



**Detailed Magnetic Field Management Plan**  
**for the**  
**TL 637 Wood-to-Steel**  
**Project**

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## **I. Proposed Project Scope**

The “TL 637 Wood-to-Steel Pole Replacement Project” (Proposed Project) is for TL 637<sup>1</sup> between Creelman and Santa Ysabel Substations and includes pole replacement and re-conductor of this tieline. It is to replace approximately one hundred fifty-six (156) wood poles with equivalent weathering steel structures for a distance of approximately 14.0 miles and will follow the current alignment centered on the existing rights-of-way (ROW) the full length. The reconductor will change out existing 3/0 ACSR/AW with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from approximately 43 to 110 feet and will be located as close as possible to the existing pole locations.

The Proposed Project begins in San Diego County at Creelman Substation located south of Creelman lane and east of San Vicente road in Ramona, California. The line heads north east, staying on the south side of State Highway 78 and ends at Santa Ysabel Substation just west of Columbia Street in Santa Ysabel, California (Please see “Appendix 1 – Proposed Project Segment Map”). TL 637 traverses on private and public lands, including lands owned by the County of San Diego, Bureau of Land Management (BLM), and Cleveland National Forest (CNF). This region of San Diego County (County) is sparsely populated with small, scattered, unincorporated communities. Completion of the Proposed Project will help increase safety and reliability measures for both existing and future electric infrastructure that serves the Ramona to Santa Ysabel area.

The scope of replacing the 156 wood structures will include, approximately 69 directly-embedded and approximately 87 micropile foundations. They will have like pole top configurations compared to the existing wood poles. The new steel poles are approximately 12 feet taller on average, stronger, and with expanded circuit separation placing the three phase circuit wires farther apart from each other. The 636 ACSS/AW circuits themselves are thicker, heavier wire. As a result, they are less likely to be affected by high winds and chance of blow-out will be reduced. This is also referred to as “fire-hardening” for areas which are considered high-risk fire areas, such as major portions of the Proposed Project scope.

There is a small portion of this line coming into Santa Ysabel substation where facilities must support both TL 637 and TL 626B. This line segment is approximately 3,500 feet in length with approximately 12 structures which will be replaced with double circuit steel structures to support the two 69 kV tielines, one 12 kV distribution circuit, and two communications circuits per structure.

The Proposed Project will be constructed within existing easements or ROWs throughout the entire scope. The scope of magnetic field analysis for this “Detailed Magnetic Field

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<sup>1</sup> In accordance with CPUC General Order 131-D, the term "power line" is used in this document in reference to TL 637, a 69 kV line. The term "transmission," when used, refers to internal SDG&E operating departments, internal SDG&E standards and/or other guidelines, and is not intended to suggest that TL 637 is designed for immediate or eventual operation at 200 kV or above.

Management Plan (FMP)” does not include the distribution lines, per the “SDG&E EMF<sup>2</sup> Design Guidelines for Electrical Facilities” which states, “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 “Proposed Project” only includes the wood-to-steel conversion and re-conductor of electric power line TL 637 and a portion of TL 626B near Santa Ysabel Substation where new double circuit steel poles will be installed. Minor work will be done at Creelman and Santa Ysabel Substations to provide for connection of the re-conducted TL 637 and TL 626B circuit wire and underbuilt distribution line.

## II. Magnetic Field Management Design Guidelines

The CPUC requires SDG&E apply its *EMF Design Guidelines for Electrical Facilities* (“Guidelines”) to all new electric 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 FMP.

The 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.

## III. Methodology

In Decision 06-01-042, the CPUC notes that modeling is used to compare the relative effectiveness of field-reduction options and is not to be used to predict post-construction field levels. CPUC Decision 06-01-042, Finding of Fact 14: “Utility modeling methodology is intended to compare differences between alternative EMF [Electromagnetic Field] mitigation measures and not determine actual EMF amounts.”<sup>3</sup> The CPUC also notes that “modeling indicates relative differences in magnetic field reductions between different transmission line construction methods, but does not measure actual environmental magnetic fields.”<sup>4</sup>

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

- Apply SDG&E’s EMF Guidelines for transmission circuit facilities to the Proposed Project design.
- Identify and implement appropriate “no-cost” measures, i.e., those that will not increase overall project costs but will reduce the magnetic field levels.

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<sup>2</sup> EMF refers to electric and magnetic fields.

<sup>3</sup> CPUC Decision D.06-01-042, Finding of Fact 14, p. 20.

<sup>4</sup> Ibid, p.11.

- 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, per the Guidelines.

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 Field Management Plan (FMP) will be used. The FMP consists of a project description, a checklist table showing evaluation of magnetic field reduction measures adopted or rejected per transmission line, evaluation of “no-cost” and “low-cost” magnetic field reduction techniques, magnetic field models where multiple lines are involved within the same easement or ROW, and a summary with recommendations.

Field levels were calculated using the RESICALC program developed and maintained by the Electric Power Research Institute. As the in-service date of the Proposed Project will be September 2014 the projected high usage currents, “2014 heavy summer,” were used in the calculations. For the purpose of evaluating the field management measures, magnetic field levels were calculated and compared at a height of one meter above ground.

To evaluate the effectiveness of various magnetic field reduction measures, calculated values for a given technique were compared to calculated values without the technique. Since all power lines of the Proposed Project are within easements, or franchise ROW, magnetic field levels were calculated and compared at the adjacent parallel property lines, or edges of ROW.

#### **IV. Project Description**

The “TL 637 Wood-to-Steel Project” (Proposed Project) begins in San Diego County at the Creelman Substation located south of Creelman lane and east of San Vicente road in Ramona, California. The line heads north east, staying on the south side of Highway 78. This power line ends in San Diego County at the Santa Ysabel Substation, just west of Columbia Street, in Santa Ysabel (see “Appendix 1 – Proposed Project Segment Map”). This region of San Diego County (County) is sparsely populated with small, scattered, unincorporated communities.

The scope of the Proposed Project includes replacing existing wood poles with weathering steel poles with like pole top configurations along the entire route, and re-conductor of the 69 kV power line, TL 637. The new steel poles are approximately 12 feet taller on average, stronger, and with expanded circuit separation placing the three phase circuit wires farther apart from each other. The circuits themselves also are thicker, heavier wire. As a result, they are less likely to be affected by high winds and chance of blow-out will be reduced. This is also referred to as “fire hardening” for areas which are consider high-risk fire areas, such as major portions of this Proposed Project scope.

To further define the Proposed Project land use areas, it is located within eastern San Diego County on county park land (Simon Preserve), BLM land (Mt. Gower Preserve), U.S. Forest Service property (CNF), SDG&E-owned lands, and private property. The Proposed Project involves the entire, approximately 14.0 miles, expanse of TL 637. For purposes of this FMP, the Proposed Project alignment is divided up into five (5) separate Segments of land use from the western to the eastern ends of the line:

- **Segment 1**- (0.93 miles) is located in the unincorporated community of Ramona within a semi-rural residential area with agricultural uses such as crop cultivation and pasture for cattle and horses. This segment of the project alignment is within franchise of Creelman Lane and is bordered by rural residential and undeveloped land use, and ends at the western boundary of Simon Preserve, a County open-space park
- **Segment 2**- (1.3 miles) is located in the Simon Preserve. Uses of the preserve include hiking, equestrian riding, and mountain biking. This segment of the Proposed Project alignment is surrounded by the Preserve as it crosses the southern portion of the Preserve in a west/east alignment and ends at its eastern boundary.
- **Segment 3**- (1.9 miles) is located in the San Diego Country Estates subdivision consisting of tract residential development. This segment of the Proposed Project alignment traverses between private lots, starting at the west edge and continuing across a Home Owners Association (HOA) open-space-easement heading north, then turning east on the north boundary of the subdivision between private lots and the Mt. Gower Preserve BLM property.
- **Segment 4**- (9.7 miles) is located in the Mt. Gower Preserve BLM in the western portion of the unit, and private property for most of the remainder of the unit, except for two pole sites on CNF land. The unit covers a large area of undeveloped land, ranchland, and pastures in a northeasterly direction for approximately 9.7 miles. The main land uses are for preserve and agricultural uses of crop cultivation and ranchland for cattle and horses. The segment briefly crosses CNF land with poles P115 and P116. Both of these poles were previously replaced with steel poles through the Corrective Maintenance Program (CMP) and are not intended to be replaced again in this Proposed Project.
- **Segment 5**- (0.17 miles) is the eastern terminus of TL 637 and is comprised of a small amount of commercial uses, residential development, and the Santa Ysabel Substation in the rural community of Santa Ysabel. This portion of the tieline alignment is where facilities must support both TL 637 and TL 626B on new steel double circuit poles.

Construction for the Proposed Project will typically require one for one structure replacement. Some minor relocations may be made to avoid environmentally, biologically, or culturally sensitive locations. All new structures will typically be placed within six (6) to eight (8) feet from the existing structures in the same alignment.

The small portion of this tieline alignment coming into Santa Ysabel Substation in Segment 5, (see “Appendix 1 – Proposed Project Segment Map”) is where facilities must support both TL 637 and TL 626B. These, approximately 12, wood double circuit structures will be replaced with approximately 5 steel pole structures supported by micropile foundations, and

approximately 7 direct embedded steel pole structures. This portion of TL 626B will be re-conducted along with TL 637.

Currently, the rest of TL 637 consists of approximately 144 wood pole structures and 4 light duty steel pole structures supporting one 69 kV circuit of 3-phase single wire 3/0 ACSR/AW conductor and ranging in minimum sag heights of approximately 41 feet. to 110 feet. above grade. These structures will be replaced by approximately 64 steel pole structures supported by micropile foundations, and 80 direct embedded steel pole structures supporting one 69 kV circuit of 3-phase single wire 636ACSS/AW conductor and will range in minimum sag heights of approximately 41 feet. to 110 feet. above grade. The average height increase of the poles would be approximately 12 feet over the entire alignment – this is an average of approximately 19 percent increase in height.

Existing distribution circuits numbered Ckt. 970, 975, or 222 are currently underbuilt through portions of the TL 637 route between the Creelman and Santa Ysabel Substations, or on their own distribution pole structures. The current distribution underbuilt will be transferred to the new steel poles in an overhead position throughout the majority of the TL 637 route. Where distribution underbuilt circuits currently reside on poles within the corridor and there are distribution circuits that are on separate poles along Creelman Lane, Segment 1, (see, “Appendix 1 – Proposed Project Segment Map”) both will be moved over to the new steel poles creating a second distribution underbuilt to consolidate and “fire-harden” the 12 kV in addition to the 69 kV. After circuits are moved, the old wood poles will be removed creating a significant reduction of poles in the area. In addition, taller poles with a vacant distribution position will be added for those portions of TL 637’s alignment where overhead distribution is not present at this time. This vacant distribution position is being created to support projected growth and future distribution needs in the Ramona to Santa Ysabel area. Completion of this Proposed Project will help increase safety and reliability measures for both existing and future electric infrastructure that serves the Ramona to Santa Ysabel area.



## V. Field Management Measures Considered

Per the “EMF Design Guidelines for Electrical Facilities, Table 3-1”, all portions of the power lines, TL 637 and TL 626B, within scope of the Proposed Project were reviewed for suitable application of magnetic field reduction measures, as listed in “*Table 1: Magnetic Field Reduction Measures Adopted or Rejected*” below. These techniques will be discussed under the “Section VI- Magnetic Field Reduction Measures Evaluated for the Project” that follows.

**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- 5	Within TL 637 existing ROW	Residential, Agricultural, Commercial, Undeveloped	<b>Locate power lines closer to center of the utility corridor to extent possible.</b>	No	N/A
1- 5	Within TL 637 existing ROW	Residential, Agricultural, Commercial, Undeveloped	<b>Increasing structure height</b>	Yes	No-Cost

Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
1 - 5	Within TL 637 existing ROW	Residential, Agricultural, Commercial, Undeveloped	<b>Reduce conductor (phase) spacing.</b>	No	N/A
	<p><b>Reason not adopted:</b> The new steel poles in the Proposed Project have equivalent pole top configurations as the existing wood poles had, which provide optimum magnetic field reduction. As part of the enhanced SDG&amp;E transmission design standards for the backcountry in Fire Threat Zone or in High Risk Fire Areas such as this Proposed Project scope, phase spacing will be increased, longer polymer insulators that are less susceptible to contamination will be installed, avian protection will be improved and overall maintenance requirements for the pole will be reduced as a fire hardening measure. There are no alternative poletop configurations to be considered for this Project. Therefore this option was rejected.</p>				
5	Within TL 637 existing ROW	Residential, Agricultural, Commercial, Undeveloped	<b>Phasing Circuits to Reduce Magnetic Fields</b>	No	N/A
	<p><b>Reason not adopted:</b> Reduction of magnetic field values (milligauss) through phasing techniques was considered and modeled for the Proposed Project for <u>Segments 5</u> where two tielines share a common corridor. For approximately 0.6 miles before Santa Ysabel Substation, <b>TL 637</b> shares common structures with <b>TL 626B</b> within the same easement. Current flow in these two tielines travels in opposite directions. Double circuits with current flow in opposite directions should be phased the same for lowest magnetic field values at ROW ( e.g.,A-B-C (t-b) and A-B-C (t-b)). Modeling showed a difference of <b>69.6%</b> at left ROW and <b>58.4%</b> right ROW for same phase configuration vs. opposite phase configuration ( e.g.,A-B-C (t-b) and C-B-A (t-b)). Phase currently is <b>(A-B-C (t-b))</b> for <b>TL 626B</b> and <b>(A-B-C (t-b))</b> for <b>TL 637</b> so both should remain as is. Therefore, no "no-cost" or "low-cost" alternatives were considered for this portion of the Proposed Project.</p>				
1 - 5	Within TL 637 existing ROW	Residential, Agricultural, Commercial, Undeveloped	<b>Placing Overhead Underground</b>	No	N/A
	<p><b>Reasons not adopted:</b> These segments vary in length from several feet to several miles as the tieline travels between Creelman Substation and Santa Ysabel Substation, a total of approximately 13.6 miles. Based on preliminary cost estimates for the Proposed Project, only approximately 0.3 miles of the 13.6 miles could be undergrounded and still be considered a "low-cost" field-reduction measure. As there are no known schools, day-care centers or hospitals on lands adjacent any of these segments, priority for low-cost field reduction would be given to segments adjacent to residential land use. Preliminary review suggests that the total of segment miles adjacent to residences is far greater than 0.3 miles. Though evaluation of "low-cost" measures for these Segments can be prioritized by considering location and/or density of adjacent permanently occupied structures<sup>5</sup>, the population density along most of these Segments is consistently sparse, making prioritization difficult. A more broadly effective "no-cost" measure is proposed for use under "Increasing structure height" in this Table. For these reasons, undergrounding as a "low-cost" field-reduction measure was not adopted.</p>				

<sup>5</sup> SDG&E Guidelines, p. 12: "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."

Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
1 - 5	Within TL 637 existing Easement	Residential, Agricultural, Commercial, Undeveloped	Increase trench depth	No	N/A
	<b>Reasons not adopted:</b> Undergrounding the 69 kV tieline, TL 637, is not within scope of the Proposed Project and was discarded due to the cost that would far exceed 4% of the total Project cost. (see “Placing overhead underground” above in this table)				

## VI. Magnetic Field Reduction Measures Evaluated for the Project

Per SDG&E’s Guidelines this FMP is limited to an assessment of increasing structure height as a field reduction technique, and phasing circuits to reduce magnetic fields for those double circuit pole portions near Santa Ysabel Substation in Segment 5 where TL 637 and TL 626B share a common easement. Other techniques such as locating power lines closer to the center of the easement, reducing conductor (phase) spacing, placing overhead underground to reduce magnetic fields, and increasing trench depth were not implemented.

**Locating power lines closer to the center of the easement:** The alignment of the new steel poles and re-conductor for all power lines is to be the same as the old poles, which is as close to center of easement as possible. The steel poles will be located as close as possible to the existing pole locations. Therefore locating power lines closer to center of easement was discarded as a reduction technique.

**Increasing structure height:** By design, the pole height will increase for the Proposed Project to compensate for heavier conductor wire while maintaining minimum sag. Per SDG&E Standards for 69 kV double circuit and single circuit overhead power lines with no distribution underbuild, minimum sag height is 30 feet from lowest circuit wire to ground as per *GO-95 Design Standards* and 35 feet from lowest circuit wire for double underbuild. In some Segments in this Proposed Project there will be single distribution 12 kV underbuild and/or double distribution underbuild.

Through modeling, it was found by raising the sag height from the initial *GO-95 Design Standard* minimum height for this configuration by an additional three (3) feet (**33ft. sag**) for Segment 1 and 5 where the alignment is 6-8 feet from edge of franchise or ROW at closest side, an additional six (6) feet (**41ft. sag**) for Segment 1 where there is double underbuild, and an additional four (4) feet (**34ft. sag**) for Segments 2-4 where the alignment centers on 30-50 easement width and permanent residence exist (i.e., which also raises pole heights by approx. that amount) the 15% reduction at ROW for a “low-cost” option could be achieved. However, the initial Proposed Project design shows minimum sag height to be from **41ft. to 64ft.** from lowest circuit wire to ground for TL 637. This is due to an additional vertical separation distance implemented by SDG&E for both transmission and distribution circuits sharing the same pole for “safety and maintenance considerations” by design. This achieves a magnetic field reduction of **55 - 76%** for no underbuild or single underbuild, and **34 - 65%** for double underbuild

respectively, at the closest ROW without raising milligauss values at the opposite ROW. This should be considered as a “no-cost” EMF reduction measure, as it indeed reduces fields at no additional Proposed Project cost. Raising pole heights beyond that imposed by SDG&E for safety and maintenance reasons as a “low-cost” measure would be unreasonable, as the final initial design heights already will be 12 feet higher on average than the existing poles and thereby could create visual and/or aesthetic concerns. (see “no-cost” options below)

**Reducing conductor (phase) spacing:** The new steel poles in the Proposed Project have SDG&E Standard pole-head configurations equivalent to those on the existing wood poles which provide optimum magnetic field reduction. As part of the enhanced transmission design standards for the backcountry in “Fire Threat Zone” or in a “High Risk Fire Areas” such as this Proposed Project scope, phase spacing will be increased, longer polymer insulators that are less susceptible to contamination will be installed, avian protection will be improved and overall maintenance requirements for the pole will be reduced as a “fire hardening” measure. Therefore reducing conductor phase spacing to reduce magnetic fields was rejected as a reduction technique.

**Phasing Circuits to Reduce Magnetic Fields:** Reduction of magnetic field values (milligauss) through phasing techniques was considered and modeled for the Proposed Project for Segment 5 where two tielines share a common easement. For approximately 0.6 miles before Santa Ysabel Substation, **TL 637** shares common structures with **TL 626B** within the same easement. Current flow in these two tielines travels in opposite directions. Double circuits with current flow in opposite directions should be phased the same for lowest magnetic field values at ROW ( e.g.,A-B-C (t-b) and A-B-C (t-b)). Modeling showed a difference of **69.6%** at left ROW and **58.4%** right ROW for same phase configuration vs. opposite phase configuration ( e.g.,A-B-C (t-b) and C-B-A (t-b)). Phase currently is **(A-B-C (t-b))** for **TL 626B** and **(A-B-C (t-b))** for **TL 637** so both should remain as is. Therefore, no "no-cost" or "low-cost" alternatives were considered for this portion of the Proposed Project.

**Undergrounding to reduce magnetic fields:** These Segments vary in length from several feet to several miles as the tieline travels between Creelman Substation and Santa Ysabel Substation, a total of approximately 13.6 miles. Based on preliminary cost estimates for Proposed Project, only approximately 0.3 miles of the 13.6 miles could be undergrounded and still be considered a "low-cost" field-reduction measure. As there are no known schools, day-care centers or hospitals on lands adjacent any of these segments, priority for low-cost field reduction would be given to segments adjacent to residential land use. Preliminary review suggests that the total of segment miles adjacent to residences is far greater than 0.3 miles. Though evaluation of “low-cost” measures for these Segments can be prioritized by considering location and/or density of adjacent permanently occupied structures<sup>6</sup>, the population density along most of these Segments is consistently sparse, making prioritization difficult. A more broadly effective "no-cost" measure is proposed for use under "Increasing structure height" in the Table 1 above. For these reasons, undergrounding as a "low-cost" field-reduction measure was rejected as a reduction technique.

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<sup>6</sup> Ibid

**Increasing trench depth:** Undergrounding the 69 kV tieline, TL 637, is not within scope of the Proposed Project and was discarded due to the cost that would far exceed 4% of the total Project cost. (see “Table 1: Magnetic Field Reduction Measures Adopted or Rejected: Undergrounding to reduce magnetic fields” above). Therefore this reduction technique was rejected.

## **VII. Magnetic Field Reduction Measures Recommended for the Project**

Reduction of magnetic field values by increasing structure height as a field reduction technique was adopted as a viable method to reduce magnetic fields at the edge-of-ROW for the Proposed Project. The recommended field reduction techniques are:

### **A. “No-Cost” Field Management Technique:**

The Proposed Project design shows minimum sag height to be from **41ft.** to **64ft.** from lowest circuit wire to ground for TL 637. This is due to an additional vertical separation distance implemented by SDG&E for both transmission and distribution circuits sharing the same pole for “safety and maintenance considerations” by design. This achieves a magnetic field reduction of **55 - 76%** for no underbuild or single underbuild, and **34 - 65%** for double underbuild respectively, at the closest ROW without raising milligauss values at the opposite ROW. This constitutes a “no-cost” EMF reduction measure, as it indeed reduces fields at no additional Project cost.

### **B. “Low-Cost” Field Management Technique:**

There are no “low-cost” magnetic field reduction techniques recommended for the Proposed Project.

# Appendix 1

## Proposed Project

### Segment Map

