	Residential	**Increase Structure Height**	Yes	No-Cost
	Calculations for the proposed initial design which increases the current pole height of 64 feet to 79 feet show that the magnetic values are reduced by 81% at the edge of the right-of-way (ROW). This should be considered as a "no-cost" EMF reduction measure, as it indeed reduces fields at no additional Project cost.				
1, 3	TL 616 TL 6939	Residential	**Place Overhead Lines Underground**	Yes	No-Cost
	Per design, reduction of EMF through placing overhead lines into an underground trench shows that the magnetic values are reduced by an average of 98% at the edge of the right-of-way (ROW).				
1, 3	TL 616 TL 6939	Residential	**Increase Trench Depth**	No	N/A
	Reason not adopted: Burying the cable any deeper does not reduce EMF by 15% and would degrade the capacity, not allowing the needed 200 MVA.				
2	TL 616 TL 6939	Residential	**Place Overhead Lines Underground**	No	N/A
	Reason not adopted: To place TL616 & TL6939 underground would far exceed the 4% cost guideline for low-cost reduction measures.				

VI. Magnetic Field Reduction Measures Recommended for the Project

The following no-cost magnetic field reduction measures are recommended for the Proposed Project:

Segment 1, 2, & 3 – Phase reconfiguration

Segment 2 – Increase structure height

Segment 1 & 3 – Place overhead lines underground

There are no low-cost magnetic field reduction measures recommended for the Proposed Project.

VII. Magnetic Field Details

Reduction Method	Segment	Current		Proposed		EMF Percent Δ	
		North ROW	South ROW	North ROW	South ROW	North ROW	South ROW
Phase Reconfiguration	1	1.24 mG	1.26 mG	0.04 mG	0.06 mG	-97%	-95%
	2	0.87 mG	0.87 mG	0.17 mG	0.17 mG	-81%	-81%
	3	1.34 mG	1.35 mG	0.02 mG	0.02 mG	-99%	-99%
Increase Structure Height	2	0.87 mG	0.87 mG	0.17 mG	0.17 mG	-81%	-81%
Place Overhead Lines Underground	1	1.24 mG	1.26 mG	0.04 mG	0.06 mG	-97%	-95%
	3	1.34 mG	1.35 mG	0.02 mG	0.02 mG	-99%	-99%

* Calculated values are for design comparison only and not meant to predict actual magnetic field levels. Phase reconfiguration was applied in the calculations for increased structure height and placing lines underground.

VIII. Checklist Magnetic Field Management Plan for the Substation Component of the Project

Generally, magnetic field values along the substation perimeter are low compared to the substation interior because of the distance to the energized equipment. Normally, the highest values of magnetic fields around the perimeter of a substation are caused by overhead power lines and underground duct banks entering and leaving the substation, and not by substation equipment. Therefore, the magnetic field reduction measures generally applicable to a substation project are as follows:

- Site selection for a new substation;
- Setback of substation structures and major substation equipment (such as bus, transformers, and underground cable duct banks, etc.) from the perimeter;
- Field reduction for transmission lines entering and exiting the substation.

The Substation Checklist FMP identifies the no-cost and low-cost measures considered for the substation project, the measures adopted, and reasons that certain measures were not adopted.

Item	No-Cost and Low-Cost Magnetic Field Reduction Measures Evaluated for a Substation Project	Measure Adopted? (Yes/No)	Reason(s) If Not Adopted
1	Keep high current devices, transformers, capacitors, and reactors, away from the substation property lines by bringing into the substation property as much as possible.	Yes	N/A
2	For underground duct banks, the minimum distance should be 12 feet from the adjacent property lines or to the extent practical.	Yes	N/A
3	Locate new substations close to existing transmission line rights-of-way to the extent practical.	Yes	N/A
4	Increase the substation property boundary to the extent practical.	Yes	N/A
5	Other: NONE	N/A	N/A

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Date:

July 1, 2016

Appendix – Proposed Project Segment Map