



**Magnetic Field Management Plan**  
**For The**  
**Sunrise Powerlink 500/230 kV Project**

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File:

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## I. Scope

San Diego Gas & Electric (SDG&E) has proposed the Sunrise Powerlink 500 kV/230 kV Project (the Project) to import renewable energy from the Imperial Valley into the San Diego area and relieve congestion on existing SDG&E circuits.

The Project proposes construction of a new 500 kV transmission line, approximately 90 miles long and located on a new right-of-way, from SDG&E's existing Imperial Valley Substation near El Centro, CA to a proposed new Central Substation in the Warner Springs/Santa Ysabel area in central San Diego County. An existing right-of-way would be used for a portion of the route for the two proposed new 230 kV transmission circuits from the proposed Central Substation to the Sycamore Canyon and Peñasquitos Substations. This right-of-way is approximately 40 miles long and is occupied by existing 230 kV, 138 kV, and 69 kV circuits.

## II. Magnetic Field Management Design Guidelines

The California Public Utilities Commission (CPUC) requires SDG&E to apply its *EMF<sup>1</sup> Design Guidelines for Electrical Facilities* (EMF Guidelines) to all new electrical projects to reduce public exposure to magnetic fields. SDG&E filed its EMF Guidelines with the CPUC in accordance with CPUC Decisions 93-11-013 and 06-01-042.

Consistent with SDG&E's EMF Guidelines, Magnetic Field Management Plans, such as this one (this Plan), deal solely with magnetic fields since that has been the focus of the EMF research. Also, per the EMF Guidelines, minimizing the magnetic field strength is only one of many factors to consider in planning and designing a transmission system. It must be considered along with other issues such as safety, environmental concerns, reliability, insulation and electrical clearance requirements, aesthetics, cost, operations and maintenance.

## III. Methodology

In accordance with SDG&E's EMF Design Guidelines, SDG&E will take the following measures for this Project:

- Apply SDG&E EMF design guidelines for transmission circuit facilities to the design of this Project.
- Identify “no-cost” techniques in the design stage that will not involve an increase in project costs but will reduce the magnetic field strength.
- Identify “low-cost” techniques that cost in the range of 4% of the total Project cost and will reduce the magnetic field strength in an area by 15% or more at the edge of the Project right-of-way.
- When there is a sufficiency of “low-cost” techniques available to reduce the strength of the magnetic fields, such that it is difficult to stay within the 4% cost guideline, application of these “low-cost” techniques will be based on the following priorities per CPUC Decision 06-01-042:

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<sup>1</sup> EMF refers to electric and magnetic fields.

- Schools, licensed day-care centers and hospitals
- Residential
- Commercial/Industrial
- Recreational
- Agricultural
- Undeveloped Land

Note: CPUC Decision 06-01-042 [p. 20] notes that “Low-cost EMF mitigation is not necessary in agricultural and undeveloped land except for permanently occupied residences, schools or hospitals located on these lands.”

The proposed arrangement and configuration of new and existing lines, and the proposed lines for the Project, were examined along the proposed and existing rights-of-way to determine effective conductor configurations for the management of magnetic fields. These field levels were calculated at a height of one meter, across and up to both edges of the right-of-way, using currents (Amps) based on the projected 2010 SDG&E system summer peak load. Magnetic fields vary with current levels.

To evaluate the effectiveness of various magnetic field reduction techniques, calculated values for a given technique were compared to calculated values without the technique. This comparison was performed at both edges of the transmission right-of-way.

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

This Project involves constructing a new 500 kV transmission circuit for approximately 90 miles from the existing Imperial Valley Substation to the proposed Central Substation. For this segment, the line will be constructed on new lattice and tubular steel structures. Along a portion (segments 6P and 8P) of the 500 kV line route outside of the Anza-Borrego Desert State Park (ABDSP), the existing 69 kV and 92 kV lines will be underbuilt below the 500 kV line on the same structures. With ABDSP, in segment 7P, the existing 69 kV and 92 kV lines will be placed underground within Highway 78. Between the Central and Sycamore Canyon Substations, two new 230 kV circuits will be constructed on double circuit tubular steel poles over a distance of 45 miles. For the 15 miles between the Sycamore Canyon and Peñasquitos Substations, a new 230 kV circuit will be constructed along with relocated 69 kV and 138 kV circuits on new double circuit tubular steel pole structures.

In addition to the new 500 kV and 230 kV circuits, this Project involves relocating approximately 19 miles of existing 69 kV transmission circuits, in the Warner Springs/Santa Ysabel area.

A new 500 kV/230 kV Central Substation is proposed in the Warner Springs/Santa Ysabel area. Substation construction will include installation of new transformers, power circuit breakers, disconnect switches, along ancillary equipment and supporting structures. The substation will be located on property to be purchased for the Project.

Modifications will be needed at the Imperial Valley, Sycamore Canyon, and Peñasquitos Substations, including new 500 kV and 230 kV circuit breakers and associated disconnect switches, steel and protection equipment. All substation modifications will be on existing utility-owned property, within existing, developed substations.

The Project is located in Imperial and San Diego Counties and passes through the City of San Diego, Anza Borrego Desert State Park, Marine Corps Air Station Miramar and unincorporated areas in portions of both counties. Existing land use around the Project varies from primarily undeveloped open space and agricultural lands in the east, sparse occasional residential and light commercial areas in the central, and medium-density residential areas in the western segment of the Project.

All proposed construction is anticipated to take place in new and existing rights-of-way and substation locations. The continuous right-of-way varies in width from 100 feet to 300 feet. Construction is scheduled to begin in the summer of 2008 with an in-service date of June 2010.

Existing transmission circuits along these rights-of-way, as shown in Figure 1, include, at 500 kV, TL50001; at 230 kV, TL23051; at 138 kV, TL13804, and TL13821; and at 69 kV, TL637, TL675, TL685, TL686, TL6906, TL6917, and 6920.

Figure 1: Transmission Circuits Along the Desert Right-of-Way

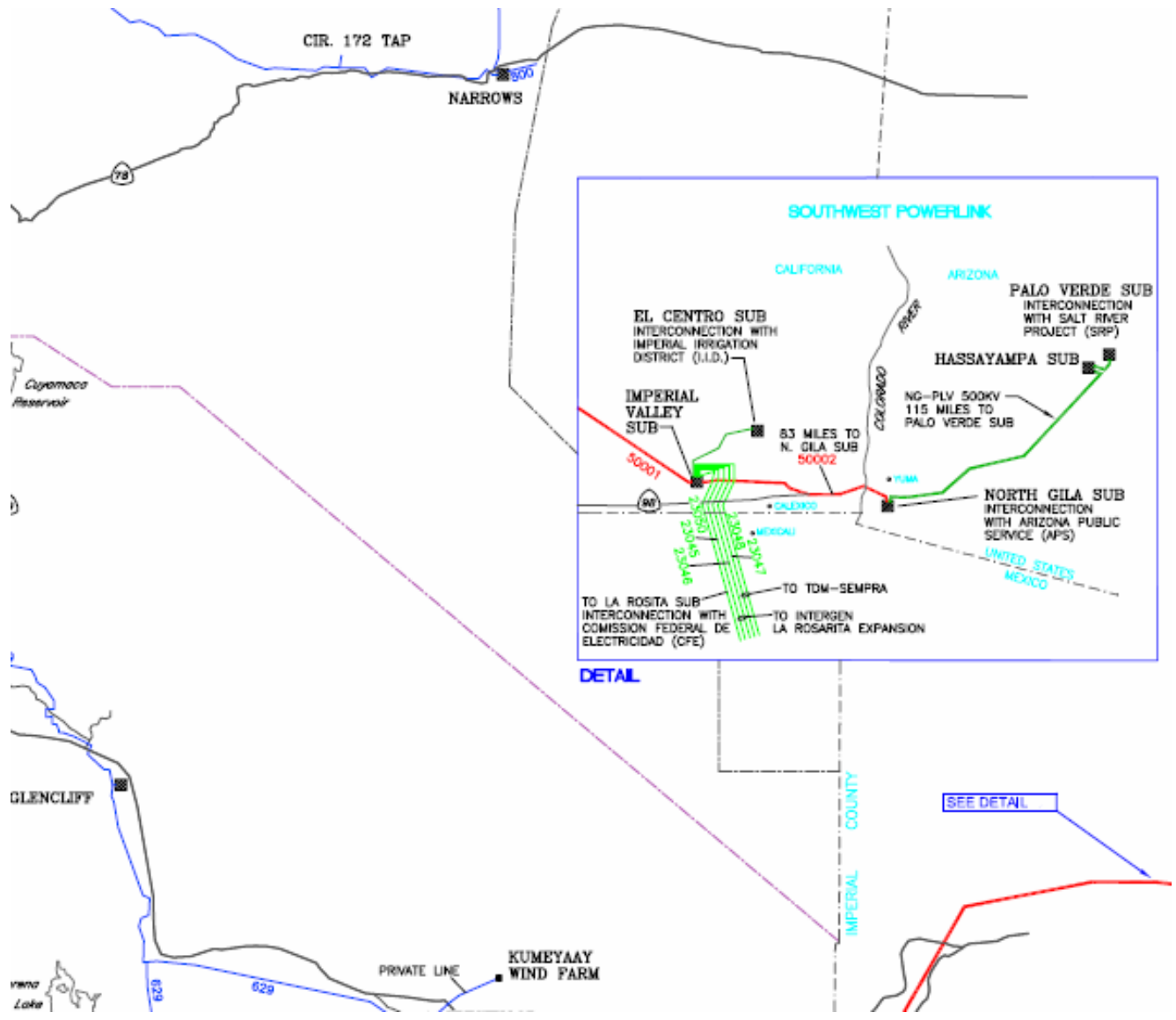
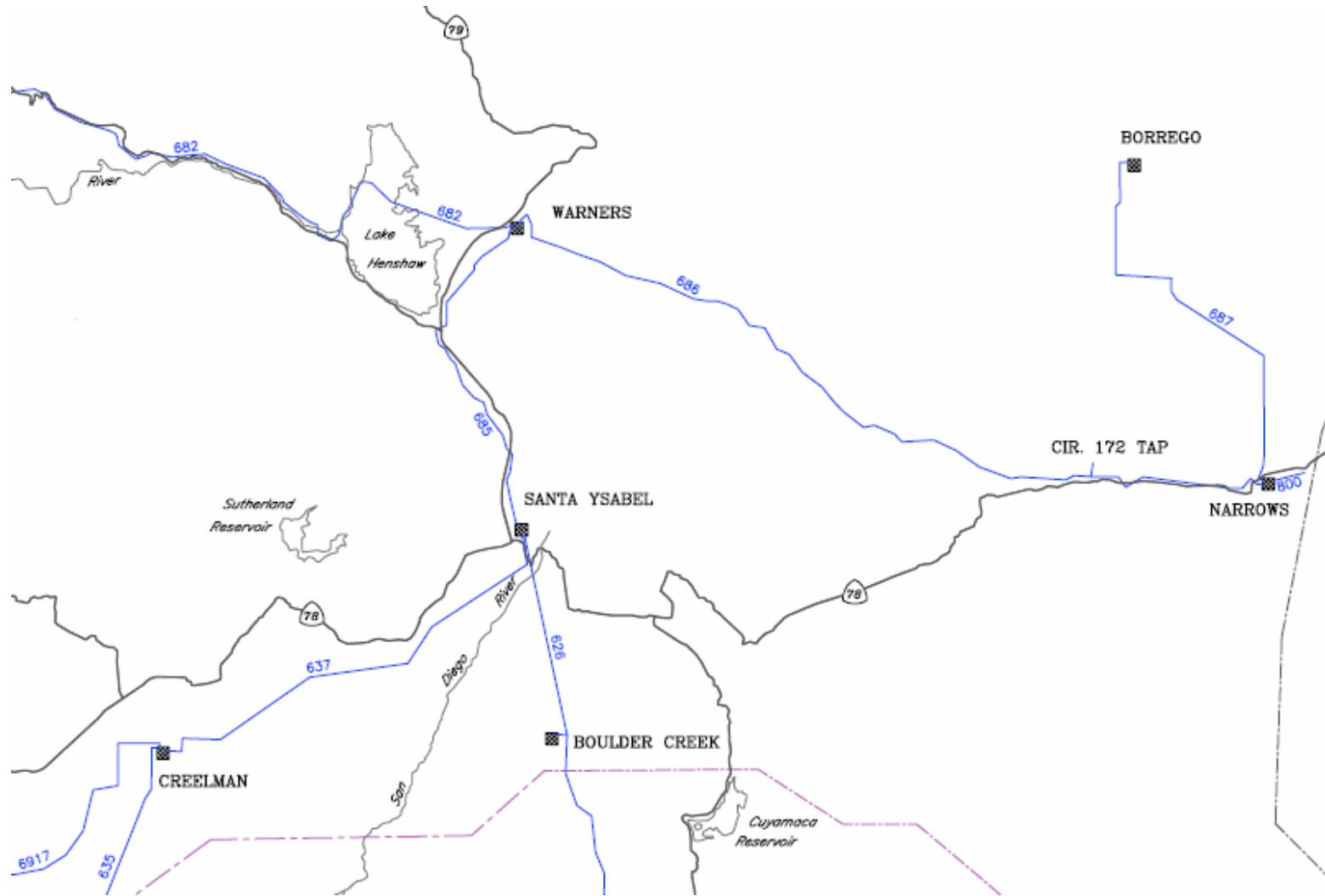
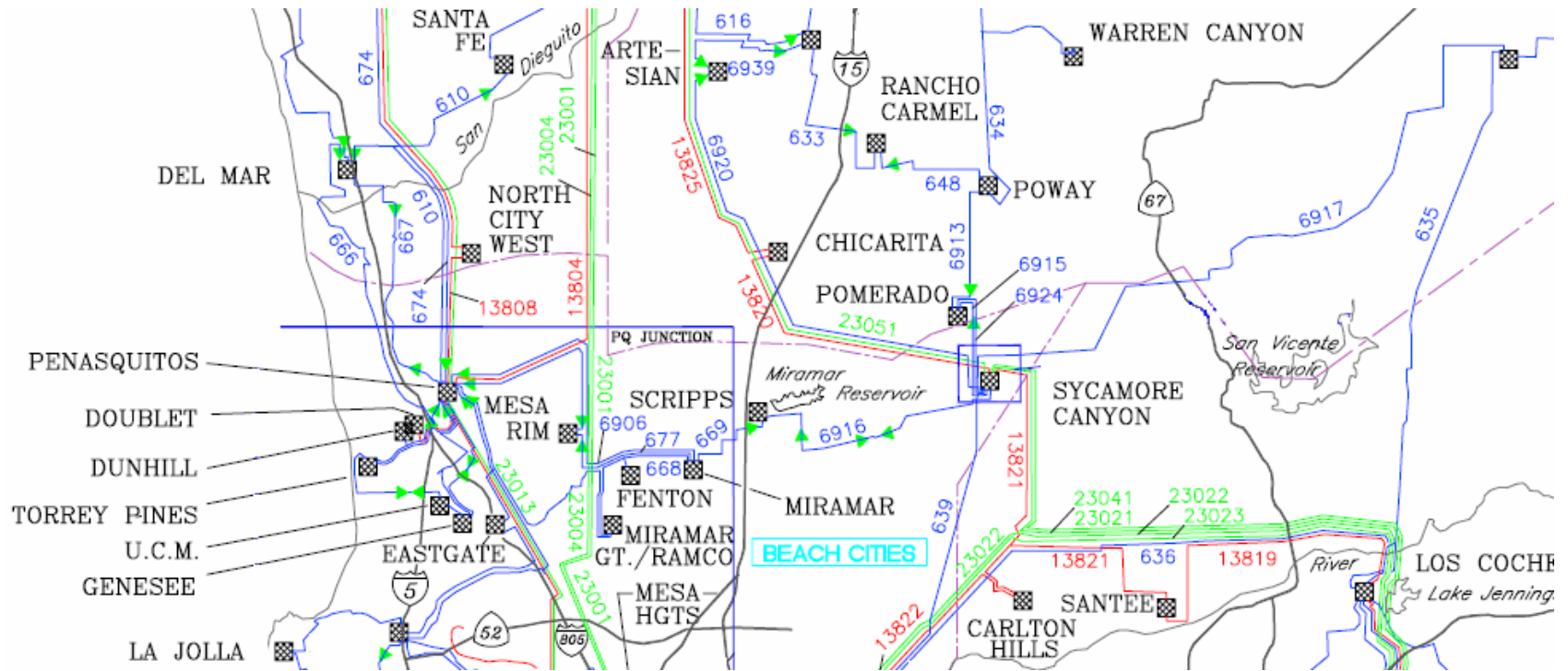




Figure 2: Transmission Circuits Along the Central/Inland Valley Right-of-Way



**Figure 3: Transmission Circuits Along the Coastal Right-of-Way**



For the purpose of analyzing the magnetic field levels, the transmission circuits along the Project right-of-way were grouped into 26 segments, as shown in Figure 4. These segments were based on right-of-way width, transmission circuit associations, conductor configurations, variations in current direction and magnitude, and adjacent land-use.

Figure 4: Project Magnetic Field Calculation Segments—Preferred Segments 1P through 7P and Alternate Segments 1A and 2A

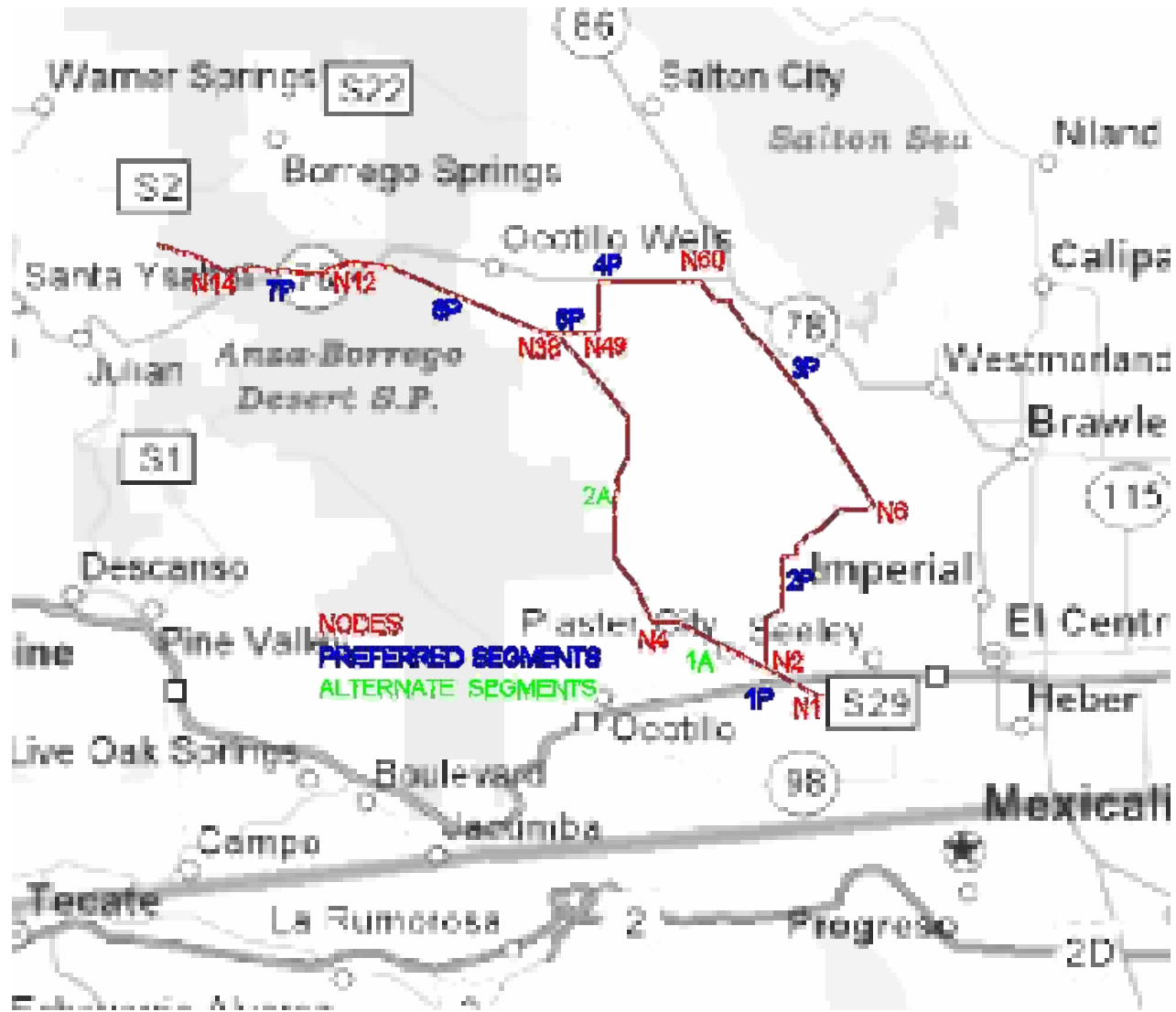


Figure 4: Project Magnetic Field Calculation Segments—Preferred Segments 8P through 17P and Alternate Segments 3A through 9A



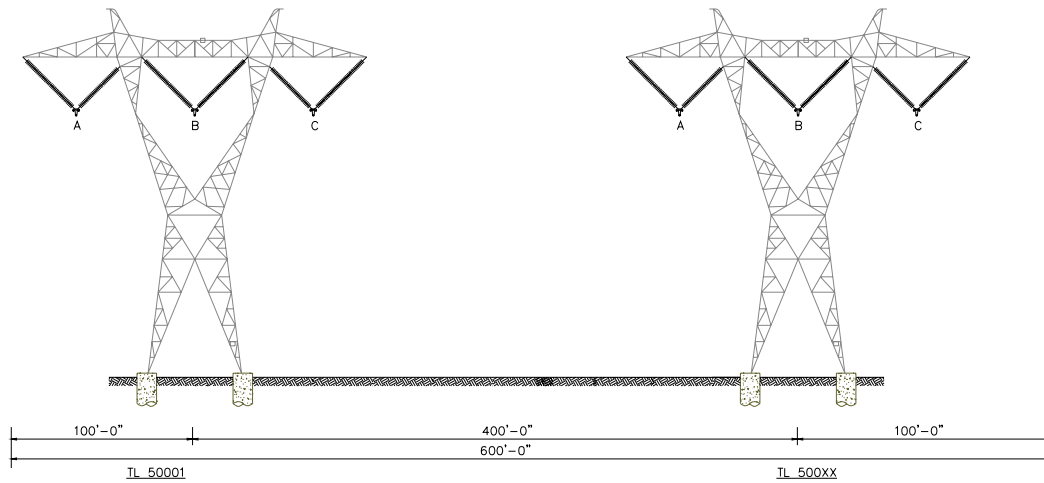
The 26 Project segments, each with different magnetic field characteristics, are identified in Figure 4 and subsequent pages by starting and ending node designations (e.g., N1 – N2). These nodes are consistent with those used in SDG&E's Proponent's Environmental Assessment (PEA) for the purpose of detailing the proposed design. The applicable segment numbers are shown between node numbers. The letter "P" after the segment number designates that the segment is along the "Preferred" route; the letter "A" designates that the segment is along the alternate route.

All segments and their proposed configurations are described and shown on the drawings below and are presented sequentially from Imperial Valley Substation to Peñasquitos Substation. Wherever new transmission circuits are created by work associated with this Project and the new circuits have not yet been assigned new numbers, they are shown on these drawings by their voltage level and alphabetic characters (e.g., XX). For example, the new Imperial Valley – Central transmission line is identified as TL500XX.

## V. Sunrise Powerlink Preferred Project Segments 1P through 17P

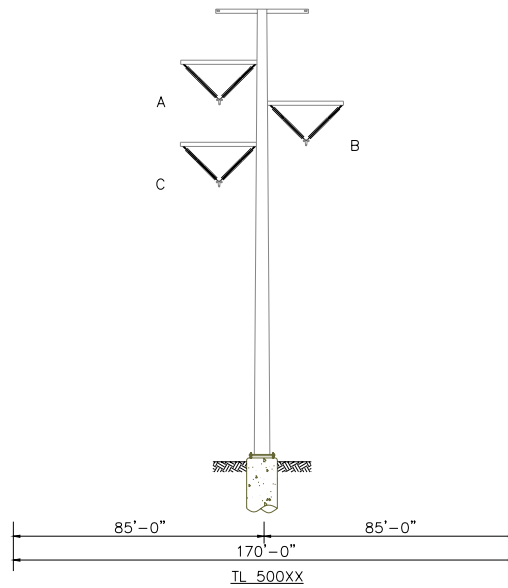
### Segment 1P, Preferred Route: N1-N2, Imperial Valley – Parallel Southwest Powerlink

Land Use – Undeveloped Land  
Segment Length – 4.04 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 600 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet



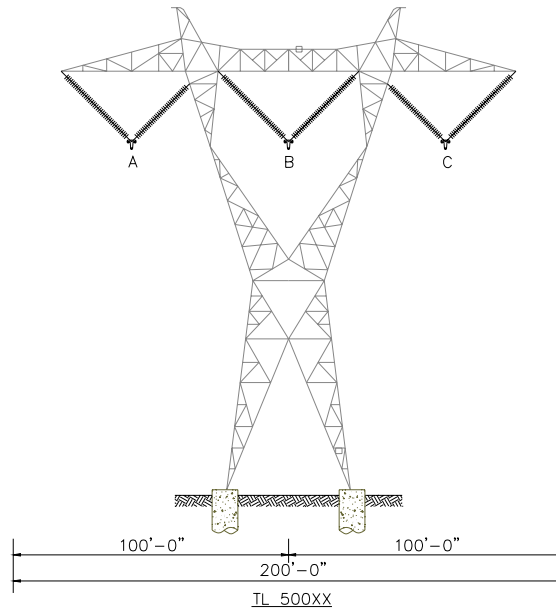
**Segment 2P, Preferred Route: N2-N6, Imperial Valley**

Land Use – Agricultural, Undeveloped Land  
Segment Length – 16.39 miles  
Structure Type – 500 kV Tubular Steel Poles  
ROW Width – 200 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet



**Segment 3P, Preferred Route: N6-N60, Imperial Valley – Parallel Imperial Irrigation District**

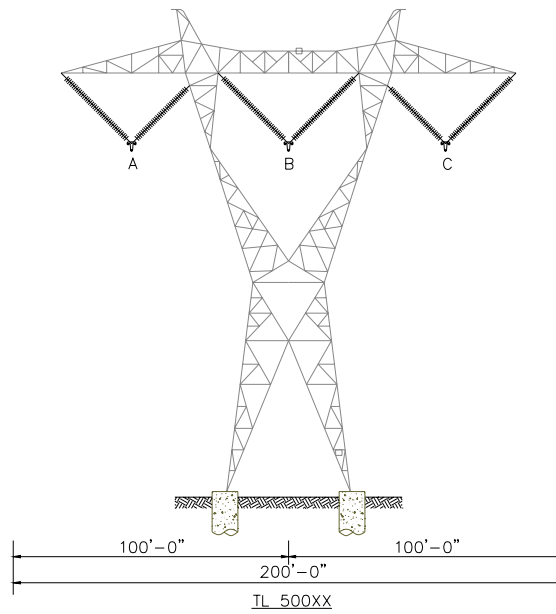
Land Use – Undeveloped Land  
Segment Length – 19.93 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 200 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet





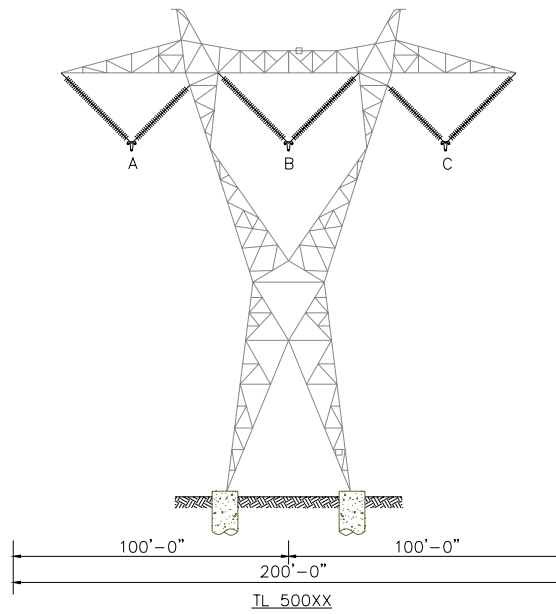
**Segment 4P, Preferred Route: N60-N49, Imperial Valley – Parallel Highway 78**

Land Use – Undeveloped Land  
Segment Length – 10.34 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 200 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet



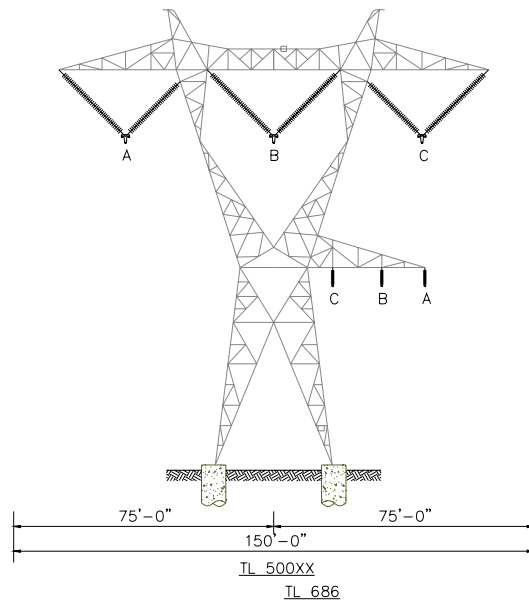
**Segment 5P, Preferred Route: N49-N38, Imperial Valley – South of Ocotillo Wells**

Land Use – Undeveloped Land  
Segment Length – 3.90 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 200 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet



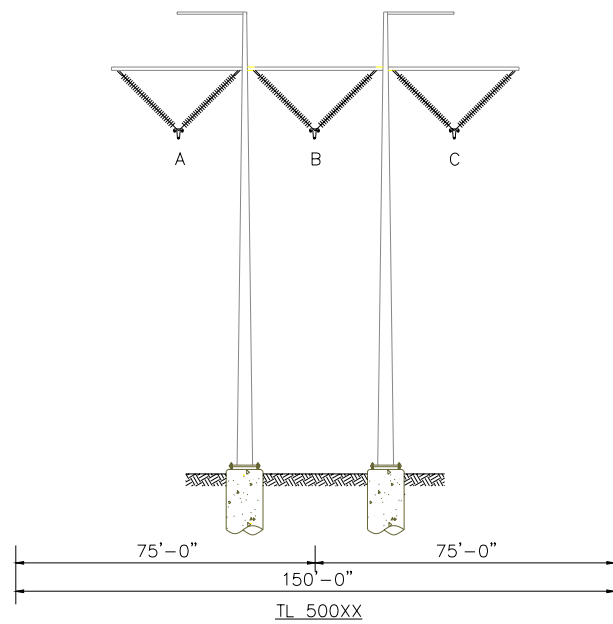
**Segment 6P, Preferred Route: N38-N12, East Anza Borrego Desert State Park  
(Lattice with Underbuild)**

Land Use – Undeveloped Land  
Segment Length – 14.0 miles  
Structure Type – 500 kV Lattice Steel Tower with 69 kV Underbuild  
ROW Width – 150 feet  
Conductor Size – 3-1033.5 ACSR/AW (500 kV), 1-1033.5 ACSR/AW (69 kV)  
Current – 3000 Amps (500 kV), 270 Amps (69 kV)  
Structure Height – 125 feet  
Conductor to Ground Clearance – 35 feet (69 kV)  
Vertical Circuit Separation – 32 feet



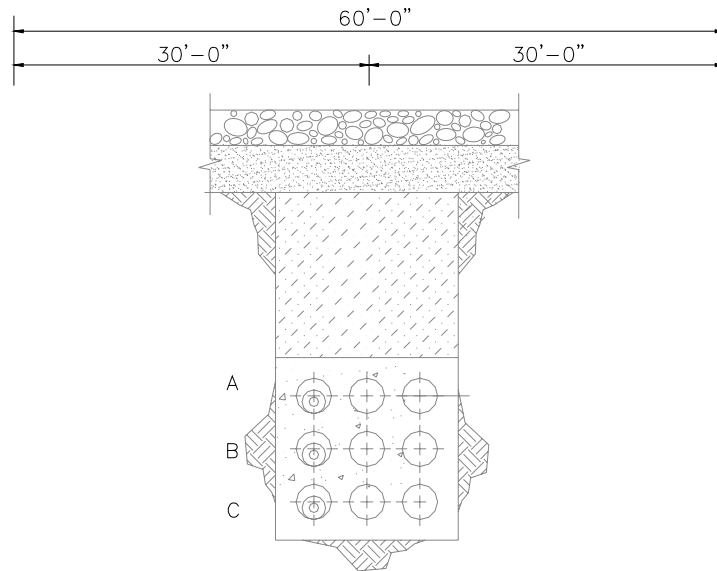
**Segment 7P, Preferred Route: N12-N14, Central Anza Borrego Desert State Park (H-Frame)**

Land Use – State Park Land, Undeveloped  
Segment Length – 9.72 miles  
Structure Type – 500 kV Tubular Steel H-Frame  
ROW Width – 150 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps 500 kV  
Structure Height – 125 feet  
Conductor to Ground Clearance – 39 feet



**Segment 7P, Preferred Route: N12-N14, Central Anza Borrego Desert State Park—  
69 kV/92 kV Underground within Highway 78**

Land Use – State Park Land, Undeveloped  
Segment Length – 9.72 miles  
Structure Type – Vertical Duct Bank  
ROW Width – 60 feet  
Conductor Size – 1-3500 kcmil / phase  
Current – 270 Amps (69 kV), 270 Amps (92 kV)  
Burial Depth – 3 feet to top of uppermost conduit



TL 686/800

**Segment 8P, Preferred Route: N14-N16, Anza Borrego Desert State Park – Central East Substation**

Land Use – State Park Land, Undeveloped

Segment Length – 11.92 miles

Structure Type – 500 kV Lattice Steel Tower with 69 kV Underbuild

ROW Width – 200 feet

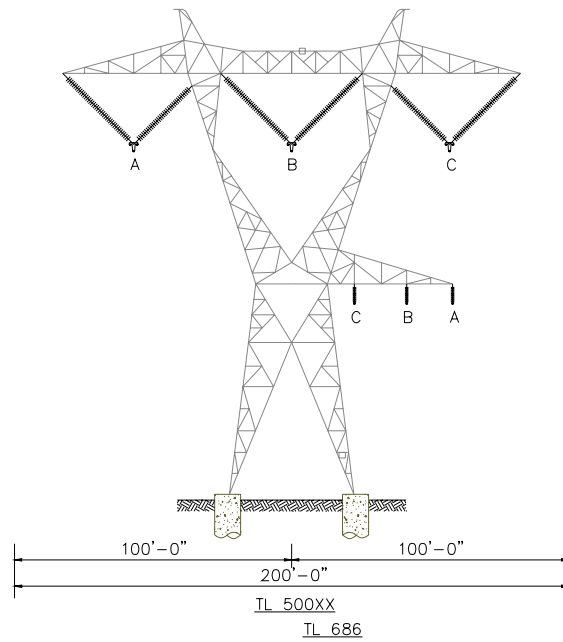
Conductor Size – 3-1033.5 ACSR/AW (500 kV), 1-1033.5 ACSR/AW (69 kV)

Current – 3000 Amps (500 kV), 270 Amps (69 kV)

Structure Height – 150 feet

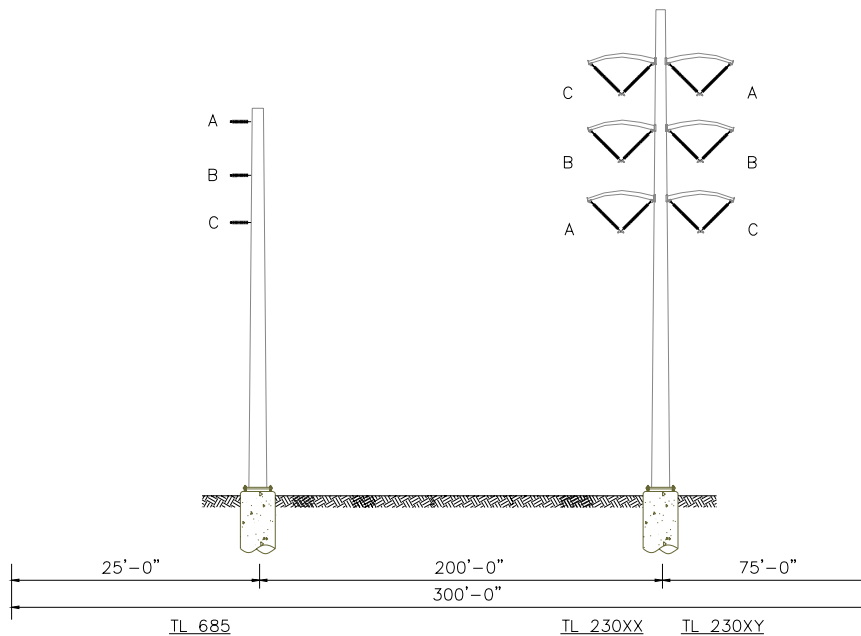
Conductor to Ground Clearance – 35 feet (69 kV)

Vertical Circuit Separation – 32 feet



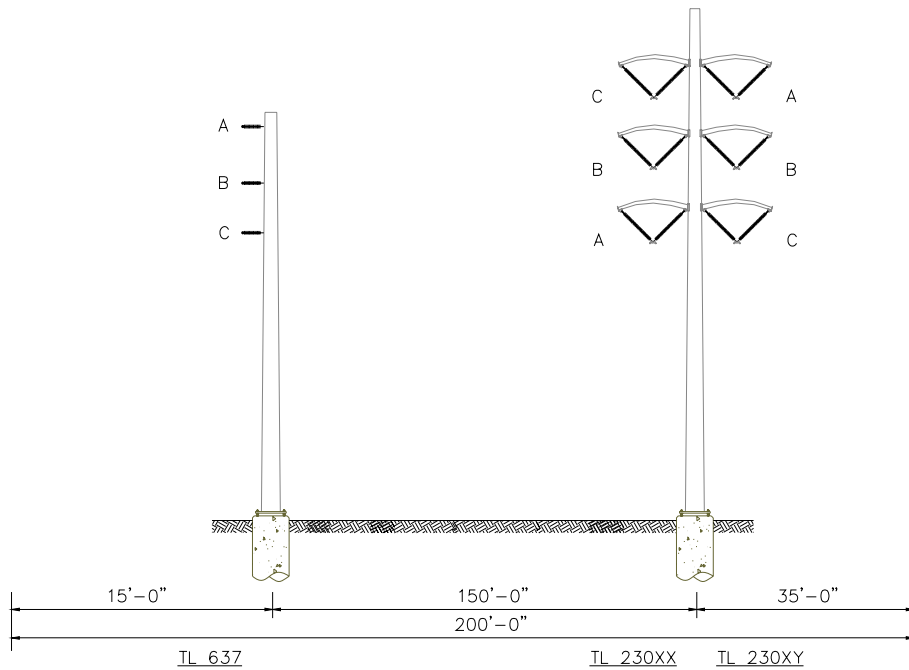
**Segment 9P, Preferred Route: N16-N20, Central East Substation – Central South Substation (230 kV Option)**

Land Use – Low-density Residential, Agricultural, Undeveloped Land  
Segment Length – 19.32 miles  
Structure Type – 230 kV Tubular Steel Pole with Adjacent 69 kV  
ROW Width – 300 feet  
Conductor Size – 2-900 ACSS/AW (230 kV), 1-1033.5 ACSR/AW (69 kV)  
Current – 2290 Amps (230 kV), 816 Amps (69 kV)  
Structure Height – 120 feet  
Conductor to Ground Clearance – 35 feet  
Horizontal Line Separation – 200 feet



**Segment 10P, Preferred Route: N20-N77, Central South Substation – San Diego Country Estates**

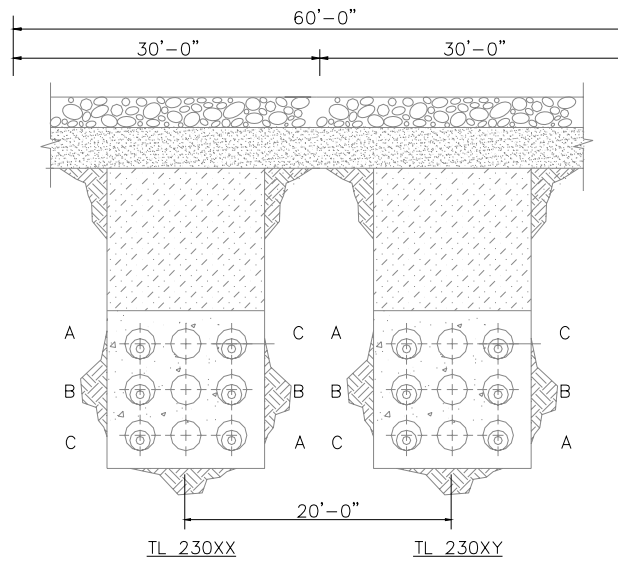
Land Use – Low-density Residential, Undeveloped Land  
Segment Length – 6.42 miles  
Structure Type – 230 kV Tubular Steel Pole with Adjacent 69 kV  
ROW Width – 200 feet  
Conductor Size – 2-900 ACSS/AW (230 kV), 1-1033.5 ACSR/AW (69 kV)  
Current – 2290 Amps (230 kV), 816 Amps (69 kV)  
Structure Height – 120 feet  
Conductor to Ground Clearance – 35 feet  
Horizontal Line Separation – 150 feet





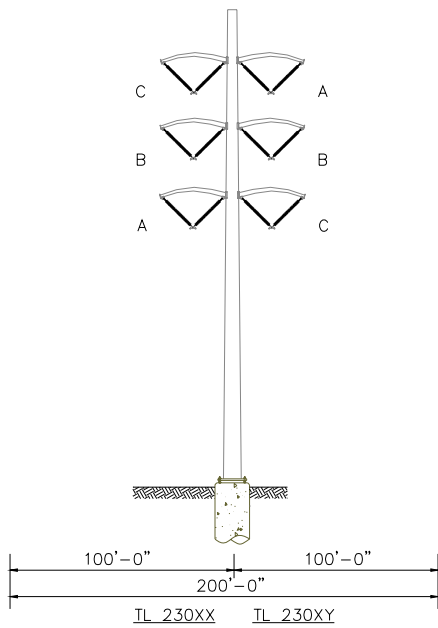
**Segment 11P, Preferred Route: N77-N51, San Diego Country Estates – Underground**

Land Use – Medium-density Residential  
Segment Length – 4.94 miles  
Structure Type – 2- 3x3 Duct Banks  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2290 Amps  
Burial Depth – 3 feet to top of uppermost conduit  
Horizontal Duct Separation – 20 feet

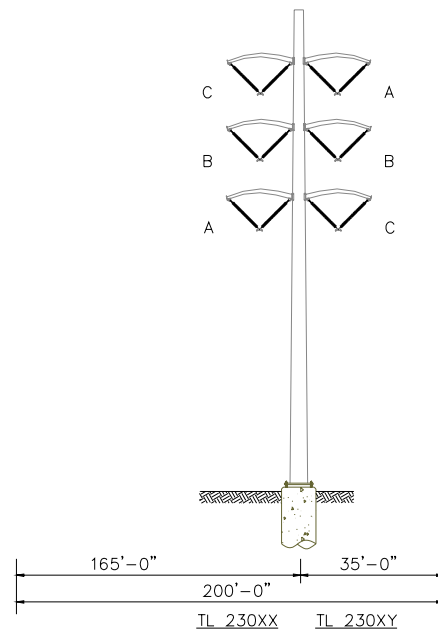


**Segment 12P, Preferred Route: N51-N27, San Vicente - Overhead**

Land Use – Low-density Residential, Undeveloped Land  
 Segment Length – 1.25 miles  
 Structure Type – 230 kV Tubular Steel Pole  
 ROW Width – 200 feet  
 Conductor Size – 2-900 ACSS/AW  
 Current – 2290 Amps (230 kV)  
 Structure Height – 120 feet  
 Conductor to Ground Clearance – 35 feet



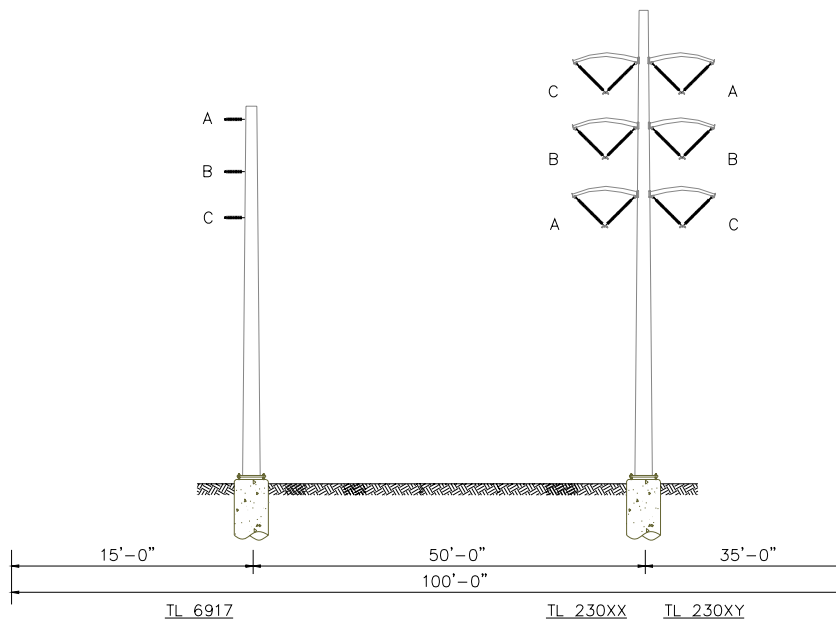
**Option 1:  
Structure centered in right-of-way**



**Option 2:  
Structure 35' from edge of right-of-way**

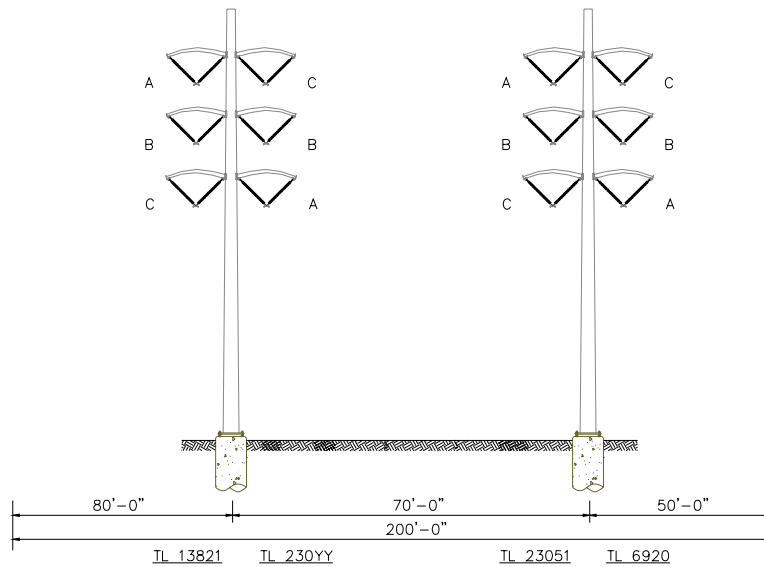
**Segment 13P, Preferred Route: N27-N28, Creelman Substation to Sycamore Canyon Substation**

Land Use – Low-density Residential, Undeveloped Land  
Segment Length – 12.99 miles  
Structure Type – 230 kV Tubular Steel Pole with Adjacent 69 kV  
ROW Width – 100 feet  
Conductor Size – 2-900 ACSS/AW (230 kV), 1-1033.5 ACSR/AW (69 kV)  
Current – 2290 Amps (230 kV), 816 Amps (69 kV)  
Structure Height – 120 feet  
Conductor to Ground Clearance – 35 feet  
Horizontal Line Separation – 50 feet



**Segment 14P, Preferred Route: N28-N29, Sycamore Canyon Substation – Chicarita Substation**

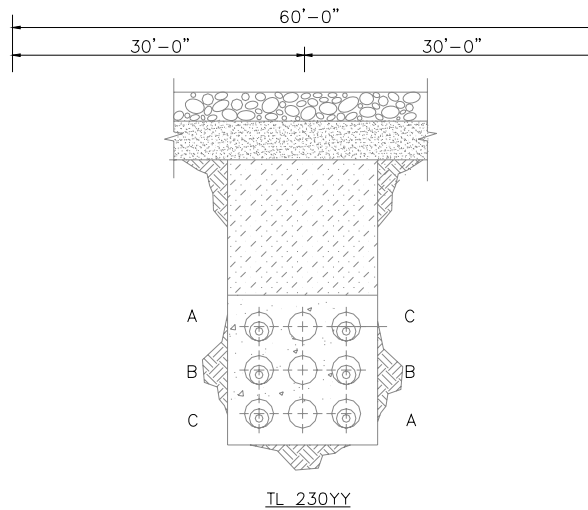
Land Use – Medium-density Residential  
 Segment Length – 5.89 miles  
 Structure Type – 230/138 kV Tubular Steel Pole with Adjacent 230/69 kV  
 ROW Width – 200 feet  
 Conductor Size – 2-900 ACSS/AW (New 230 kV), 2-1033.5 ACSR/AW (Existing 230 kV), 1-636 ACSR/AW (138 kV) 1-1033.5 ACSR/AW (69 kV)  
 Current – 2000 Amps (New 230 kV), 2290 Amps (Existing 230 kV), 854 Amps (138 kV), 816 Amps (69 kV)  
 Structure Height – 120 feet  
 Conductor to Ground Clearance – 35 feet  
 Horizontal Line Separation – 70 feet



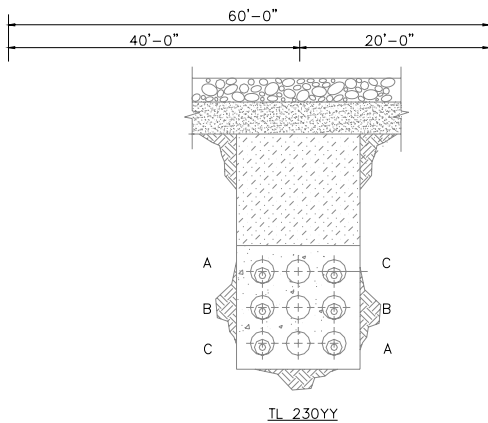
**Segment 15P, Preferred Route: N29-N56, Chicarita Substation – Underground**

Land Use – Medium-density Residential  
Segment Length – 1.86 miles  
Structure Type – 1- 3x3 Duct Bank  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2000 Amps  
Burial Depth – 3 feet to top of uppermost conduit

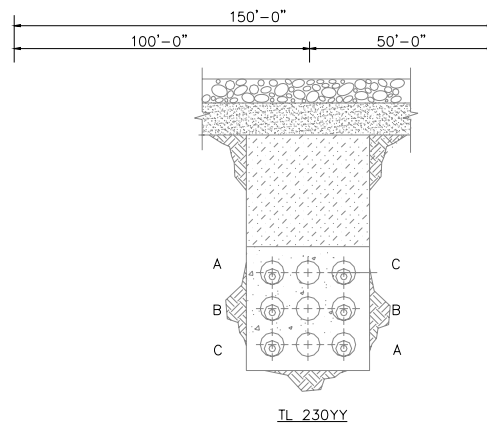
**Option 1: Duct package centered in 60' right-of-way**



**Option 2: Duct package 20' from edge of 60' right-of-way**

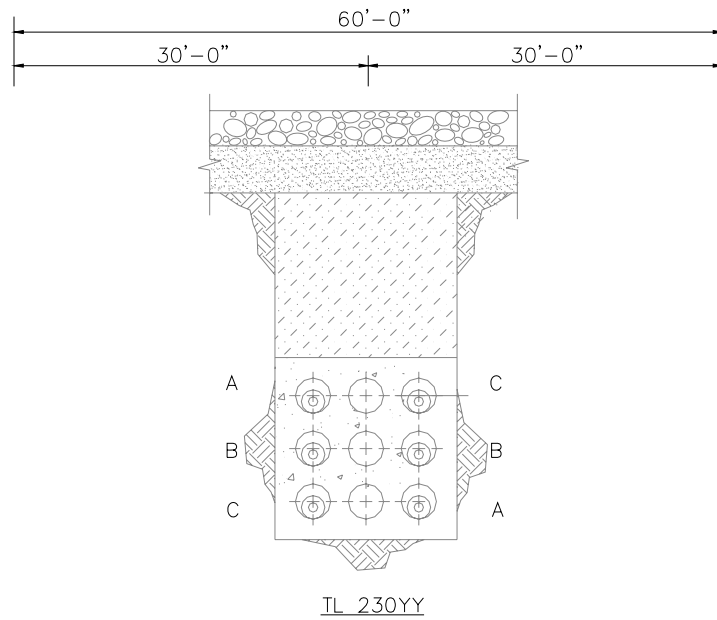


**Option 3: Duct package 50' from edge of 100' right-of-way**



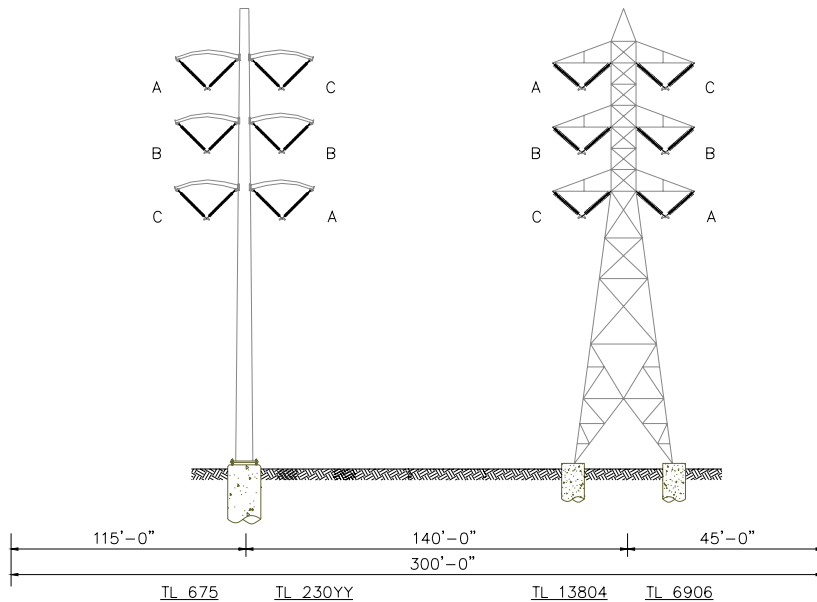
**Segment 16P, Preferred Route: N56-N33, Peñasquitos Junction – Underground**

Land Use – Medium-density Residential  
Segment Length – 2.42 miles  
Structure Type – 1- 3x3 Duct Bank  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2000 Amps  
Burial Depth – 3 feet to top of uppermost conduit



**Segment 17P, Preferred Route: N33-N34, Peñasquitos Junction – Peñasquitos Substation**

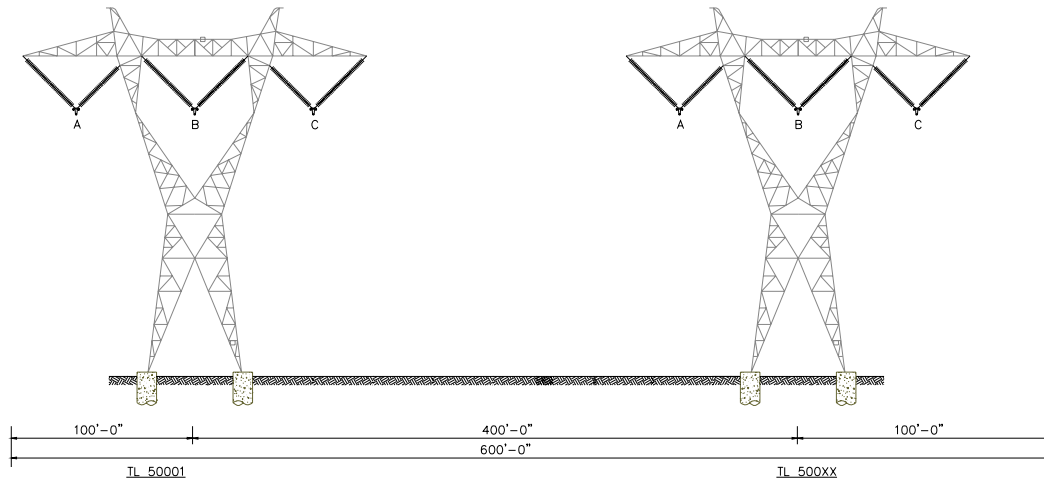
Land Use – Medium-density Residential, Undeveloped Land  
 Segment Length – 3.26 miles  
 Structure Type – 230/138 kV Tubular Steel Pole with Adjacent 230/69 kV  
 ROW Width – 200 feet  
 Conductor Size – 2-900 ACSS/AW (New 230 kV), 2-1033.5 ACSR/AW (Existing 230 kV), 1-636 ACSR/AW (138 kV) 1-1033.5 ACSR/AW (69 kV)  
 Current – 2000 Amps (New 230 kV), 2290 Amps (Existing 230 kV), 854 Amps (138 kV), 816 Amps (69 kV)  
 Structure Height – 120 feet  
 Conductor to Ground Clearance – 35 feet  
 Horizontal Line Separation – 140 feet



## VI. Sunrise Powerlink Alternate Project Segments 1A through 9A

### Segment 1A, Alternate Route: N2-N4, Imperial Valley – Parallel Southwest Powerlink

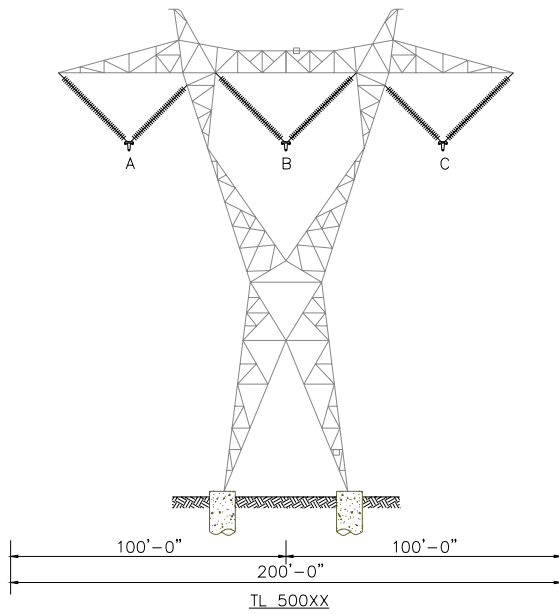
Land Use – Undeveloped Land  
Segment Length – 8.64 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 600 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet





**Segment 2A, Alternate Route: N4-N38, Imperial Valley – Southwest Powerlink  
Divergence – North**

Land Use – Undeveloped Land  
Segment Length – 23.13 miles  
Structure Type – 500 kV Lattice Tower  
ROW Width – 200 feet  
Conductor Size – 3-1033.5 ACSR/AW  
Current – 3000 Amps  
Structure Height – 150 feet  
Conductor to Ground Clearance – 39 feet



**Segment 3A, Alternate Route: N16-N20, Central East Substation – Central South Substation (500 kV Option)**

Land Use – Mixed Use: Low-density Residential, Agricultural, Undeveloped Land

Segment Length – 19.32 miles

Structure Type – 500 kV Lattice Steel Tower with Adjacent 69 kV Pole

ROW Width – 300 feet

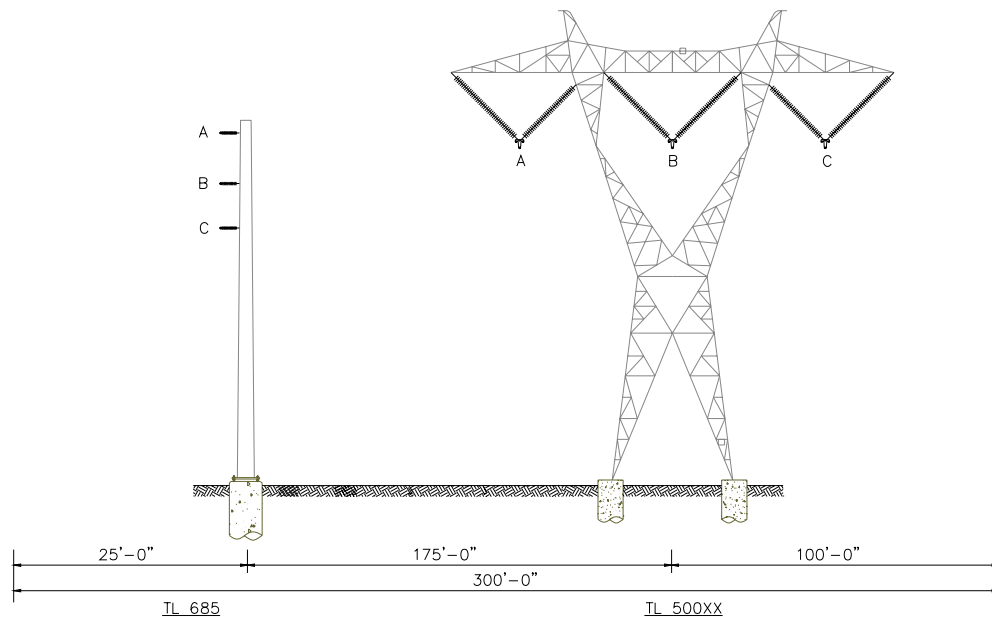
Conductor Size – 3-1033.5 ACSR/AW (500 kV), 1-1033.5 ACSR/AW (69 kV)

Current – 3000 Amps (500 kV), 270 Amps (69 kV)

Structure Height – 180 feet

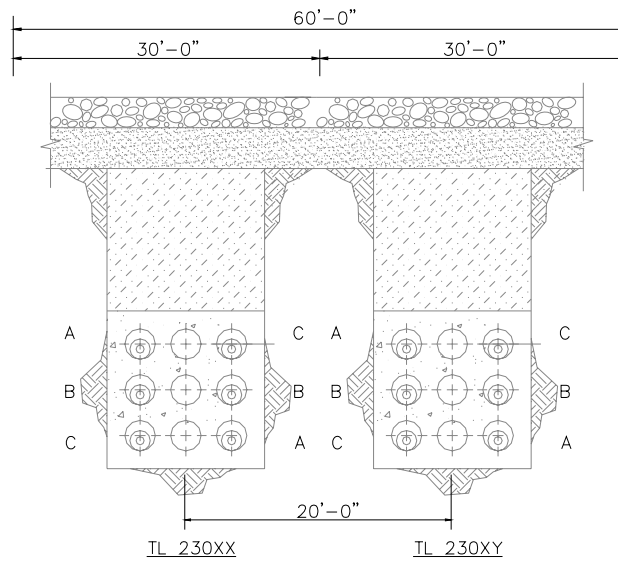
Conductor to Ground Clearance – 39 feet (500 kV), 35 feet (69 kV)

Horizontal Line Separation – 175 feet



**Segment 4A, Alternate Route: N77-N58, San Diego Country Estates – Underground**

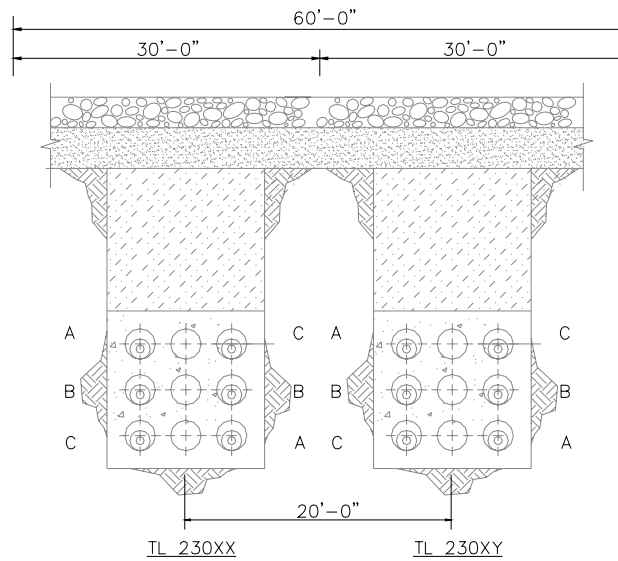
Land Use – Medium-density Residential  
Segment Length – 2.31 miles  
Structure Type – 2- 3x3 Duct Banks  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2290 Amps  
Burial Depth – 3 feet to top of uppermost conduit  
Horizontal Duct Separation – 20 feet





**Segment 6A, Alternate Route: N23-N70, Creelman – Underground**

Land Use – Low-density Residential  
Segment Length – 2.07 miles  
Structure Type – 2- 3x3 Duct Banks  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2290 Amps  
Burial Depth – 3 feet to top of uppermost conduit  
Horizontal Duct Separation – 20 feet



**Segment 7A, Alternate Route: N70-N27, Creelman Substation**

Land Use – Mixed Use: Low-density Residential, Agricultural, Undeveloped Land

Segment Length – 1.03 miles

Structure Type – 230 kV Tubular Steel Pole with Adjacent 69 kV

ROW Width – 100 feet

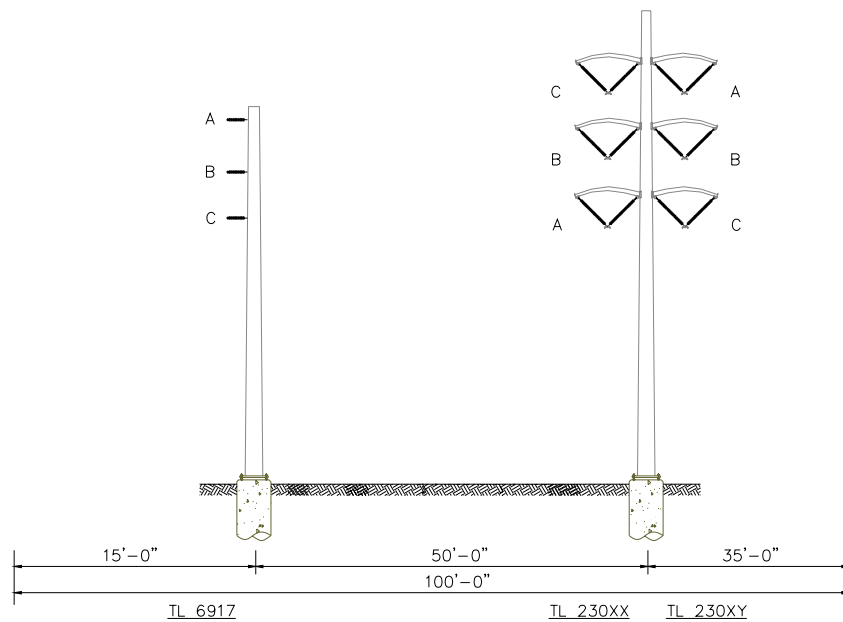
Conductor Size – 2-900 ACSS/AW (230 kV), 1-1033.5 ACSR/AW (69 kV)

Current – 2290 Amps (230 kV), 816 Amps (69 kV)

Structure Height – 120 feet

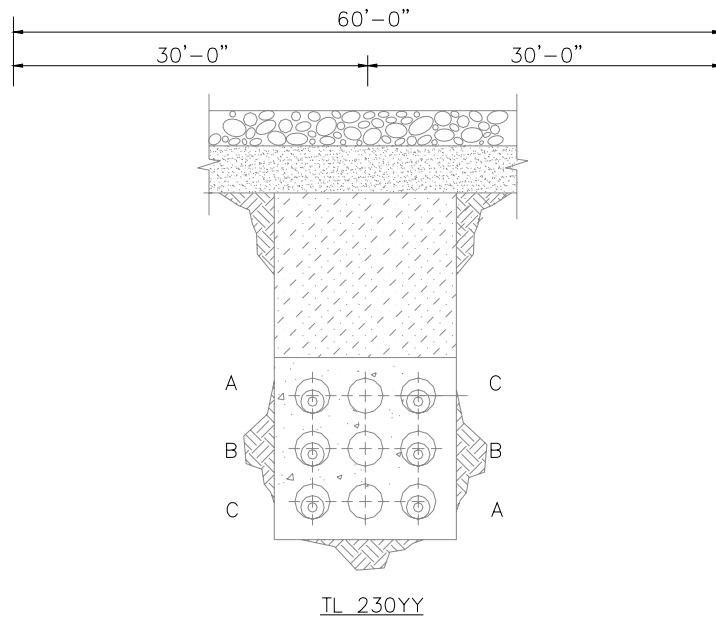
Conductor to Ground Clearance – 35 feet

Horizontal Line Separation – 50 feet



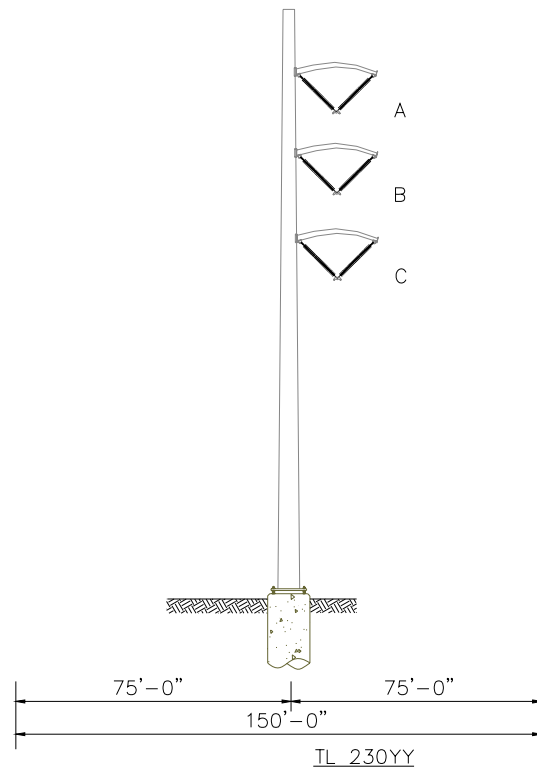
**Segment 8A, Alternate Route: N56-N75, Peñasquitos Junction – Underground**

Land Use – Medium-density Residential  
Segment Length – 0.17 miles  
Structure Type – 1- 3x3 Duct Bank  
ROW Width – 60 feet  
Conductor Size – 2-3500 kcmil / phase  
Current – 2000 Amps  
Burial Depth – 3 feet to top of uppermost conduit



**Segment 9A, Alternate Route: N56-N33, Peñasquitos Junction – Overhead**

Land Use – Mixed Use: Medium-density Residential, Undeveloped Land  
Segment Length – 3.51 miles  
Structure Type – 230 kV Tubular Steel Pole  
ROW Width – 150 feet  
Conductor Size – 2-900 ACSS/AW  
Current – 2290 Amps (230 kV)  
Structure Height – 120 feet  
Conductor to Ground Clearance – 35 feet





## **VII. Magnetic Field Reduction Techniques Considered for the Project**

### **Field Reduction Techniques Considered for Central Substation**

SDG&E has designed the Central Substation to include the following magnetic field reduction techniques, to the extent practical. These techniques are considered “no-cost” since they are part of the initial design of the facilities:

- Keep substation electrical equipment as compact as possible.
- Orient buses and cables so that parallel runs are as far from the property lines as practical.
- Keep high current devices, transformers, capacitors, and reactors, away from the substation fence.
- Utilize setbacks and landscaping to restrict public access to the area around the substation.
- Locate the substation away from normally occupied areas.

### **Field Reduction Techniques Considered for the Project Transmission Lines**

SDG&E has considered several magnetic field reduction techniques for the Project transmission lines as identified in Table 1. The 26 proposed transmission line segments and the proposed Central Substation were reviewed for suitable application of these techniques.

#### “No-Cost” Field Reduction Techniques

The following “no-cost” techniques were considered for reducing magnetic fields at the edge of the right-of-way for all segments of the Project:

- Locate power lines closer to center of the utility corridor.
- Phase circuits to reduce magnetic fields.

#### “Low-Cost” Field Reduction Techniques

The assessment of “low-cost” magnetic field reduction techniques is a function of the total project cost. “Low-cost” has been defined as by the CPUC as “in the range of 4% of the total cost of a budgeted project.”<sup>2</sup> Additionally, for low-cost techniques, the CPUC has directed that “EMF reductions will be 15% or greater at the utility ROW [right-of-way].”<sup>3</sup>

In general, “low-cost” techniques considered for reducing magnetic fields at the edge of the right-of-way include:

- Increase conductor height.
- Increase trench depth.
- Increase right-of-way width.

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<sup>2</sup> CPUC Decision 93-11-013, § 3.3.2

<sup>3</sup> CPUC Decision 06-01-042, p. 10

Those "no-cost" and "low-cost" techniques that were feasible and appropriate for the preferred segments of the Project transmission lines were evaluated and incorporated into this Plan as summarized in Table 1.

**Table 1: Preferred Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>All Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1P – 8P (N1–N16)	Imperial Valley – Anza Borrego Desert State Park to Central East Substation (500 kV)	Sparse Occasional Residential and Commercial, Agricultural, Undeveloped Land	<b>Locate power lines closer to center of the utility corridor to extent possible.</b>	Yes	No-cost
9P (N16-N20)	Central East Substation – Central South Substation (230 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	Yes	No-cost
10P (N20-N77)	Central South Substation – San Diego Country Estates	Low-density Residential, Undeveloped Land	"	Yes	No-cost
11P (N77-N51)	San Diego Country Estates – Underground	Medium-density Residential	"	Yes	No-cost
12P (N51-N27)	San Vicente – Overhead	Low-density Residential, Undeveloped Land	"	Yes	No-cost
13P (N27-N28)	Creelman Substation to Sycamore Canyon Substation	Low-density Residential, Undeveloped Land	"	Yes	No-cost
14P (N28-N29)	Sycamore Canyon Substation to Chicarita Substation	Medium-density Residential	"	Yes	No-cost
15P, 16P (N29-N33)	Chicarita Substation to Peñasquitos Junction – Underground	Medium-density Residential	"	Yes	No-cost
17P (N33-N34)	Peñasquitos Junction – Peñasquitos Substation	Medium-density Residential, Undeveloped Land	"	Yes	No-cost

**Table 1: Preferred Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected (cont.)**

<b>All Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1P-5P (N1-N38)	Imperial Valley – Anza Borrego Desert State Park (Parallel Southwest Powerlink) to Imperial Valley, South of Ocotillo Wells	Sparse Occasional Residential and Commercial, Agricultural, Undeveloped Land	<b>Phase circuits to reduce magnetic fields.</b>	No	N/A
	<b>Reason(s) if not adopted:</b> These 500 kV line segments consist of only a single circuit. There are no adjacent circuits that can be used to arrange phasing to cancel fields. The underground position of relocated existing 69 kV and 92 kV lines in segment 7P does not affect calculated fields for the overhead 500 kV.				
6P (N38-N12)	East Anza Borrego Desert State Park (Lattice with Underbuild)	State Park Land, Undeveloped	<b>Phase circuits to reduce magnetic fields.</b>	Yes	No-cost
7P (N12-N14)	Central Anza Borrego Desert State Park (H-Frame)	State Park Land, Undeveloped	"	No	N/A
<b>Reason(s) if not adopted:</b> This 500 kV line segment consists of only a single circuit. The underground position of relocated existing 69 kV and 92 kV lines in segment 7P does not affect calculated fields for the overhead 500 kV.					
8P (N14-N16)	East Anza Borrego Desert State Park (Lattice with Underbuild)	State Park Land, Undeveloped	<b>Phase circuits to reduce magnetic fields.</b>	Yes	No-cost
9P (N16-N20)	Central East Substation – Central South Substation (230 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	Yes	No-cost
10P (N20-N77)	Central South Substation – San Diego Country Estates	Low-density Residential, Undeveloped Land	"	Yes	No-cost
11P (N77-N51)	San Diego Country Estates – Underground	Medium-density Residential	"	Yes	No-cost
12P (N51-N27)	San Vicente – Overhead	Low-density Residential, Undeveloped Land	"	Yes	No-cost
13P (N27-N28)	Creelman Substation to Sycamore Canyon Substation	Low-density Residential, Undeveloped Land	"	Yes	No-cost
14P (N28-N29)	Sycamore Canyon Substation to Chicarita Substation	Medium-density Residential	"	Yes	No-cost
<b>Table 1: Preferred Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected (cont.)</b>					

All Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
15P, 16P (N29-N33)	Chicarita Substation to Peñasquitos Junction – Underground	Medium-density Residential	Phase circuits to reduce magnetic fields.	Yes	No-cost
17P (N33-N34)	Peñasquitos Junction – Peñasquitos Substation	Medium-density Residential, Undeveloped Land	"	Yes	No-cost

Overhead Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
1P – 8P (N1–N16)	Imperial Valley – Anza Borrego Desert State Park to Central East Substation (500 kV)	Sparse Occasional Residential and Commercial, Agricultural, Undeveloped Land	Increase structure height.	No	N/A
9P (N16-N20)	Central East Substation – Central South Substation (230 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
10P (N20-N77)	Central South Substation – San Diego Country Estates	Low-density Residential, Undeveloped Land	"	No	N/A
12P (N51-N27)	San Vicente – Overhead	Low-density Residential, Undeveloped Land	"	No	N/A
13P (N27-N28)	Creelman Substation to Sycamore Canyon Substation	Low-density Residential, Undeveloped Land	"	No	N/A
1P-13P	<b>Reason(s) if not adopted:</b> Increased height was rejected as a technique for these segments. For most of the 500 kV segments, adjacent land uses are agricultural and undeveloped lands for which low-cost reduction would not be applicable based upon CPUC EMF Policy. For the 230 kV segments that contain existing facilities, new structures were maintained at heights similar to those of existing structures to minimize visual impacts.				
14P (N28-N29)	Sycamore Canyon Substation – Chicarita Junction	Medium-density Residential	"	No	N/A
17P (N33-N34)	Peñasquitos Junction – Peñasquitos Substation	Medium-density Residential, Undeveloped Land	"	Yes	\$4 million

**Table 1: Preferred Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected (cont.)**

<b>Underground Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
11P (N77-N51)	San Diego Country Estates – Underground	Medium-density Residential	<b>Increase trench depth.</b>	No	N/A
	<p><b>Reason(s) if not adopted:</b> The CPUC noted in D.06-01-042 that, 1) "placing a transmission line underground should normally provide sufficient mitigation"; 2) undergrounding transmission lines usually is more costly than and typically reduces magnetic fields in comparison with overhead line construction; and 3) "[N]on-routine mitigation measures should only be considered under unique circumstances."</p> <p>Increasing trench depth was rejected as a reduction technique, since this segment will not only be installed underground, but "no-cost" phase-arrangement techniques result in additional magnetic field reduction at both edges of the right-of-way of an average of 80%. To achieve an additional average 15% reduction at the edges of right-of-way would necessitate a trench depth of at least 11 feet, a non-routine measure that would result in decreased ampacity of the lines. Moreover, the centerline of either duct package would be at least 20 feet from property lines and a greater distance from occupied buildings, where calculated field values would be lower than those shown in Table 3 at the edges of the right-of-way. Trenching for greater depth also would extend construction time and could increase construction-related traffic and disruption to local neighborhoods.</p>				
15P, 16P (N29-N33)	Chicarita Substation to Peñasquitos Junction– Underground	Medium-density Residential	<b>Increase trench depth.</b>	No	N/A
	<p><b>Reason(s) if not adopted:</b> The CPUC noted in D.06-01-042 that, 1) "placing a transmission line underground should normally provide sufficient mitigation"; 2) undergrounding transmission lines usually is more costly than and typically reduces magnetic fields in comparison with overhead line construction; and 3) "[N]on-routine mitigation measures should only be considered under unique circumstances."</p> <p>Increasing trench depth was rejected as a reduction technique, since this segment will not only be installed underground, but "no-cost" phase-arrangement techniques result in additional magnetic field reduction at both edges of the right-of-way of an average of at least 90%. To achieve an additional average 15% reduction at the edges of right-of-way would necessitate a trench depth of at least 14 feet, a non-routine measure that would result in decreased ampacity of the lines. Moreover, the centerline of either duct package would be at least 20 feet (and, in segment 15P, as much as 50 feet) from property lines, and a greater distance from occupied buildings, where calculated field values would be lower than those shown in Table 3 at the edges of the right-of-way. Trenching for greater depth also would extend construction time and could increase construction-related traffic and disruption to local neighborhoods.</p>				

**Table 1: Preferred Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected (cont.)**

All Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
1P – 8P (N1–N16)	Imperial Valley – Anza Borrego Desert State Park to Central East Substation (500 kV)	Sparse Occasional Residential and Commercial, Agricultural, Undeveloped Land	<b>Increase right-of-way width.</b>	No	N/A
	<b>Reason(s) if not adopted:</b> Segments 7P and 8P are located in the Anza-Borrego Desert State Park (ABDSP) where the right-of-way width is limited to 150 feet by ABDSP policy, compared to 200 feet in other segments where 500 kV construction is proposed. Acquisition of additional right-of-way, where not prohibited by Park policies, would be very difficult and very expensive, and would likely require condemnation of private properties and residences.				
9P (N16-N20)	Central East Substation – Central South Substation (230 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	<b>Increase right-of-way width.</b>	No	N/A
10P (N20-N77)	Central South Substation – San Diego Country Estates	Low-density Residential, Undeveloped Land	"	No	N/A
11P (N77-N51)	San Diego Country Estates – Underground	Medium-density Residential	"	No	N/A
12P (N51-N27)	San Vicente – Overhead	Low-density Residential, Undeveloped Land	"	No	N/A
13P (N27-N28)	Creelman Substation to Sycamore Canyon Substation	Low-density Residential, Undeveloped Land	"	No	N/A
14P-16P (N28-N33)	Sycamore Canyon Substation – Peñasquitos Junction – Underground	Medium-density Residential	"	No	N/A
17P (N33-N34)	Peñasquitos Junction – Peñasquitos Substation	Medium-density Residential, Undeveloped Land	"	No	N/A
1P-17P	<b>Reason(s) if not adopted:</b> Acquisition of additional right-of-way along these segments would be very difficult and very expensive, and would likely require condemnation of private properties and residences.				

Those "no-cost" and "low-cost" techniques that were feasible and appropriate for the alternate segments of the Project transmission lines were evaluated and incorporated into this Plan as summarized in Table 2.

**Table 2: Alternate Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>All Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1A (N2-N4)	Imperial Valley – Parallel Southwest Powerlink	Undeveloped Land	<b>Locate power lines closer to center of the utility corridor to extent possible.</b>	Yes	No-cost
2A (N4-N38)	Southwest Powerlink Divergence – North	Undeveloped Land	"	Yes	No-cost
3A (N16-N20)	Central East Substation – Central South Substation (500 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	Yes	No-cost
4A (N77-N58)	San Diego Country Estates – Underground	Medium-density Residential	"	Yes	No-cost
5A (N58-N23)	San Diego Country Estates – Overhead	Medium-density Residential, Undeveloped Land	"	Yes	No-cost
6A (N23-N70)	Creelman – Underground	Low-density Residential	"	Yes	No-cost
7A (N70-N27)	Creelman Substation	Low-density Residential, Agricultural, Undeveloped Land	"	Yes	No-cost
8A (N56-N75)	Peñasquitos Junction – Underground	Medium-density Residential	"	Yes	No-cost
9A (N75-N33)	Peñasquitos Junction – Overhead	Medium-density Residential, Undeveloped Land	"	Yes	No-cost

**Table 2: Alternate Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>All Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1A (N2-N4)	Imperial Valley – Parallel Southwest Powerlink	Undeveloped Land	<b>Phase circuits to reduce magnetic fields.</b>	No	N/A
2A (N4-N38)	Southwest Powerlink Divergence – North	Undeveloped Land	"	No	N/A
3A (N16-N20)	Central East Substation – Central South Substation (500 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
1A – 3A	<b>Reason(s) if not adopted:</b> Segments 1A and 2A consist of only one 500 kV circuit. There are no adjacent circuits that can be used to arrange phasing to cancel fields. The 500 kV line in Segment 3A is located 175 feet from the existing 69 kV circuit TL685, a distance too great to achieve reduction by phase arrangement.				
4A (N77-N58)	San Diego Country Estates – Underground	Medium-density Residential	<b>Phase circuits to reduce magnetic fields.</b>	Yes	No-cost
5A (N58-N23)	San Diego Country Estates – Overhead	Medium-density Residential, Undeveloped Land	"	Yes	No-cost
6A (N23-N70)	Creelman – Underground	Low-density Residential	"	Yes	No-cost
7A (N70-N27)	Creelman Substation	Low-density Residential, Agricultural, Undeveloped Land	"	Yes	No-cost
8A (N56-N75)	Peñasquitos Junction - Underground	Medium-density Residential	"	Yes	No-cost
9A (N75-N33)	Peñasquitos Junction – Overhead	Medium-density Residential, Undeveloped Land	"	No	N/A
9A	This 230 kV line segment consists of only a single circuit. There are no adjacent circuits that can be used to arrange phasing to cancel fields.				



**Table 2: Alternate Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>Overhead Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1A (N2-N4)	Imperial Valley – Parallel Southwest Powerlink	Undeveloped Land	<b>Increase structure height.</b>	No	N/A
2A (N4-N38)	Southwest Powerlink Divergence – North	Undeveloped Land	"	No	N/A
3A (N16-N20)	Central East Substation – Central South Substation (500 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
5A (N58-N23)	San Diego Country Estates – Overhead	Medium-density Residential, Undeveloped Land	"	No	N/A
7A (N70-N27)	Creelman Substation	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
9A (N75-N33)	Peñasquitos Junction – Overhead	Medium-density Residential, Undeveloped Land	"	No	N/A
1A-3A, 5A, 7A, 9A	<b>Reason(s) if not adopted:</b> Increased height was rejected as a technique for these segments. For most of the 500 kV segments, adjacent land uses are agricultural and undeveloped lands for which low-cost reduction would not be applicable based upon CPUC EMF Policy. For the 230 kV segments that contain existing facilities, new structures were maintained at heights similar to those of existing structures to minimize visual impacts.				

**Table 2: Alternate Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>Underground Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
4A (N77-N58)	San Diego Country Estates – Underground	Medium-density Residential	<b>Increase trench depth.</b>	No	N/A
6A (N23-N70)	Creelman – Underground	Low-density Residential	"	No	N/A
8A (N56-N75)	Peñasquitos Junction – Underground	Medium-density Residential	"	No	N/A
4A, 6A, 8A	<p><b>Reason(s) if not adopted:</b> The CPUC noted in D.06-01-042 that, 1) "placing a transmission line underground should normally provide sufficient mitigation"; 2) undergrounding transmission lines usually is more costly than and typically reduces magnetic fields in comparison with overhead line construction; and 3) "[N]on-routine mitigation measures should only be considered under unique circumstances."</p> <p>Increasing trench depth was rejected as a reduction technique, since this segment will not only be installed underground, but "no-cost" phase-arrangement techniques result in additional magnetic field reduction at both edges of the right-of-way of an average of at least 90%. To achieve an additional average 15% reduction at the edges of right-of-way would necessitate a trench depth of at least 14 feet, a non-routine measure that would result in decreased ampacity of the lines. Moreover, the centerline of either duct package would be at least 20 feet from property lines and a greater distance from occupied buildings, where calculated field values would be lower than those shown in Table 3 at the edges of the right-of-way. Trenching for greater depth also would extend construction time and could increase construction-related traffic and disruption to local neighborhoods.</p>				

**Table 2: Alternate Transmission Line Segments—Magnetic Field Reduction Measures Adopted or Rejected**

<b>All Segment(s)</b>	<b>Location (Street, Area)</b>	<b>Adjacent Land Use</b>	<b>Reduction Measure Considered</b>	<b>Measure Adopted? (Yes/No)</b>	<b>Estimated Cost to Adopt</b>
1A (N2-N4)	Imperial Valley – Parallel Southwest Powerlink	Undeveloped Land	Increase right-of-way width.	No	N/A
2A (N4-N38)	Southwest Powerlink Divergence – North	Undeveloped Land	"	No	N/A
3A (N16-N20)	Central East Substation – Central South Substation (500 kV Option)	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
4A (N77-N58)	San Diego Country Estates – Underground	Medium-density Residential	"	No	N/A
5A (N58-N23)	San Diego Country Estates – Overhead	Medium-density Residential, Undeveloped Land	"	No	N/A
6A (N23-N70)	Creelman – Underground	Low-density Residential	"	No	N/A
7A (N70-N27)	Creelman Substation	Low-density Residential, Agricultural, Undeveloped Land	"	No	N/A
8A (N56-N75)	Peñasquitos Junction – Underground	Medium-density Residential	"	No	N/A
9A (N75-N33)	Peñasquitos Junction – Overhead	Medium-density Residential, Undeveloped Land	"	No	N/A
1A-9A	<b>Reason(s) if not adopted:</b> Acquisition of additional right-of-way along these segments would be very difficult and very expensive and would likely require condemnation of private properties and residences.				

## **VIII. Summary of Magnetic Field Reduction Recommended for the Project Substation Facilities**

As discussed in section V, SDG&E has included several “no-cost” magnetic field reduction techniques in the initial design of the Central Substation. No additional “low-cost” techniques will be used. Field reduction techniques for the transmission circuits related to the proposed substation were evaluated as part of the 26 transmission line segments.

## **IX. Summary of Magnetic Field Reduction Recommended for the Project Transmission Lines—Preferred Segments 1P through 17P**

### **“No-Cost” Magnetic Field Reduction Techniques for Preferred Segments**

- For all segments, place new or re-located power lines closer to the center of the utility corridor to the extent possible.
- For overhead segments 6P and 8P, install existing 69 kV circuit TL686 on lattice towers beneath 500 kV circuit TL500XX.
- For overhead segments 9P, 10P, 12P and 13P, install TL230XX on common structures with TL 230XY with phases reversed.
- For underground segment 11P of bundled 230 kV circuits TL230XX and TL230XY, install conductors in duct packages with bundled phases split and reversed.
- For overhead segment 14P, remove existing 138 kV H-frame structures and re-locate existing TL13821 on the outside position of the new 230 kV poles and TL230YY on the inside position, with phases reversed.
- For underground segments 15P and 16P of bundled 230 kV circuit TL230YY, install conductors in duct package with bundled phases split and reversed.

### **“Low-Cost” Magnetic Field Reduction Techniques for Preferred Segments**

- For overhead segment 17P, remove existing 69 kV structures and re-locate existing 69 kV tieline TL675 on the outside position of the new 230 kV poles and TL230YY on the inside position, with phases reversed. This design raises the conductor heights for TL675 and allows phase cancellation, both resulting in magnetic field reduction.

### **Calculated Magnetic Fields for Preferred Segments 1P through 17P**

The calculated magnetic field values and corresponding reduction percentages at the edges of the rights-of-way for each preferred segment of the Project are summarized in Table 3 on the next page.

**Table 3: Magnetic Fields in Milligauss (mG) Calculated at the Edges of the Project Right-of-Way for Preferred Segments 1P through 17P**

Project Segment	(A) Magnetic Field From Initial Design (in mG)		(B) Magnetic Fields After Reduction Techniques Applied (in mG)		Magnetic Field Reduction [(A-B)/A] in Percent	
	Left ROW	Right ROW	Left ROW	Right ROW	Left ROW	Right ROW
1P	122	122	122	122	0%	0%
2P	65	86	65	86	0%	0%
3P	119	119	119	119	0%	0%
4P	119	119	119	119	0%	0%
5P	119	119	119	119	0%	0%
6P	127	129	124	115	2%	11%
7P	196	196	196	196	0%	0%
7P(69/92 kV UG)	10	10	10	10	0%	0%
8P	91	89	88	82	3%	8%
9P	33	118	28	26	15%	78%
10P	69	50	27	8	61%	84%
11P	75	75	14	14	81%	81%
12P (option 1)	77	77	15	15	81%	81%
12P (option 2)	32	267	4	91	87%	66%
13P	155	266	31	88	80%	67%
14P	90	56	10	21	89%	62%
15P (option 1)	24	24	2	2	92%	92%
15P (option 2)	14	52	1	6	92%	88%
15P (option 3)	3	9	0	1	99%	89%
16P	24	24	2	2	92%	92%
17P	37	29	9	23	76%	21%

## X. Summary of Magnetic Field Reduction Recommended for the Project Transmission Lines—Alternate Segments 1A through 9A

### “No-Cost” Magnetic Field Reduction Techniques for Alternate Segments

- For all segments, place new or re-located power lines closer to the center of the utility corridor to the extent possible.
- For underground segments 4A and 6A of bundled 230 kV circuits TL230XX and TL230XY, install conductors in duct packages with bundled phases split and reversed.
- For overhead segments 5A and 7A, install TL230XX on common structures with TL230XY with phases reversed.
- For Project alternate underground segment 8A of single 230 kV circuit TL230YY, install conductors in duct package with phases reversed.

### “Low-Cost” Magnetic Field Reduction Techniques for Alternate Segments

No “low-cost” reduction techniques are recommended for the alternate segments of the Project.

### Calculated Magnetic Fields for Preferred Segments 1A through 9A

The calculated magnetic field values and corresponding reduction percentages at the edges of the rights-of-way for each alternate segment of the Project are summarized in Table 4.

**Table 4: Magnetic Fields In Milligauss (mG) Calculated at the Edges of the Project Right-of-Way for Alternate Segments 1A through 9A**

Project Segment	(A) Magnetic Field From Initial Design (in mG)		(B) Magnetic Fields After Reduction Techniques Applied (in mG)		Magnetic Field Reduction [(A-B)/A] in Percent	
	Left ROW	Right ROW	Left ROW	Right ROW	Left ROW	Right ROW
1A	122	122	122	122	0%	0%
2A	119	119	119	119	0%	0%
3A	57	120	57	120	0%	0%
4A	75	75	14	14	81%	81%
5A	77	77	15	15	81%	81%
6A	75	75	14	14	81%	81%
7A	155	266	31	88	80%	67%
8A	24	24	2	2	92%	92%
9A	45	63	45	63	0%	0%