Draft

Detailed Magnetic Field Management Plan for the Cleveland National Forest (CNF) Powerline Replacement Projects

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Work Order No.: **xxxxx**
In-Service Date: **2018**

Transmission Lines: **TL 625, 626, 629, 682, 6923**

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

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I. Proposed Project Scope

The Cleveland National Forest (CNF) Powerline Replacement Projects (Proposed Project) are wood-to-steel pole replacement and re-conductor projects. The Proposed Project is located in the central portion of San Diego County, California, within and around the CNF. This region of San Diego County (County) is sparsely populated with small, scattered, unincorporated communities. Completion of this Proposed Project will help increase safety and reliability measures for both existing and future electric infrastructure that serves the U.S. Forest Service (USFS), fire threat, communication, and other emergency services, along with camp grounds, homes, businesses, and other customers within these areas.

The scope of the Proposed Project includes replacing approximately 2,000 existing wood poles with fire-resistant, weatherized, steel poles along an estimated 150 miles of transmission and distribution lines, and re-conductor the five (5) 69kV transmission lines and six (6) 12kV distribution lines. The new steel transmission poles are approximately 15 feet taller, 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.

The Proposed Project also includes a reliability enhancement portion, which includes looping in two existing transmission lines to two separate substations and removing the two existing 3 way taps, which are a single point of failure. TL625-B will loop-in to Loveland Substation and TL629-E will loop-in to Crestwood substation. These transmission lines will be connected to existing structures within the substation. In addition, the newest portion of TL629 going from Crestwood to Cameron Substation (TL6958) will be converted to underground for approximately 792 feet before entering Crestwood Substation.

The Proposed Project will be constructed within existing rights-of-way (ROWs) throughout the entire scope. The scope of this "Detailed Magnetic Field Management Plan (FMP)" does not include the distribution lines, per the "SDG&E EMF[1] 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" includes the wood-to-steel conversion and re-conductor of five existing transmission line facilities (but not the six distribution circuits) that are included in the overall Proposed Project.

Each of these 69 kV power line fire hardening projects is subject to review by the California Public Utilities Commission (CPUC) irrespective of whether the activity is taking place within or outside of the CNF. Relative to the Proposed Project action, the 69 kV power line fire hardening projects outside the USFS-administrative boundary of the CNF are considered "*Connected Actions*". The USFS' National Environmental Policy Act (NEPA) defines "*Connected Actions*" as actions that are closely related and therefore should be discussed in the same impact

[1] EMF refers to electric and magnetic fields.

statement. For the Proposed Project, these include replacement of approximately 1,011 existing wood utility poles with steel poles along the five existing 69 kV power lines at locations outside the administrative boundary of the CNF.

SDG&E is seeking Proposed Project approval in 2013, through a comprehensive process conducted by the CPUC and USFS. After the Proposed Project is approved, construction is scheduled in phases over the next five years. Completion of the Proposed Project will complement SDG&E's Community Fire Safety Program that includes new fire prevention measures and enhanced emergency response.

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 transmission circuit locations associated with the Proposed Project. The results of this evaluation are contained in this FMP.

The Proposed Project includes looping in two existing transmission lines to two separate substations. TL625-B will loop-in to Loveland Substation and TL629-E will loop-in to Crestwood substation. These transmission lines will be connected to existing structures within the substation. Per the SDG&E Guidelines regarding substations, "The Substation Checklist FMP evaluates the no-cost and low-cost measures considered for the substation project, the measures adopted, and reasons that certain measures were not adopted." is included in this FMP. (see Section IX. *Field Management Plan Checklist for the Loveland and Crestwood Substation Loop-In Portions of the Proposed Project*)

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."[2] 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."[3]

[2] CPUC Decision D.06-01-042, Finding of Fact 14, p. 20.
[3] Ibid, p.11.

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.
- 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 FMP will be used. The Detailed 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 rights-of-way (ROW), and a summary with recommendations, including tables showing resultant magnetic field reduction levels at the edge of the ROW where applicable.

Field levels were calculated using the RESICALC program developed and maintained by the Electric Power Research Institute**.** As the proposed in-service date of the five transmission lines in the Proposed Project will be over a five year period (2013-2018), the projected high usage currents, "2018 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 five transmission lines of the Proposed Project are within defined easements, magnetic field levels were calculated and compared at the adjacent parallel property lines, or edges of ROW.

IV. Project Description

San Diego Gas & Electric Company (SDG&E) proposes to replace existing electricity transmission and distribution facilities within and around the United States (U.S.) Forest Service (USFS) Cleveland National Forest (CNF) as part of its "CNF Powerline Replacement Projects". The Proposed Project is located predominantly within the CNF Congressional Boundary and includes a series of electric transmission and distribution line replacement projects. The transmission and distribution lines to be replaced extend outside of CNF administered lands into private and tribal lands, as well as other state and federally administered lands.

The scope of this Detailed FMP does not include the distribution lines, as per the Guidelines 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 includes the wood-to-steel conversion and re-conductor of five existing transmission line facilities (but not the six distribution circuits) that are included in the overall Proposed Project.

Each of these five 69 kV power line fire hardening projects are subject to review by the CPUC irrespective of whether the activity is taking place within or outside of the CNF. Relative to the Proposed Project action, the 69 kV power line fire hardening projects outside the USFS-administrative boundary of the CNF are considered "*Connected Actions*". The USFS' National Environmental Policy Act (NEPA) defines "*Connected Actions*" as actions that are closely related and therefore should be discussed in the same impact statement. For the Proposed Project, these include replacement of approximately 1,011 existing wood utility poles with steel poles along the five existing 69 kV power lines at locations outside the administrative boundary of the CNF.

The Proposed Project also includes a reliability enhancement portion, which includes looping in two existing transmission lines to two separate substations and removing the two existing 3 way taps, which are a single point of failure. TL625-B will loop-in to Loveland Substation and TL629-E will loop-in to Crestwood substation. These tielines will be connected to existing structures within the substation.

The location of the Proposed Project is in the central portion of San Diego County, California, in and around the CNF. The Proposed Project boundaries are approximately 4.5 miles north of the U.S.-Mexico border, 14.5 miles west of the Imperial County border, 8.5 miles south of the Riverside County border, and 14.5 miles east of the City of San Diego. The "Appendix 1: Proposed Project Map" displays the Project and transmission line locations.

The five 69kV transmission lines in the Proposed Project are defined as:

- Transmission Line (TL) 625 – approximately 22.5 miles in length with approximately 6.5 miles located within the CNF boundary and approximately 16 miles located outside the CNF boundary; runs from Loveland Substation east to Barrett Tap, from Barrett Tap east to Descanso Substation, and from Barrett Tap south to Barrett Substation.

- TL626 – approximately 18.8 miles in length with approximately 8.2 miles located within the CNF boundary and approximately 10.6 miles located outside the CNF boundary; runs from Santa Ysabel Substation south to Descanso Substation.

- TL629 – approximately 29.8 miles in length with approximately 9.6 miles located within the CNF boundary and approximately 20.2 miles located outside the CNF boundary; runs from Descanso Substation east to Glencliff Substation, from Glencliff Substation southeast to Cameron Tap, from Cameron Tap south to Cameron Substation, and from Cameron Tap east to Crestwood Substation.

- TL682 – approximately 20.2 miles in length with approximately 2.5 miles located within the CNF boundary and approximately 17.7 miles located outside the CNF boundary; runs from Rincon Substation east to Warners Substation.

- TL6923 – approximately 13.4 miles in length with approximately 1.7 miles located within the CNF boundary and approximately 11.7 miles located outside the CNF boundary ; runs from Barrett Substation east to Cameron Substation.

The above transmission lines connect from substation to substation and traverse private lands as well as USFS-administered lands and other public lands. All of the approximately 104.7 miles of transmission lines included in the Proposed Project are within existing ROWs; however, some ROW expansion may be required to accommodate single-to-double circuit conversion along portions of TL625B and TL629E. The locations of these transmission lines are depicted in "Appendix 1: Proposed Project Map" and are described in more detail as follows:

- **TL625**

  The approximately 22.5-mile-long portion of TL625 is located near the unincorporated communities of Alpine and Descanso in central San Diego County. TL625 consists of the following three sections, as shown in "Appendix 1: Proposed Project Map":

  - **TL625B** - The Proposed Project will reconfigure this portion of TL625 from a three terminal line to two separate tie lines by replacing the single circuit portion from Loveland Substation to the three way tap point, called internally, Barrett Tap, with a double circuit steel pole line, a distance of 6.2 miles. Approximately 5.1 of these miles are outside CNF through private land. Currently there are approximately 52 H-frame and approximately 13 single wood pole structures supporting one 69kV circuit with 636ACSR/AW conductor, ranging in heights from approximately 45 to 90 feet above grade. These structures will be replaced with approximately 55 double circuit steel pole structures with foundations, eliminating 10 transmission and 5 distribution wood structures. The new steel poles will follow the original alignment and be placed as close as possible to the original pole locations. The engineered poles will support 2-69kV circuits of 3-phase single wire 636ACSS/AW conductor and will range in heights from approximately 60 to 120 feet above grade.

  - **TL625C –** This portion of the Proposed Project is from Barrett Tap to Descanso Substation, and includes approximately 10 miles of pole replacement and re-conductor. Approximately 7.3 of these miles are outside CNF through private land. Currently there are approximately 148 wood poles which will be replaced with equivalent direct bury steel poles. The new steel poles will follow the original alignment and be placed as close as possible to the original pole locations. The reconductor will change out existing 1/0 CU. with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 50 to 90 feet above grade.

- **TL625D –** This portion of TL625 in the Proposed Project is from Barrett Tap to Barrett Substation, and includes approximately 7.4 miles of pole replacement and re-conductor. Approximately 3.7 of these miles are outside CNF through private land. Currently there are approxamately 73 wood poles which will be replaced with equivalent direct bury steel poles. The new steel poles will follow the original alignment and be placed as close as possible to the original pole locations. 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 50 to 90 feet above grade.

- The proposed name changes of TL625B, TL625C, and TL625D will be TL625 from Loveland to Descanso, and **TL6957** from Loveland to Barrett.

- Approximately 6.5 miles of TL625 are included in the CNF. Outside of the CNF, TL625 crosses approximately 16.1 miles of private land, state lands, and Bureau of Land Management (BLM)-administered land. The BLM and state land transmission line distances are yet to be determined. Land uses along the TL625 route include agriculture, recreation, residences, the Loveland Reservoir, and the Descanso Detention Facility.

- **TL626**

  The approximately 18.8-mile-long portion of TL626 is located between the communities of Santa Ysabel and Descanso in central San Diego County. TL626 runs from Santa Ysabel Substation to Descanso Substation, as shown in "Appendix 1: Proposed Project Map". For the Proposed Project, TL626 has been subdivided into two sections: TL626A and TL626B.

  - **TL626B** - This portion of TL626 is from Santa Ysabel Substation to Boulder Creek Substation, and includes approximately 7.1 miles of pole replacement and re-conductor. Approximately 5.0 of these miles are outside CNF through private land. The first 0.6 miles from Santa Ysabel, TL626 shares common structures with TL637. Separate poles will be used where dead-ends exist for this section. The new steel poles will follow the original alignment and be placed as close as possible to the original pole locations. The reconductor will change out existing 1/0 CU with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade.

  - **TL626A** - This portion of TL626 then begins, heading south from Boulder Creek Substation to Descanso Substation and includes approximately 11.9 miles of pole replacement and re-conductor. Approximately 4.6 of these miles are outside CNF through private land. The reconductor will change out existing 1/0 CU with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

- Currently TL626 consists of approximately 285 wood poles. These will be replaced with equivalent direct bury steel poles the entire distance of approximately 18.8 miles. The new steel poles in the Proposed Project have equivalent SDG&E Standard pole-head configurations the wood poles had, which provide optimum magnetic field reduction.

- Approximately 9.4 miles of TL626 are included in the CNF. Outside of the CNF, TL626 crosses approximately 9.6 miles of private land. Land uses along the TL626 route include agriculture, commercial, recreation, and residences.

- **TL629**

  The approximately 29.8-mile-long portion of TL629 is located near the communities of Descanso, Guatay, and Pine Valley in central San Diego County. TL629 consists of the following four sections, as shown on "Appendix 1: Proposed Project Map":

  - **TL629A –** This section of TL629 of the Proposed Project is from Descanso Substation to Glencliff Substation and includes approximately 11.4 miles of pole replacement and re-conductor. Approximately 7.5 of these miles are outside CNF, 5.6 of which is in Cuyamaca Rancho State Park, the rest through private land . The re-conductor will change out existing 1/0 ACSR/AW with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

  - **TL629C -** The section of TL629 is from Glencliff Substation to Cameron Tap and includes approximately 6.3 miles of pole replacement and re-conductor. Approximately 3.1 of these miles are outside CNF through private land. The re-conductor will change out existing 1/0 ACSR/AW with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

  - **TL629D –** This section of TL629 from Cameron Tap to Cameron Substation includes approximately 4.7 miles of pole replacement and re-conductor. Approximately 3.5 of these miles are outside CNF through, 3.0 of which is in BLM-administered land and 0.5 through private land. The reconductor will change out existing 1/0 ACSR/AW with heavier 636-ACSS/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

  - **TL629E -** The fourth section on this transmission line includes reconfiguration of TL629 from a three way tap point, called internally, Cameron Tap, to two separate tie lines by replacing the this single circuit portion from Cameron Tap to Crestwood Substation (TL629E), a distance of approximately 7.6 miles, with a double circuit steel pole line eliminating Cameron Tap. The distance includes 4.4

miles through private land, BLM-administered land, and the Campo Indian Reservation. This Proposed Project will also include re-conductor of this segment to 636-ACSS/AW to increase the 69kV transmission line ratings and replace all current wood structures with steel structures. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

- The resultant configuration of TL629 will be, TL629A from Descanso Substation to Glencliff Substation (as before), TL629C Glencliff Substation to Crestwood Substation, and rename TL629E to **TL6958** from Crestwood to Cameron Substation.

- As part of the single-to-double-circuit conversion of TL629E, SDG&E proposes to replace the existing overhead connection of TL629E (new **TL6958**) to Crestwood Substation with an underground connection. This underground connection would begin at the replacement steel pole west of Crestwood Substation, proceed east to the western shoulder of Old Highway 80, continue north along the western shoulder of Old Highway 80, cross under Old Highway 80 to the west via jack-and-bore construction, continue east along SDG&E's access road to Crestwood Substation, and finally turn south into the substation where it would connect to the existing rack. This route is approximately 792 feet and resides within franchise, or within SDG&E existing land around Crestwood Substation.

- Approximately 11.3 miles of TL629 crosses CNF administered land. Outside of the CNF, TL629 crosses approximately 18.5 miles of land which includes 5.5 miles of known private land, and 13.0 miles of Cuyamaca Rancho State Park land, BLM-administered land, tribal land. Land uses along the TL629 route include agriculture, commercial, recreation, residences, and the Campo Indian Reservation.

- **TL682**

  This portion of the Proposed Project includes pole replacement and re-conductor of approximately 20.2 miles of TL682 which runs from Rincon Substation to Warners Substation, as shown in ""Appendix 1: Proposed Project Map". Approximately 17.7 of these miles are outside CNF, 11.0 of which are through tribal land and 6.7 through private land. It is located near the communities of Pauma Valley and Warner Springs in central San Diego County. All wood poles will be replaced with equivalent direct bury steel poles. The reconductor will change out existing 2/0 CU with heavier 636-ACSR/AW circuit wire. The steel poles will range in height from 65 to 100 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

  - Approximately 2.5 miles of TL682 crosses USFS-administered land. Outside of the CNF, TL682 crosses approximately 17.7 miles of tribal land and private land. Land uses along the TL682 route include agriculture, recreation, residences, and the La Jolla Indian Reservation.

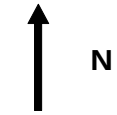
- **TL6923**

  TL6923 is located near the communities of Potrero and Campo in central San Diego County and runs from Barrett Substation to Cameron Substation, as shown in "Appendix 1: Proposed Project Map". This portion of the Proposed Project will replace approx. 13.5 miles of TL6923 current structures with steel structures that will support a single 69kV transmission circuit. Approximately 0.8 of these miles are outside CNF through private land, 1.7 miles within USFS-administrated land, and the remaining distance of 11.0 miles either traverses along the boundary between CNF and BLM-administered land, or follows the CNF boundary. This Proposed Project will also replace existing 336-ACSR/AW conductor with 636-ACSS/AW to increase the line ratings. There are currently 116 wood pole structures, 21 light duty steel poles, and engineered steel pole structures supporting TL6923 ranging in heights from approx. 50' to 85' above grade. These structures will be replaced with approximately 52 engineered steel pole structures and approximately 85 light duty direct bury steel pole structures, ranging in height from 60 to 110 feet above grade, follow the original alignment, and will be located as close as possible to the existing pole locations.

    - TL6923 Approximately 1.7 miles of TL6923 crosses USFS-administered land. Outside of the CNF, TL6923 crosses approximately 0.8 miles of private land, and the remaining 12.7 miles either traverses along the boundary between CNF and BLM-administered land, or follows the CNF boundary. Land uses along the TL6923 route include agriculture, recreation, and residences.

Drawings and descriptions showing a typical pole top configuration, transmission line relative locations to each other and left and right ROW are included in Appendix 1. Figure 1 below shows the drawing symbols; the arrows on the drawings indicate the viewing direction for orienting each drawing and the direction of current flow.

Figure 1: Drawing Symbol Definitions

Symbol	Interpretation	Meaning
	Viewing Direction	The orientation as seen when looking toward the north
	Current flow into the page	Direction of current flow is same as viewing direction
	Current flow out of the page	Direction of current flow is opposite of viewing direction
	Underground Transmission Circuit	Location of underground transmission circuit
	Underground Transmission Circuit	Location of Underground Transmission in Bridge Cell

V. Field Management Measures Considered

Per the "EMF Design Guidelines for Electrical Facilities, Table 3-1", all portions of the five transmission lines 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

Transmission Tieline (TL)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
625, 626, 629, 682, 6923	Within TL existing Easement	Residential, Agricultural, Commercial, Industrial, Undeveloped	**Locate power lines closer to center of the utility corridor to extent possible.**	**No**	**N/A**
	Reason not adopted: The alignment of the new steel poles and re-conductor for all tielines 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 this option was rejected.				
625, 626, 629 ,682, 6923	Within TL existing Easement	Residential, Agricultural, Commercial, Industrial, Undeveloped	**Increasing structure height**	**Yes**	**Not Available**
	Reason adopted: All single circuit tielines, which are not adjacent to undeveloped land must be considered for "low-cost" mitigation.[4] Modeling was done for the Proposed Project single circuit steel poles, and easement widths from 12-20 feet, and by raising the minimum sag by three (3) feet (33 ft. min) a reduction of 15% was met at each ROW, and for easement widths of thirty (30) feet, by raising the minimum sag by four (4) feet, a reduction of at least 15% was achieved at each ROW. For those portions of TL625C and TL682 where easement width is 50 or 100 feet, raising the minimum sag by four (4) or seven (7) feet respectfully a reduction of 15% was achieved at each ROW. This "low-cost" mitigation should be implemented where applicable.				
625, 626, 629, 682, 6923	Within TL existing Easement	Residential, Agricultural, Commercial, Industrial, Undeveloped	**Reduce conductor (phase) spacing.**	**No**	**N/A**
	Reason not adopted: The new steel poles in the Proposed Project have equivalent pole-head configurations the wood poles had, 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. There are no alternative pole-head configurations to be considered for this Project. Therefore this option was rejected.				

[4] Additionally, tielines adjacent to agricultural, commercial, industrial and recreational areas (e.g., campgrounds and seasonal cabins), regardless of the adjacent land use, must be considered for "low-cost" mitigation.

Transmission Tieline (TL)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
625B, 629E	Within TL existing Easement	Residential, Agricultural, Commercial, Industrial, Undeveloped	**Phasing Circuits to Reduce Magnetic Fields**	**Yes**	**N/A**
	Reason adopted: **TL625B-** Current flow goes south out of Loveland Sub. to Barrett Sub. and south, then east, to Descanso Sub. Therefore, the current flow on the double circuit poles from Loveland to the Barrett Tap will be in the same direction. Double circuits with current flow in the same direction should be reverse phased for lowest magnetic field values at ROW (e.g.,A-B-C (t-b) and C-B-A (t-b)). Modeling showed a difference of 71.9% at each ROW for this reverse phased configuration. The existing phase of **TL625B** is **(A-B-C (t-b))**. The new tieline names will be **TL625** from Loveland to Descanso, and **TL6957** from Loveland to Barrett. Therefore tieline **TL6957** should be **(C-B-A (t-b)).** As part of this Proposed Project, this phase change of double circuit pole configuration should be considered as a "no-cost" option. **TL629E** - Current flow goes north out of Crestwood Substation to Glencliff Substation (TL629C), and south from Crestwood Substation to Cameron Substation (new TL6958) Therefore, the current flow on the double circuit poles for this segment will be in the same direction. Modeling showed a difference of 67.7% at each ROW for this reverse phased configuration. The existing phase of **TL629A** and **TL629C** is **(B-C-A (t-b)).** Therefore new tieline **TL6958** should be installed as **(A-C-B (t-b)).** As part of this Proposed Project, this phase change of double circuit pole configuration should be considered as a "no-cost" option.				
626B, 637, 682, 6923	Within TL existing Easement	Residential, Agricultural, Commercial, Industrial, Undeveloped	**Phasing Circuits to Reduce Magnetic Fields**	**No**	**N/A**
	Reason not adopted: **TL626B-** The first 0.6 miles from Santa Ysabel, **TL626B** shares common structures with **TL637**. 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. Phase currently is **(A-B-C (t-b))** for **TL626B** and **(A-B-C (t-b))** for **TL637** so both should remain as is. Therefore, no "no-cost" or "low-cost" alternatives were considered for this portion of the Proposed Project. **TL682** and **TL6923** are single circuit 69kV transmission lines. Since phase re-arrangement of a single transmission circuit, with no other transmission circuits within the ROW provides the same EMF values at each ROW, this option was not considered. Therefore, no "no-cost" or "low-cost" alternatives were considered for this Project.				

<table>
<tr><th>Transmission Tieline (TL)</th><th>Location (Street, Area)</th><th>Adjacent Land Use</th><th>Reduction Measure Considered</th><th>Measure Adopted? (Yes/No)</th><th>Estimated Cost to Adopt</th></tr>
<tr><td rowspan="2">625, 626, 629, 682, 6923</td><td>Within TL existing Easement</td><td>Residential, Agricultural, Commercial, Industrial, Undeveloped</td><td>Placing Overhead Underground</td><td>No</td><td>N/A</td></tr>
<tr><td colspan="5"><u>Reasons not adopted</u>: These segments vary in length from several feet to several miles as the tieline weaves in and out of Agency areas, and total to approximately 76 miles of the 104.7-mile Proposed Project. Based on preliminary cost estimates for Proposed Project, only three of the 76 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 three, Though evaluation of low-cost measures for these segments can be prioritized by considering location and/or density of adjacent permanently occupied structures,[1] the population density along most of these segments is consistently sparse, making prioritization difficult. A more broadly effective "low-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.
<u>TL629E-</u> As part of the single-to-double-circuit conversion the new circuit to share double circuit steel poles with TL629E will be converted to underground the last 792 feet before entering Crestwood Substation. The long path is required to stay within franchise or on SDG&E owned land from the proposed steel cable pole location south of Old Hwy 80 and enter Crestwood Substation on the west side without having to cross Campo Indian Reservation Tribal land as much as possible. As part of the initial Proposed Project, this is not a “no-cost” or “low-cost” mitigation.</td></tr>
<tr><td rowspan="2">629E</td><td>Within TL existing Easement</td><td>Residential, Agricultural, Commercial, Industrial, Undeveloped</td><td>Increase trench depth</td><td>No</td><td>N/A</td></tr>
<tr><td colspan="5"><u>Reasons not adopted</u>:

<u>TL629E-</u> As part of the single-to-double-circuit conversion the new circuit to share double circuit steel poles with TL629E will be converted to underground the last 792 feet before entering Crestwood Substation. The long path is required to stay within franchise or on SDG&E owned land from the proposed steel cable pole location south of Old Hwy 80 and enter Crestwood Substation on the west side without having to cross Campo Indian Reservation Tribal land as much as possible.. It will be installed at the standard 3 feet top-of-conduit by extensive jack-and-bore construction. Open-cut trenching is not permitted or is infeasible, as the underground installation crosses Old Highway 80 in this case. This specialized construction requires 20 to 40 foot wide boring pits, 10 to 20 feet deep which require special permits. Increasing the depth of the conduit for the transmission line would make these pits even deeper which would eliminate the possibility of permitting. Therefore increasing trench depth of TL629E (new TL6958) was rejected as a “low-cost” option.</td></tr>
</table>

[1] 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."

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 of TL625B and TL629E. 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. For certain portions of the Proposed Project increasing pole height and phasing circuits to reduce magnetic fields were also not implemented.

All single circuit transmission lines which are not adjacent to undeveloped land, and transmission lines adjacent to agricultural, commercial, industrial and recreational areas (e.g., campgrounds and seasonal cabins), regardless of the adjacent land use, must be considered for "low-cost" mitigation

Locating power lines closer to the center of the easement: The alignment of the new steel poles and re-conductor for all transmission 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.

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.

Undergrounding to reduce magnetic fields: These segments vary in length from several feet to several miles as the transmission line weaves in and out of Agency areas, and total to approximately 76 miles of the 104.7-mile Proposed Project. Based on preliminary cost estimates for Proposed Project, only three of the 76 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 three. Though evaluation of low-cost measures for these segments can be prioritized by considering location and/or density of adjacent permanently occupied structures,[1] the population density along most of these segments is consistently sparse, making prioritization difficult. A more broadly effective "low-cost" measure

[1] 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."

is proposed for use under "Increasing structure height" as shown in "Table 1" above. For these reasons, undergrounding as a "low-cost" field-reduction measure was not adopted.
Increasing trench depth: As part of the single-to-double-circuit conversion of **TL629E** the new circuit to share double circuit steel poles, **TL6958**, will be converted to underground the last 792 feet before entering Crestwood Substation. The long path was required in order to stay within franchise or on SDG&E owned land from the proposed steel cable pole location south of Old Hwy 80 and enter Crestwood Substation on the west side without having to cross Campo Indian Reservation Tribal land as much as possible. It will be installed at the standard 3 feet top-of-conduit by extensive jack-and-bore construction. Open-cut trenching is not permitted or is infeasible, as the underground installation crosses Old Highway 80 in this case. This specialized construction requires 20 to 40 foot wide boring pits, 10 to 20 feet deep which require special permits. Increasing the depth of the conduit for the transmission line would make these pits even deeper which could affect the ability to obtain permits. Therefore increasing trench depth for **TL6958** was rejected as a "low-cost" option.

Phasing Circuits to Reduce Magnetic Fields: For the first 0.6 miles from Santa Ysabel, **TL626B** shares common structures with **TL637**. Current flow in these two transmission lines 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. Phase currently is **(A-B-C (t-b))** for **TL626B** and **(A-B-C (t-b))** for **TL637** so both should remain as is. Therefore, no "no-cost" or "low-cost" alternatives were considered for this portion of the Proposed Project.

TL682 and **TL6923** are single circuit 69kV transmission lines. Since phase re-arrangement of a single transmission circuit, with no other transmission circuits within the ROW provides the same EMF values at each ROW, this option was not considered. Therefore, no "no-cost" or "low-cost" alternatives were considered for this Project.

Phasing Circuits to Reduce Magnetic Fields (no-cost): Phase re-arrangement of two transmission lines sharing a double circuit pole was studied for the Proposed Project with these results:

- **TL625B-** Current flow goes south out of Loveland Sub. to Barrett Sub. and south, then east, to Descanso Sub. Therefore, the current flow on the double circuit poles from Loveland to the Barrett Tap will be in the same direction. Double circuits with current flow in the same direction should be reverse phased for lowest magnetic field values at ROW (e.g.,A-B-C (t-b) and C-B-A (t-b)). Modeling showed a difference of 71.9% at each ROW for this reverse phased configuration. The existing phase of **TL625B** is **(A-B-C (t-b))**. The new tieline names will be **TL625** from Loveland to Descanso, and **TL6957** from Loveland to Barrett. Therefore tieline **TL6957** should be **(C-B-A (t-b))** as a "no-cost" option.

- **TL626B-** The first 0.6 miles from Santa Ysabel, **TL626B** shares common structures with **TL637**. 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. Phase currently is **(A-B-C (t-b))** for **TL626B** and **(A-B-C (t-b))** for **TL637** so both should remain as is.

- **TL629E** - Current flow goes north out of Crestwood Substation to Glencliff Substation (TL629C), and south from Crestwood Substation to Cameron Substation (new TL6958) Therefore, the current flow on the double circuit poles for this segment will be in the same direction. Modeling showed a difference of 67.7% at each ROW for this reverse phased configuration. The existing phase of **TL629A** and **TL629C** is **(B-C-A (t-b)).** Therefore new transmission line **TL6958** should be installed as **(A-C-B (t-b))** as a "no-cost" option.

Increasing structure height: Modeling was done for the Proposed Project single circuit steel poles, and easement widths from 12-20 feet, and by raising the minimum sag by three (3) feet (33 ft. min) a reduction of 15% was met at each ROW, and for easement widths of thirty (30) feet, by raising the minimum sag by four (4) feet, a reduction of at least 15% was achieved at each ROW. For those portions of TL625C and TL682 where easement width is 50 or 100 feet, raising the minimum sag by four (4) or seven (7) feet respectfully a reduction of 15% was achieved at each ROW. This "low-cost" mitigation should be implemented where applicable.

VII. Magnetic Field Reduction Measures Recommended for the Project

Reduction of magnetic field values by increasing structure height and phasing circuits to reduce magnetic fields reduction techniques were adopted as viable methods to reduce magnetic fields at the edge-of-ROW for the Proposed Project. For the percentage of magnetic field reduction see tables located in *"Section VIII. - Summary of Calculated Magnetic Field Levels."* The recommended field reduction techniques are:

A. "No-Cost" Field Management Technique:

After discussing phase re-arrangement as a reduction technique with Transmission Engineering, the following was selected for most viable "no-cost" technique to reduce magnetic fields:

- **TL625B**- Current flow goes south out of Loveland Sub. to Barrett Sub. and south, then east, to Descanso Sub. Therefore, the current flow on the double circuit poles from Loveland to the Barrett Tap will be in the same direction. Double circuits with current flow in the same direction should be reverse phased for lowest magnetic field values at ROW (e.g.,A-B-C (t-b) and C-B-A (t-b)). Modeling showed a difference of 71.9% at each ROW for this reverse phased configuration. The existing phase of **TL625B** is **(A-B-C (t-b))**. The new transmission line names will be **TL625** from Loveland to Descanso, and **TL6957** from Loveland to Barrett. Therefore transmission line **TL6957** should be **(C-B-A (t-b)).** As part of this Proposed Project, this phase change of double circuit pole configuration should be considered as a "no-cost" option.

- **TL629E** - Current flow goes north out of Crestwood Substation to Glencliff Substation (TL629C), and south from Crestwood Substation to Cameron Substation (new TL6958) Therefore, the current flow on the double circuit poles for this segment will be in the

same direction. Modeling showed a difference of 67.7% at each ROW for this reverse phased configuration. The existing phase of **TL629A** and **TL629C** is **(B-C-A (t-b)).** Therefore new transmission line **TL6958** should be installed as **(A-C-B (t-b)).** As part of this Proposed Project, this phase change of double circuit pole configuration should be considered as a "no-cost" option.

- **All transmission lines**: The pole design for the Proposed Project will result in many areas in a sag height greater than the minimum requirement. This constitutes a "no-cost" EMF reduction measure, as it indeed reduces fields at no additional Project cost.

B. "Low-Cost" Field Management Technique:

After discussing increasing structure height reduction techniques with Transmission Engineering, the following was selected for most viable "low-cost" technique to reduce magnetic fields:

Modeling was done for the Proposed Project single circuit steel poles, and easement widths from 12-20 feet, and by raising the minimum sag by three (3) feet (33 ft. min) a reduction of 15% was met at each ROW, and for easement widths of thirty (30) feet, by raising the minimum sag by four (4) feet, a reduction of at least 15% was achieved at each ROW. For those portions of **TL625C** and **TL682** where easement width is 50 or 100 feet, raising the minimum sag by four (4) or seven (7) feet respectfully a reduction of 15% was achieved at each ROW. This "low-cost" mitigation should be implemented where applicable. See "*Table 2: Increasing Sag Height within 12 ft. to 100 ft. wide easements"* in Section VIII below.

VIII. Summary of Calculated Magnetic Field Levels

The following tables show the initial design and recommended ("low-cost") design magnetic field values (milligauss) and the percent change for increasing minimum sag height in residential zoned areas within the Proposed Project Scope. The magnetic field values were calculated at the edges-of-ROWs, or edge-of-easement for all transmission lines.

Table 2: Increasing Sag Height within 12 ft. to 100 ft. wide easements

	Single Circuit 69kV Increase Sag Height for Field Reduction							
		Milligauss Values at Edge-Of-Easement				(%) milligauss Reduction		
MIN SAG HEIGHT		30	33	34	37	33	34	37
	12ft	6.23	5.20	4.91	3.74	16.5%	21.2%	40.0%
Easement	20ft	5.93	4.99	4.72	3.63	15.9%	20.4%	38.8%
Width	30ft	5.37	4.59	4.36	3.42	14.5%	18.8%	36.3%
	50ft	4.07	3.60	3.46	2.85	11.5%	15.0%	30.0%
	100ft	1.86	1.76	1.72	1.57	5.4%	7.5%	15.6%

Table 3: Phasing Circuits to Reduce Magnetic Fields

	Double Circuit 69kV Phase Circuits to Reduce Magnetic Fields								
	TL625-TL6957 (50ft. Easement)			TL626B-TL637 (30ft. Easement)			TL629-TL6958 (30ft. Easement)		
	ABC-ABC	ABC-CBA	% milligauss Reduction	ABC-CBA	ABC-ABC	% milligauss Reduction	BCA-BCA	BCA-ACB	% milligauss Reduction
Left ROW	7.59	2.13	71.9%	11.38	3.46	69.6%	9.58	3.09	67.7%
Right ROW	7.59	2.13	71.9%	11.92	4.96	58.4%	9.58	3.09	67.7%

IX. Field Management Plan Checklist for the Loveland and Crestwood Substation Loop-In Portions of the Proposed 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 perimeter;
- Field reduction for transmission lines entering and exiting the substation.

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

No.	No-Cost and Low-Cost Magnetic Field Reduction Measures Evaluated	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	The addition of switchgear or other apparatus is limited in scope and does not provide significant opportunity to implement magnetic field reduction measures.
2	For underground duct banks, the minimum distance should be 12 feet from the adjacent property lines or to the extent practical.	N/A	N/A
3	Locate new substations close to existing transmission line rights-of-way to the extent practical.	N/A	N/A
4	Increase the substation property boundary to the extent practical.	N/A	N/A
5	Other: NONE	N/A	N/A

Appendix 1
Proposed Project Map