3.1 SUMMARY OF PROPOSED PROJECT

3.1.1 Segment 1: Antelope-Pardee

Segment 1 is needed to enable interconnection of a potential 201 MW wind generation project to the SCE grid. The scope of Segment 1 is to construct a new 25.6-mile-long 500 kV T/L between the existing Antelope and Pardee 220 kV substations. Although this T/L would be designed and built for operation at 500 kV, it would initially be operated at 220 kV. To accommodate construction of the 500 kV T/L, certain 66 kV and 500 kV facilities would be removed. In addition, certain 66 kV and 12 kV facilities would be relocated. The following sections provide a summary of the major elements of Segment 1.

3.1.1.1 Transmission Line Facilities

R-O-W. The proposed Segment 1 T/L route is shown on Figure 3-1 (General Location Map) and Figure 3-2 (Location Map, Antelope-Pardee, Segment 1). The proposed T/L route would utilize existing R-O-W except new R-O-W would be required for small sections of the proposed T/L near the Antelope Substation and in the Haskell Canyon area northeast of the Pardee Substation.

The first 1.1 miles (refer to Figure 3-1) of proposed T/L from the Antelope Substation would be constructed within a new 180-foot-wide R-O-W. From mile 1.1 to mile 18.6 the proposed T/L would replace the existing Antelope-Pole Switch 74 66 kV line located within the Saugus-Del Sur R-O-W. From mile 1.1 to mile 5.7 the existing Saugus-Del Sur R-O-W would be widened from 50 feet to 180 feet. From mile 5.7 to 18.6 the T/L line would travel through the Angeles National Forest within the Saugus Del-Sur R-O-W. Within the Angeles National Forest, the Saugus-Del Sur R-O-W would be widened from 100 feet to 160 feet. At mile 18.6 the T/L would exit the forest. From mile 18.6 to mile 20.3 the T/L would be constructed within a new 180-foot R-O-W. From mile 20.3 to mile 22.3, the proposed T/L would replace existing single-circuit tower design on the Pardee-Vincent 500 kV R-O-W with double-circuit tower design. From mile 22.3 to the T/L's termination at Pardee, the proposed T/L would be constructed along the existing Pardee-Vincent 500 kV T/L on double-circuit 500 kV towers. Upon completion, the existing 500 kV single-circuit towers would be removed.

Transmission Line and Towers. The new 25.6-mile-long T/L would use both single- and double-circuit tower construction. It is currently estimated that a total of 115 (114 new and one existing) 500 kV towers would be used. Approximately 119 existing 66 kV towers and associated hardware would be removed from the Saugus-Del Sur R-O-W (mile 1.1 to mile

18.6) and recycled and/or disposed of in an approved manner offsite. Some of the existing tower sites would require grading to accommodate the new 500 kV tower foundations.

Access and Spur Roads. Existing access and spur roads would be repaired. Drainage structures would be installed. Approximately 10 spur roads to existing tower sites in the Angeles National Forest would need to be temporarily re-opened and re-graded. New spur roads would be built for approximately 20 tower locations.

Pulling and Splicing Locations. Approximately 24 new pulling locations and 15 new splicing locations would be needed to construct Segment 1. The preliminary locations for pulling and splicing sites are indicated on the aerial photographs presented in Appendix H.

3.1.1.2 Subtransmission and Distribution Work

The following subtransmission and distribution work would be required as part of Segment 1 of the proposed project:

- The existing Antelope Substation would be expanded 1,145 feet by 1,185 feet with 205 feet by 300 feet being used for the 220 kV substation improvements (refer to Figures 3-3A and 3-3B). In addition, a 200-feet wide strip of R-O-W would be located adjacent to the expanded substation south and east perimeter fences for relocation of existing 66 kV lines. In order to clear the 205 feet by 300 feet expansion located southwest of the existing substation site, it would be necessary to relocate three, 1,000-feet-long segments of double-circuit 66 kV subtransmission line. This relocation would require replacement of 18, 70-foot-tall wood poles with 18 new 70-foot-tall light weight steel poles outside of the southwesterly portion of Antelope Substation. New conductor along each line segment would have to be installed to facilitate these relocations.
- The existing Antelope-Pole Switch 74 66 kV line, located on the Saugus-Del Sur R-O-W between mile 1.1 to mile 18.6, would need to be removed to make room for the new Antelope-Pardee 500 kV line.
- There is also an existing 12 kV circuit on one side of the Antelope-Pole Switch 74 66 kV line structures in the Antelope area. This circuit runs approximately 4 miles from Elizabeth Lake Pine Canyon Road to Avenue J. The appropriate section of this line would be relocated to new distribution poles within the expanded Saugus-Del Sur R-O-W.

3.1.1.3 Substation Facilities

Antelope Substation. Segment 1 would require the installation of four additional 220 kV line positions to the south. Two positions are required to accommodate a third party's proposed 220 kV generation tie line and the proposed Antelope-Pardee 500 kV T/L. The proposed project also requires the upgrade of the existing 220 kV buses to 3700 ampere (A) rating. Segment 1 also includes the acquisition and fencing of approximately 31 acres of land adjacent to the existing Antelope 220 kV Substation as shown on Figure 3-3B, which would be necessary to increase the substation rating from 220 kV to 500 kV. A photograph of a representative SCE 500 kV substation (Lugo Substation) is presented on Figure 3-3C for reference purposes.

Two additional line positions are required to accommodate the future Vincent 500 kV T/L and the future Substation One 500 kV T/L for Segment 2 and Segment 3 of the Antelope Transmission Project, respectively (note: Segments 2 and 3 of the Antelope Transmission Project are addressed in a separate CPCN Application and PEA). The 220 kV switchyard expansion would create new line positions 10, 11, 12 and 13.

The proposed configuration of the 500 kV lines coming into the station requires the relocation of the existing Vincent and Mesa 220 kV T/Ls from their present Positions 6 and 8 to the new Positions 12 and 13.

A total of six new 220 kV circuit breakers, four line and eight bus dead-end structures, and fourteen 220 kV disconnect switches would be installed at Antelope Substation. New protective relay equipment would be installed in a new Mechanical Electrical Equipment Room (MEER) adjacent to the existing Control Room.

Pardee Substation. The new Antelope-Pardee 500 kV T/L would be terminated into an existing switchrack position (refer to Figure 3-4). Two new 220 kV circuit breakers and four new 220 kV disconnect switches would be installed. New protective relaying would be installed.

3.1.1.4 Information Technology (IT) Facilities

Two telecommunication paths would be provided for redundancy. The primary path would use the existing SCE infrastructure between Antelope and Pardee Substations. The secondary path would be provided by Optical Ground Wire (OPGW), which would be installed on all new T/Ls.

3.2 TRANSMISSION LINE FACILITIES – SEGMENT 1 (ANTELOPE-PARDEE)

3.2.1 Transmission Line Engineering Plan

3.2.1.1 Routing

Antelope to Pardee. The proposed route for the Antelope-Pardee 500 kV T/L departs the Antelope Substation on tubular steel poles by cutting across the existing Antelope-Magunden 220 kV R-O-W and the Midway-Vincent No. 3 500 kV R-O-W. The proposed route uses a new 180-foot-wide R-O-W as it leaves the Antelope Substation. At mile 1.1 the line turns southwest and enters the existing Saugus-Del Sur R-O-W. The existing Antelope-Pole Switch 74 66 kV line located in the Saugus Del-Sur R-O-W would be replaced with the new Antelope-Pardee 500 kV line. From mile 1.1 to mile 5.7, the R-O-W would be expanded to 180 feet in width.

At mile 5.7, the line enters the Angeles National Forest and remains there for the next 13 miles. This portion of the R-O-W through the Forest would need to be widened to 160 feet. At mile 8.3 the line crosses the Midway-Vincent No. 1 and No. 2 500 kV T/Ls (refer to Figure 3-5) and at mile 9.2 crosses over Bouquet Reservoir. The line exits the forest and the existing Saugus-Del Sur R-O-W at mile 18.6.

At mile 18.6, the line turns south onto new R-O-W for approximately 1.5 miles. At mile 20.3, the line turns west and parallels the existing Pardee-Vincent 500 kV line within the Pardee-Vincent 500 kV R-O-W. From mile 20.3 to mile 22.3, the proposed T/L would replace existing single-circuit tower design on the Pardee-Vincent 500 kV R-O-W with double-circuit tower design. From mile 22.3 to the line's termination at Pardee Substation, the proposed T/L would be constructed along the existing Pardee-Vincent 500 kV T/L on double-circuit 500 kV towers. Upon completion, the existing 500 kV single-circuit towers would be removed. The proposed line spans Haskell Canyon where it crosses over several LADWP lines, including the Sylmar-Celilo 1000 kV direct current (DC) T/L and the Owens Gorge-Rinaldi 220 kV T/L.

For the 5 miles between mile 20.8 and Pardee Substation, the proposed line traverses residential neighborhoods on both sides of the R-O-W through the Santa Clarita area. At mile 22.3, both the proposed line and the Pardee-Vincent 500 kV T/L turn southwest and cross over the Pardee-Vincent 220 kV and the Eagle Rock-Pardee 220 kV T/Ls on an existing double-circuit 500 kV LST. The line terminates at the Pardee Substation at mile 25.6.

A new 12 kV distribution wood pole line would need to be installed on or near the new R-O-W south of the Antelope Substation for approximately 3.5 miles. The 12 kV line would be located inside the expanded 180-foot-wide R-O-W, 7.5 feet from the R-O-W edge.

3.2.1.2 Structures

The proposed 500 kV T/L would utilize a combination of two types of 500 kV structures:

- 500 kV structures:
  - Approximately 93 four-legged single-circuit towers (refer to Figure 3-6A) (between mile 0.1-20.3)
  - Approximately 22 four-legged double-circuit towers which includes one existing double-circuit tower at mile 22.3 (refer to Figure 3-6B) (between mile 20.3-25.6)

In addition, the following 220 kV structures would be installed as part of the proposed project (associated with initial energization at 220 kV).

- 220 kV structures:
  - Three new 70-foot-tall double-circuit tubular steel poles (between mile 0.0-0.1) (refer to Figure 3-7)

The 500 kV towers would be constructed of dull galvanized lattice steel angle members connected by steel bolts. The one existing four-legged double-circuit tower is similarly constructed. Some of the 93 single-circuit towers may be specially designed to span Bouquet Reservoir where low-flying fire suppression aircraft clearance is required. The single-circuit 500 kV towers would range in heights between 113 feet and 178 feet. The existing double-circuit tower height is 278 feet. New double-circuit towers would range in height from 175 feet to 220 feet. The double-circuit 220 kV tubular steel poles would be constructed of dull galvanized steel and would be approximately 70 feet tall.

Approximately 17.5 miles of the existing Antelope-Pole Switch 74 66 kV tower line would need to be removed to make room for the 500 kV towers. Approximately 119 existing 66 kV towers and their support hardware and insulators would be removed.

Each LST is built on four drilled pier concrete footings. Each tubular steel pole is built on one drilled pier concrete footing. The dimension of each footing is dependent on variables such as topography, tower height, span length and soil properties. On average, a typical footing has an aboveground projection of about 3 feet.

3.2.1.3 Conductor

The proposed 500 kV T/L would be strung with two-conductor bundled (2B) 2156 kcmil aluminum conductor steel reinforced (ACSR) with nonspecular finish. Approximately 783,000 feet of conductor would be strung. Approximately 549,000 feet of 4/0 copper conductor would need to be removed as part of the removal of the Antelope-Pole Switch 74 66 kV line.

3.2.1.4 Insulators

The tangent and angle 500 kV insulator assemblies would consist of two strings of insulators in the form of a “V”. Each leg of the “V” assembly would contain one or two one-piece gray polymer insulators, depending on the load. On dead-end structures, the insulators are arranged in a “barrel” configuration consisting of four polymer insulators.

3.2.1.5 Overhead Ground Wires

The overhead ground wires are located on the peaks of the transmission structures. The 500 kV structures would have two overhead ground wires, approximately 0.5 inch in diameter. One ground wire would contain optical fibers for communications and line protection.

3.2.1.6 Tower Sites Preparation

Each tower site would be graded or cleared to provide a reasonably level pad, free of any vegetation that would hinder tower construction. The tower sites would be graded such that water drains towards the direction of the natural drainage (2% minimum slope). The drainage pattern would be made in such a way that no ponding would occur and no erosive water flow would cause damage to the tower footings. The graded pad would be compacted to at least 90 percent relative density and would be capable of supporting heavy vehicular traffic. In most cases, these level pads could be used as part of crane pads used for tower erection. In areas where it would not be possible to create a level pad, construction by other means, such as by helicopter, would be considered. Some tower sites would need some grading, either to widen existing pads or to create new ones. The rest are on relatively level areas that only need some weed abatement. Topographic surveys would be needed to ascertain if grading at particular tower sites is feasible.

3.2.1.7 Access Roads and Spur Roads

T/L roads are herein classified into two groups – access roads and spur roads. Access roads are through roads that run between tower sites and form the main transport route along the major extent of the T/L. Spur roads are roads that lead from the access road and dead-end into one or more tower sites. For ease of construction (including 66 kV removal activities), and if the existing topography allows, each new tower site would be provided with a spur road. Work includes the following:

- Re-grading and repair of existing access and spur roads. These roads would be cleared of vegetation, blade-graded to remove potholes, ruts and other surface irregularities, and re-compacted to provide smooth and dense riding surface capable of supporting heavy equipment. The graded road would have a minimum drivable width of 12 feet (preferably with 2 feet of shoulder on either side). A typical road cross section is presented in Figure 3-8.
- Drainage structures such as wet crossings, water bars, overside drains, pipe culverts, as well as energy dissipaters would be installed to allow for construction equipment usage as well as to prevent erosion due to uncontrolled water flow. Refer to Figures 3-9 through 3-14 for typical erosion and drainage control structures.
- Slides, washouts and other slope failures would be repaired and stabilized by installing retaining walls or other means necessary to prevent future failures. The type of structure to be used would be based on site-specific conditions. Refer to Figure 3-15 for a typical Mechanically Stabilized Earth retaining structure.
- New spur roads would be constructed for several tower sites where no roads currently exist. These new roads would be a minimum of 12 feet wide with grades that vary from flat to approximately 15 percent. These new roads would be provided with necessary drainage and erosion control structures. Approximately 20 tower locations could need new spur roads. However, due to the existing topography of the sites, spur roads to some of the tower sites may not be feasible. Access to these tower sites would be by alternative methods, such as by helicopter, or by foot. Refer to Figure 3-8 and Figures 3-16 through 3-19 for typical road cross sections in varying topographical conditions.
- Re-open and re-grade existing spur roads that are currently closed and vehicle traffic is prohibited by the USFS. Approximately 10 tower sites would require re-opening and re-grading of the existing spur roads both for removal of the existing 66 kV towers and construction of new 500 kV towers. With permission from the USFS, these spur roads would be cleared of vegetation, re-graded as required and re-compacted, to provide smooth and dense riding surface capable of supporting heavy equipment. SCE's proposed spur road restoration plan is presented in Appendix J. Drainage structures, if needed, would be installed to prevent damage due to erosion. Depending on future needs for these roads and if the USFS allows, some or all of these roads would remain open and would be maintained by SCE.

3.2.1.8 Pulling and Splicing Locations

Approximately 24 pulling locations and 15 splicing locations have been identified as being needed for construction. These setup locations require some reasonably level areas for maneuvering equipment. The areas selected are either near or between existing towers where existing spur roads or level pads are available. However, there may be a few locations, where due to lack of maintenance, minor grading and weed cleanup may be necessary. In some locations, field snubs (anchoring and dead-end hardware) need to be installed temporarily in the ground as required for wire-stringing activities.

3.2.2 Transmission Line Construction Plan

3.2.2.1 Introduction

SCE would determine and consider the factors that have the potential to affect the construction methods for each part of the proposed project. Factors that have the potential to affect hours of operation, method of construction, mitigations necessary to address environmental and safety issues, and other factors that may directly impact construction planning would be considered.

All work would be performed with conventional construction techniques in accordance with an SCE construction specification, CPUC General Order 95 (GO-95), Institute of Electrical and Electronic Engineers (IEEE), American Concrete Institute (ACI), and other industry-specific standards. As part of the SCE specification requirements, crews would be constrained to work within the stipulations of governing documents for compliance with regional environmental, USFS, storm water pollution prevention, and fire prevention criteria. SCE's proposed Fire Prevention and Response Plan is presented in Appendix I.

Environmental protection procedures would include the following:

- Crews would be familiar with the environmental concerns within and around the work area. Specified mitigation measures would be strictly observed and enforced in order to comply with existing regulations and permit conditions.
- Contractors would avoid impacting natural and cultural resources within the proposed project area. Mitigation measures would be identified during Environmental Awareness Training, which would be required for all personnel who would work within all proposed project areas. All contractor and subcontractor personnel on the jobsite must participate in Environmental Awareness Training to be provided by SCE prior to start of any proposed project activities.

All locations demarcated as Environmentally Sensitive Areas are places where no soil disturbance is allowed. Soil disturbance for this purpose is defined as any grading operation that would remove or subtract soil from any particular location. Importing or adding soil from other sources for the purpose of filling potholes and ruts or for repair and installation of drainage structures is excluded.

Every effort would be employed to utilize existing roads, spur roads, and previously used construction set-up areas for erection cranes, placement of foundations, erection of steel, and placement of stringing equipment along R-O-W. New roadwork would be specified based upon completion of preliminary engineering and the satisfaction of permit requirements, where applicable.

3.2.2.2 Scope of Construction

The scope of work would vary for different sections of the proposed project R-O-W, and would include either removal of existing T/Ls and replacement with new, or installation of new T/Ls where none currently exist.

3.2.2.2.1 Segment 1 Scope. Construction of the new 500 kV T/L along Segment 1 would involve removal of the existing Antelope-Pole Switch 74 66 kV line and installation of the new T/L.

Between the Antelope and Pardee Substations, crews would remove the existing Antelope-Pole Switch 74 66 kV line and, in the same R-O-W, build the new 500 kV T/L. The new T/L from the Antelope to Pardee Substation would be built to 500 kV construction and initially operated at 220 kV.

- The existing Antelope-Pole Switch 74 66 kV line would be removed from mile 1.1 to mile 18.6 as follows:

  Construction activities would include establishment of marshalling yards for staging of material and equipment, completion of any roadwork, and removal of 66 kV line structures and equipment. Some guard poles may be required during certain phases of the removal scope. Following construction, clean-up, and demobilization, disturbed areas in the Angeles National Forest would be restored. The exact removal method employed and the sequence with which removal tasks are to be completed would be dependent upon final engineering, award and conditions of permits, and contractor preference.

- The new 500 kV T/L would be constructed between the Antelope and Pardee substations (500 kV operated at 220 kV) as follows:

The scope of work for T/L construction includes removal of approximately 17.5 miles of the existing Antelope-Pole Switch 74 66 kV line, from mile 1.1 to mile 18.6, in order to utilize the current R-O-W for new construction. Details of the removal work of lattice steel towers (LSTs) including access to each location, waste disposal and recycling, foundation removal, restoration methods, type of equipment used, and manpower allocations are discussed in Section 3.2.2.3. Following removal, construction of a new 500 kV T/L from the Antelope Substation to the Pardee Substation would be completed using single-circuit LSTs. Although built for 500 kV operation, initially this circuit would be operated at 220 kV. The proposed Antelope-Pardee 500 kV T/L would cross approximately 13 miles of mountain and canyon terrain in the Angeles National Forest and 3 miles of hilly terrain in Santa Clarita. After leaving Antelope Substation, approximately 20.1 miles (refer to Figure 3-2, mile 0.1 – 20.2) of the 500 kV T/L is proposed to be constructed on new single-circuit LSTs. The last 5.4 miles of this route from Haskell Canyon to the Pardee Substation (refer to Figure 3-2; mile 20.2 – 25.6) would be completed using double-circuit LSTs (note: Alternative 2 would involve use of single-circuit LSTs from mile 20.2 – 25.6 (i.e., single-circuit towers over entire length of Segment 1). Details of new construction work including access to each location, waste disposal and recycling, foundation installation, tower assembly and erection, wire stringing, restoration methods, type of equipment used, and manpower allocations are discussed in Section 3.2.2.3. Work would be completed using conventional construction techniques for access roads, foundations, tower erection, and conductor installations except where construction by helicopter may be required due to access/environmental limitations.

- A temporary bypass line would be constructed within the existing R-O-W from mile 20.3 (Haskell Canyon) to mile 22.3 in order to allow continued operation of the existing Pardee-Vincent 500 kV T/L, operating at 220 kV, while the single-circuit 500 kV towers are removed to make way for the new double-circuit towers. The bypass line would consist of a wood pole design, utilizing insulators, guys and anchors, and 3 conductors. On completion of construction of the proposed new 500 kV T/L, the temporary bypass line would be removed and the R-O-W would be restored.

3.2.2.3 Construction Activities

Construction activities would include establishment of marshalling yards for staging of material and equipment, completion of any roadwork, and removal of the Antelope-Pole Switch 74 66 kV line and structures. Following this, or in parallel, installation of foundations, steel, guard poles, conductor, then clean-up and demobilization would occur. The exact construction method employed and the sequence with which construction tasks are completed would be dependent upon final engineering, award, conditions of permits, and contractor preference.

3.2.2.3.1 <u>Primary Marshalling Yard</u>. A primary marshalling yard would be established adjacent to the existing Antelope Substation. This yard location has been selected based on its central location, and proximity to good access roads. Additionally, proximity to existing phone and power infrastructure has been considered in the selection of this area. An area up to approximately 5 acres in size would be required. Final location of this property would depend upon availability of appropriately zoned property in this area that is suitable for this purpose. Materials and equipment to be staged to this yard include but are not limited to: steel bundles, spur angles, palletized bolts, rebar, wire reels, insulators and hardware, removal material from the Antelope-Pole Switch 74 66 kV line, heavy equipment, light trucks, construction trailers, and portable sanitation facilities. In addition to the materials and equipment already detailed for new construction, the following may be routed through this yard: removed conductor, removed steel, removed concrete, and other debris associated with the removal process. Additional equipment and trash and recycle bins may be staged to this yard. Preparation of the yard would include the application of road base, installation of perimeter fencing, and implementation of Storm Water Pollution Prevention Plan (SWPPP) conditions. The property would be put into service at the start of work and would be used for the duration of construction activities. At the completion of construction activities, the property would be returned to a condition agreed upon prior to commencement of construction activities.

3.2.2.3.2 <u>Secondary Marshalling Yards</u>. Secondary marshalling yards would be established for short term utilization near the construction sites. Where possible, suitable sites along the construction corridors would be selected where there are previously disturbed property, abandoned excavations, operational industrial yards, or abandoned parking areas. Final location of this property would depend upon availability of appropriately zoned property in this area that is suitable for this purpose. The number and size of the secondary marshalling yards would be dependent upon a detailed R-O-W inspection and would take into account, where practical, suggestions by the successful bidder for the work. Typically, an area approximately 200 feet by 200 feet (approximately 0.9 acre) would be required. Materials and equipment to be staged in secondary marshalling yards would be similar to those described previously for the primary yard. Since the secondary yards have not been identified yet, biological and cultural resource studies may have not been conducted, but would be performed prior to site selection.

3.2.2.3.3 <u>Roadwork</u>. Grading preparation would be required to provide access for heavy equipment for all aspects of construction. Every effort would be made to utilize previously disturbed areas including existing R-O-W and patrol roads in order to minimize land disturbances. If new roads are necessary, strict erosion control measures would be enforced in accordance with SWPPP conditions, USFS stipulations, private property concerns, and existing SCE specifications.

Standard road-building equipment would be utilized to complete this work. In mountainous areas, benching may be required to provide access for footing construction, assembly, erection, and wire stringing activities during line construction. Benching, a technique where a tracked earth mover vehicle excavates a terraced access to LST excavations in extremely steep rugged terrain, would be used minimally and for the principal purpose of helping to ensure personnel safety during construction and secondarily to control costs in situations where potentially hazardous, manual excavations would be required. Road building and upkeep would be an ongoing process during the entire construction process on all elements of the work.

Details of roadwork are as described below.

Roadwork Related to Removal Activities. Grading preparation would be required to provide access for heavy equipment for spur roads to existing Antelope-Pole Switch 74 66 kV line LST sites. Depending on the results of a detailed review of the existing spur roads on the Antelope-Pole Switch 74 66 kV line, existing spur roads would be re-graded to facilitate the safe removal of conductor, hardware, and LST steel during removal. Where possible, the locations of new LSTs would match the sites of old LSTs. Consequently, it is anticipated that there would be a high degree of overlap on spur road grading.

Standard road-building equipment would be utilized to complete this work. In mountainous areas benching may be required to provide safe access for equipment removal.

Grading would be employed to establish temporary new spur roads to pulling and stringing locations along the R-O-W. The number of locations required would be dependent upon final engineering, topographical concerns, and availability of suitable terrain that is appropriate for stringing set-up.

Roadwork Related to New T/L Activities. For spur roads to new LST locations, grading would be employed in order to establish both temporary and permanent spur roads to as many new LST locations as possible for new line construction.

Grading would be employed in order to establish temporary new spur roads to pulling and stringing locations along the R-O-W. The number of locations required would be dependent upon final engineering, topographical concerns, and availability of suitable terrain that is appropriate for stringing set-up.

Access Roads to Splice Locations. In some circumstances, it may be necessary to construct an access road to a splice location. These locations would be used to remove temporary pulling splices and install permanent splices once the conductor is strung through the stringing travelers located on each LST. This is required as the permanent splices joining conductor together can not travel through stringing travelers.

3.2.2.3.4 Foundations. Footing work would be completed using standard "poured-in-place" augered excavation techniques. At the time of construction, elevations would be established, rebar cages set, spur angles and concrete placed, and survey positioning would be verified. Concrete samples would be drawn at time of pour and tested to ensure engineered strengths are achieved. Typically, on regular terrain, under ideal circumstances, a single footing crew could be expected to excavate, place steel cages and spur angles, and pour in place concrete for as many as one complete LST every two days. A foundation set for each LST would include four footings. Standard SCE 602 concrete typically takes approximately 20 working days to cure to a 3,000 pounds per square inch (psi) compressive break strength required for erection activity to commence.

Foundations would be installed at planned locations by accessing sites through existing spur roads for the Antelope-Pole Switch 74 66 kV line. If the exiting roads to these footings are not serviceable, roads would be prepared as previously described. Where access roads do not currently exist to LST sites in the Angeles National Forest, new roads would be built; special construction techniques would be utilized for these LST footings as described below.

Foundations for Antelope-Pole Switch 74 66 kV Line. Earth disturbing activities would be limited to pedestrian and light truck approach access only, since most footings would be abandoned in place. Any exposed steel work would be removed by cutting flush with surface so no hazard would exist. In order to remove the steel, crews would drive a light duty truck to each footing area, and use portable cutting equipment to remove any exposed steel. In the case where no roads exist, contractors would either hike in or fly in using helicopters with specialized cutting equipment to prepare the abandoned footings.

Foundations for New LSTs. Conventional construction techniques would generally be used as described above for new footing installation. In the isolated cases where crews would not have existing road access to new LST sites, equipment and material would be deposited at the LST site using helicopters or by workers on foot, and crews would prepare the footings using hand labor assisted by hydraulic or pneumatic equipment, or other methods.

3.2.2.3.5 Steel. Steel work would consist of hauling and stacking bundles of steel at each LST location per engineering drawing requirements. This activity would require several tractors with 40-foot floats and an on-site loader. Follow-up activities include the assembly of leg extensions, body panels, boxed sections and the bridges. The steel work would be completed by a combined erection and torqueing crew with a lattice boom crane. Ground disturbance would be kept to a minimum, to the extent practical. The construction crew may opt to install insulators and wire rollers (travelers) at this time. Depending on the accessibility solution for tower erection site access, helicopter erection may be required. Erection of this sort would be in accordance with SCE specifications and be similar to methods detailed in IEEE 951-1966, Guide to the Assembly and Erection of Metal Transmission Structures, Section 9, Helicopter Methods of Construction. Steel work associated with removal and new T/L construction activities are described below.

Removal of Antelope-Pole Switch 74 66 kV Line. Removal of the existing Antelope-Pole Switch 74 66 kV line may require grading near existing LSTs to allow for safe removal of existing towers. A crane pad approximately 50 feet by 50 feet (approximately 0.06 acre each) would be built to allow a LST removal crane to be set up 60 feet from the center line of each LST. The crane rail would be located transversely from the LST locations.

Wire Removal. Wire would be removed from the Antelope-Pole Switch 74 66 kV line. Wire-pulling equipment would be placed intermittently along the R-O-W in order to facilitate removal of conductor wire. It is currently estimated that the wire-pulling locations would be located approximately 15,000 feet apart. Additionally, wire-pulling locations would also be located at dead-end tower locations and points of inflection. It is currently estimated that wire-pulling locations would typically encompass approximately 200 feet by 400 feet (1.8 acres).

Guard structures would be utilized as discussed in Section 3.2.2.3.6. Once all equipment has been properly configured, the contractor would commence removal of the old conductor. In this process, the old conductor would be wound onto 'breakaway' reels as it is pulled out. A 3/8” pulling cable would replace the old conductor as it is pulled out. The intent of this process is to allow complete control of the conductor as it is removed. The conductor would then be transported to a material and equipment yard where it would be prepared for recycling. The 3/8” line would then be removed under controlled conditions so as to minimize ground disturbance. At the conclusion of the wire removal process, the equipment would be removed.

LST Assembly and Erection from Antelope to Pardee Substation. For new line construction, grading may be required at each tower location to allow for safe LST assembly and erection. For assembly and erection of new LSTs, a crane pad approximately 50 feet by 50 feet would be built to allow an erection crane to set up 60 feet from the centerline of each LST. The crane pad would be located transversely from the LST location. Some pedestrian traffic would be expected in and around the base of the LSTs as workers access the LSTs for normal construction activity.

3.2.2.3.6 <u>Guard Structures</u>. Guard poles or guard structures would be installed at all transportation, flood control and utility crossings. Guard structures may also be installed at other locations such as parks or near residences. These are temporary facilities and are removed after conductors are installed. If required, temporary netting (see Figure 3-20) would be installed to protect some types of under-built infrastructure. In some cases, guard structures can be specially equipped boom type trucks with heavy outriggers. Typical guard structures (see Figure 3-21) are standard wood poles, 60 feet to 80 feet tall, arranged in such a manner as to arrest the travel of conductor should it momentarily drop below a conventional stringing height.

For highway and open channel aqueduct crossings, SCE would work closely with the applicable jurisdiction to secure the necessary permits to string conductor across the applicable infrastructure. Agencies differ on guard structure policy and method of public protection preferred.

For major roadway crossings, typically one of four methods is employed to protect the public:

- Erection of a highway net guard structure system
- Detour of all traffic off of the highway at the crossing position
- Implementation of a controlled continuous traffic break while stringing operations are performed
- Establishment of special line trucks with extension booms onto the highway deck at strategic positions

3.2.2.3.7 <u>Wire Installation</u>. Wire stringing includes all activities associated with the installation of conductors onto the LSTs and tubular steel poles. This activity includes the installation of primary conductor and ground wire, vibration dampeners, weights, spacers, and suspension and dead-end hardware assemblies. Insulators and stringing sheaves (rollers or travelers) are attached as part of the wire stringing activity if the work is a part of a reconductor effort, otherwise they are attached typically during the steel erection process. A standard wire stringing plan includes a sequenced program of events starting with determination of wire pulls and wire pull equipment set-up positions. Advanced planning by supervision determines circuit outages, pulling times, and safety protocols needed for ensuring that safe and quick installation of wire is accomplished.

Typically, wire pulls occur every 15,000 feet on flat terrain and every 9,000 feet in mountainous terrain. Wire splices typically occur every 4,500 feet. "Wire pulls" are the length of any given continuous wire installation process between two selected points along the line. Wire pulls are selected, where possible, based on availability of dead-end LSTs at the ends of each pull, geometry of the line as affected by points of inflection, terrain, and suitability of stringing and splicing equipment set ups. In some cases, it may be preferable to select an equipment set up position between two suspension towers in which case anchor rods would be installed against which wire could be hard dead-ended for sagging purposes and also provide for convenient splicing capability. The dimensions of the area needed for stringing set-ups varies depending upon the terrain, however a typical stringing set up is 200 feet by 400 feet (approximately 1.8 acres each). Where necessary due to suitable space limitations, crews can work from within a substantially smaller area.

Special equipment is positioned at each end of the wire pull. On one side, a puller is positioned and on the other side a tensioner and wire reel stand truck is positioned. Supplemental specialized support equipment such as skidders and wire crimping equipment are strategically positioned to support the operation. Crews ensure all safety devices such as traveling grounds, guard structures, and radio equipped public safety roving vehicles and lineman are in place to protect the public and workers. Once positioned, a helicopter flies a lightweight sock line from LST to LST, carefully slipping the sock line through the stringing sheaves thus engaging a cam-lock device that secures the pulling sock in the sheave. The threading process is continued between all LSTs through the rollers for the particular set of spans selected for a conductor pull. The sock line is then used to pull in the conductor pulling cable. The conductor pulling cable is then attached to the conductor using a special swivel joint to prevent the wire from being damaged and allow it to rotate freely thus preventing complications from twisting as the conductor unwinds off of the reel. A special piece of hardware called an alligator is also installed to help the conductor feed into the stringing sheave properly. Pulling, sagging and clipping-in (attaching) or permanent dead-ending of the conductors is then completed. The final activity is to attach spacers between the bundled conductors of each phase. To do this, typically a lineman rides a small spacer cart between the wires and stops periodically to attach the spacers. Stringing equipment from one end of the pull is then rotated 180 degrees to face the new pull direction and the equipment from the other end of the pull is then 'leapfrogged' to it's new pulling position and the process is repeated. A similar process is employed for the ground wire. All activities related to conductor installation are heavy equipment intensive. Wire stringing would be in accordance with SCE specifications and similar to process methods detailed in IEEE Standard 524-1992, Guide to the Installation of Overhead Transmission Line Conductors.

3.2.2.3.8 Earth Disturbing Activities. Estimates of earth disturbing activities and acreages are presented in Table 3-1, including estimates of temporary disturbance, the acreage to be restored, and estimates of potential permanent disturbance.

3.2.3 Subtransmission Relocation Required for Antelope Substation Expansion

3.2.3.1 Proposed Project Scope

At Antelope Substation it would be necessary to relocate and replace 18 existing 70-foot-high wood poles with 18 new 70-foot-high light weight steel poles outside of the southerly fence line of Antelope Substation to clear the existing area for the expansion of Antelope Substation. These 18 light weight steel poles support six 66 kV subtransmission circuits.

3.2.3.2 66 kV Line Relocation South of Antelope Substation

3.2.3.2.1 Scope. The 66 kV work would consist of the relocation and replacement of three 1,000-foot-long, double-circuit 66 kV line sections. The three sections are described in more detail in the following sequence.

Sequence 1:Antelope-Acton-Palmdale-Shuttle 66 kV and Antelope-Anaverde 66 kV Lines. This section would be relocated 25 feet south of the new fence line constructed at the south side of Antelope Substation. This would require grading of a new 16-foot-wide access road. The relocation would involve construction of six 70-foot-tall light weight, direct buried steel poles (20-inch diameter at base), and installation of 6,000 feet of overhead 954 kcmil Stranded Aluminum Conductor (SAC). The conductor spacing and clearance specifications are as follows: on double-circuit configurations, 2 conductors at 61-foot-level; 2 conductors at 56-foot-level; and 2 conductors at the 51-foot-level.

Sequence 2: Antelope-Anaverde-Helijet 66 kV and Antelope-Oasis-Palmdale-Quartz Hill 66 kV Lines. This section would be relocated 25 feet south of Sequence 1. This would require grading of a new 16-foot-wide access road, which would service the two southerly line segments. The relocation would utilize six 70-foot-tall light weight, direct buried steel poles (20-inch diameter at base) and installation of 3,000 feet of overhead 954 kcmil SAC along with 3,000 feet of 653.9 kcmil ACSR conductor. The conductor spacing and clearance specifications are as follows: on double-circuit configurations, 2 conductors at 61-foot-grade level; 2 conductors at 56-foot level; and 2 conductors at 51-foot level.

Sequence 3: Antelope-Lancaster-Oasis-Quartz Hill 66 kV and Antelope-Shuttle 66 kV Lines. This section would be relocated 25 feet south of Sequence 2. Six 70-foot-tall light weight, direct buried steel poles (20-inch diameter at base) would be utilized and 3,000 feet

TABLE 3-1
PROPOSED PROJECT LAND DISTURBANCE ESTIMATE

Project Feature	Qty	Disturbed Acreage Calculation	Acres Disturbed During Construction	Acres to be Restored	Acres Permanently Disturbed
Guard Pole Hole[1] (qty street crossings on quad maps)	30	P/4 (28”/12)**2x4 locs *1.5	0.02	0.02	
Guard Pole Truck Damage[2] (same above)	30	2 tracks x 10’x2’x4 locs	0.11	0.11	
Steel Pole Hole[3] (qty steel poles)	3	P/4 (60”/12)**2	0.00		
Steel Pole Hole Truck Damage [4] (same above)	3	2 tracks x10’x2’	0.00	0.00	
Steel Pole Laydown Area (same above)	3	175’x8’	0.00	0.00	
LST site grading (.05 acres each)	12	12’x50’x40’	0.60		0.60
LST Footings Holes[5] (qty LST structures)	114	P/4(2)**2x4 locs	0.03		0.03
LST Footings Truck Damage[6] (same above)	114	2 tracks x 10’x2’x4 locs	0.42	0.42	
LST Laydown and Assembly Area (same above)	114	175’x60”	27.48	27.48	
Crane Pad for Erection (qty structures)	114	50’x50’	6.54	6.54	
Stringing Setups[7,11] (qty setups < overlap removal & new)	24	200’x200’ and 40’x100’	5.51	5.51	
Splicing Setups (qty setups)	15	20’x50’	0.34	0.34	
Roads New Spur (qty miles)[10]	1.7	x16’ wide	3.3		3.3
Roads Existing (impacted areas of roads only) (qty miles)	10	x16’ wide	19.4	19.4	
Radius from access road to spur road (# Spur Roads Total)	60	50’ R requires 1,464 sq. ft.	2.02		2.02
Spur Rd Related Temp Disturbed Areas[8]	60	566 sq. ft. per spur road	0.80	0.80	
Additional Spur Rd Radius for Steel Pole Trucks[9]	3	2,285 sq. ft. per spur road	0.00	0.00	0.00
Staging Areas Material and Equipment	3	3-5 acres per yard	15.00	15.00	
Antelope-Pole Switch 74 Removal Specific Truck & Ped Damage[12]	36	100 sq. ft. per LST site	0.08	0.08	
Antelope-Pole Switch 74 Removal Crane Pads	36	50’x50’			
Substation Expansion (Antelope)	1	2 acres expansion estd.	2.00		2.00
Substation Expansion (Antelope 500 kV)	1	31 acres expansion estd.	31.00		31.00
Total Estimated[13]			**114.70**	**75.70**	**39.00**

TABLE 3-1 (CONTINUED)
PROPOSED PROJECT LAND DISTURBANCE ESTIMATE

[1] guard pole-assume two guard poles per each side of street thus 4 poles for each crossing for standard 'football' design, 28” diameter poles, assume that 50% more crossings present (1.5 multiplier) due to preliminary engineering undercrossings not showing mapped distribution includes I-10, frontage roads, rural streets, dirt roads and jeep trails.

[2] Guard pole-augering process, same as above plus, assume 'dualie' type rear axle trucks with two 2' wide tracks backing to location.

[3] Steel pole-assume 60” diameter with 6” overbore for slurry/concrete backfill, thus 66” diameter hole augered.

[4] Steel pole-assume augering equipment backs in off new spur road 10' with two 2' wide tire tracks.

[5] LST-assume 36” diameter hole with 6” overbore for a Single-circuit tower.

[5a] LST-assume 42” diameter hole with 6” overbore for a Double-circuit tower.

[6] LST-assume 'dual' type rear axle trucks with two 2' wide tracks backing to four locations per LST approx. 10” from spur road.

[7] Approximately every 15,000' and at points of inflection or DE structures when convenient. Only 40% of the 200' x 200' site is disturbed.

[8] Parking tracks for 3 utility trucks (180 ft^2), and one turnaround track on an 18' radius (386 ft^2).

[9] Difference between 80' radius and 80' radius from access to spur road for access by 80' trailer bed truck.

[10] Spur road is required when access road is over 50' from structure site.

[11] One end of a stringing setup is 200' x 200' reel and tensioner end, the other is a 40' x 100' puller site. Only 40% of the 200' x 200' sites are disturbed.

[12] Total is for stand-alone Antelope-Pole Switch 74 LSTs only, not overlap LSTs, that is, only those Antelope-Pole Switch 74 LSTs that would not have new LSTs erected at that location.

[13] Rounded to nearest 0.1 acre.

of 653.9 kcmil ACSR conductor along with 3,000 feet of 336.4 ACSR conductor would be installed. The conductor spacing and clearance specifications are as follows: on double-circuit configurations, 2 conductors at 61-foot-grade level; 2 conductors at 56-foot level; and 2 conductors at 51-foot level.

3.2.3.2.2 Transmission Lay Down Area and Pulling Site Details. The transmission crews would house materials and equipment such as: conductor reels, wire stringing equipment, poles, line trucks, cross arms, insulators and any other incidental material at the Antelope Substation. The Antelope Substation is commonly used for a lay down area for projects in the area. Information on cable pulling operations, by section, follows:

- The first cable pull would be at southwesterly portion of the proposed project along Sequence 1. The crews would string from the most westerly pole to the most easterly pole. This would require an 80-foot by 80-foot area at each pole to negotiate the conductor pull.
- The first cable pull would be at southwesterly portion of the proposed project along Sequence 2. The crews would string from the most westerly pole to the most easterly pole. This would require an 80-foot by 80-foot area at each pole to negotiate the conductor pull.
- The first cable pull would be at southwesterly portion of the proposed project along Sequence 3. The crews would string from the most westerly pole to the most easterly pole. This would require an 80-foot by 80-foot area at each pole to negotiate the conductor pull.

3.2.3.2.3 Construction Plan. The actual start date of the subtransmission work (3 sequences) is currently unknown. However, the proposed daily work schedule is as follows: Monday through Saturday, 6:30 a.m. to 5:00 p.m. on all SCE-owned properties and R-O-Ws. The SCE Antelope Substation property would be used as a laydown area for equipment and materials for SCE crews as well as contract crews.

This subtransmission work would be completed in several phases. The first order of importance would be to grade in the 1,000-foot-long access road between Sequences 1 and 2 and between Sequences 2 and 3. The equipment consists of one diesel grader (772 John Deere). The grader would be expected to have 8 hours of running time with low to medium running speeds and 1 hour of idling. The grading portion of the proposed project should take one day. This would require one crew of two people.

The next phase of the subtransmission work would involve several activities occurring simultaneously. This portion of the proposed project would most likely consist of one six-person crew who would dig the pole holes using a heavy line truck with a digging capability along with a contractor-supplied backhoe. Both of these pieces of equipment would be diesel. These two pieces of equipment would have a running time of 6-8 hours with approximately one hour of idling. The digging process would take approximately 3 days to complete. Simultaneously, there would be a crew framing poles. This process should take 3 days to complete.

The next step would be to set the light weight steel poles. This would consist of one 6-man crew. The crew would have the poles delivered to their locations and would put the light weight steel poles together and set them. This phase would require a 25-ton crane (diesel), a heavy line truck (diesel), one prefabrication truck (diesel); and one utility vehicle (gas) used for crew transport. These pieces of equipment would be operated as needed for 8-10 hours a day. This portion of the proposed project should take approximately 1½ weeks.

The next phase of construction would consist of installing the overhead conductor. Work activities would include: splicing, dead-ending, terminating, sagging and clipping in the conductor. Equipment would include a heavy line truck (diesel), a bucket truck (diesel), a prefabrication truck (diesel), crane (diesel), pulling machines, cable dollies and traffic arrow boards as required. There would also be a utility vehicle (gas) on site for foreman and crew transport. This equipment would be in use as needed for 8-10 hours a day. This phase would take approximately 1½ weeks.

The next phase would consist of removing the abandoned poles and conductor with one six-person crew. Required equipment would include a heavy line truck (diesel), a bucket truck (diesel), a prefabrication truck (diesel), crane (diesel) pulling machines and cable dollies. There would also be a utility vehicle (gas) on site for foreman and crew transport. This equipment would be in use as needed for 8-10 hours a day. This phase would take approximately 4 days.

3.2.3.3 12 kV Work on Saugus-Del Sur R-O-W

There is an existing 12 kV circuit on one side of the Antelope-Pole Switch 74 66 kV line structures in the Antelope area. This circuit runs from Elizabeth Lake Pine Canyon Road to Avenue J. The appropriate section of this line would be relocated to new distribution poles within the expanded R-O-W.

3.3 SUBSTATION FACILITIES – SEGMENT 1 (ANTELOPE-PARDEE)

3.3.1 Substation Engineering Plan

3.3.1.1 Antelope Substation

The Antelope Substation is an existing 220/66 kV substation that is owned, operated and maintained by SCE.

Segment 1 of the Antelope Transmission Project requires the installation of four additional 220 kV line positions to the south. Two of these 220 kV line positions are necessary to accommodate a 220 kV generation tie line proposed by a third party and the Pardee 500 kV T/L. Segment 1 also requires the upgrade of the existing 220 kV buses to 3700A rating. In addition, Segment 1 includes the acquisition and fencing of approximately 31 acres of land adjacent to Antelope Substation. This land will be required to upgrade Antelope Substation from 220 kV to 500 kV.

The additional two line positions are required to accommodate the future Vincent 500 kV T/L, which will be addressed during discussion of Segment 2 of the Antelope Transmission Project, and the Substation One 500 kV T/L, which will be addressed during discussion of Segment 3 of the Antelope Transmission Project. This 220 kV switchyard expansion would create new line positions 10, 11, 12 and 13. As discussed previously, Segment 2 (Antelope-Vincent) and Segment 3 (Antelope to Substations One and Two) of the proposed Antelope Transmission Project are addressed in a separate CPCN Application and PEA.

In addition, the proposed configuration of the 220 kV and 500 kV lines coming into the Antelope Substation requires the relocation of the existing Vincent and Mesa 220 kV T/L from their present Positions 6 and 8 to the new Positions 12 and 13.

The expansion of the existing Antelope 220 kV switchyard requires the installation of the following equipment beyond the present substation perimeter fence on the southwest portion of the existing site in an area of 205 feet by 300 feet (refer to Figure 3-3A). This 205 foot by 300 foot fenced area would be within a larger expansion totaling 1,145 feet by 1,185 feet required for the future 500 kV facility (refer to Figure 3-3B).

- Two bus dead-end structures
- Four line dead-end structures
- Two 210-foot-long segments of bus conductor
- Six circuit breakers

- Fourteen disconnect switches

The upgrade of the existing 220 kV buses would require replacement of the following elements:

- Six bus dead-end structures
- Twenty-four bus dead-end insulator assemblies
- 720 feet of 2B-1590 kcmil ACSR bus conductors (approximately 4,500 feet total)

3.3.1.1.1 <u>220 kV Switchyard</u>. The existing 220 kV buses would need to be upgraded from 3000A Rating to 3700A Rating as follows:

- Replace six 38-foot-high by 48-foot-wide lattice bus dead-end structures with six new rigid steel structures to support the heavier conductors
- Remove and salvage 24 existing bus dead-end insulator assemblies
- Install 24 new bus dead-end insulator assemblies
- Remove and salvage 720 feet of 2B-1590 kcmil ACSR bus conductors
- Install 720 feet of new 2B-2156 kcmil ACSR bus conductors (approximately 4,500 feet total)

Additionally, the following equipment would need to be installed to extend the 220 kV buses four positions to the south:

- Two, 45-foot-high by 45-foot-wide bus dead-end structures and foundations
- Twelve insulator dead-end assemblies
- Two, 210-foot-long segments of East and West buses equipped with 2B-2156 kcmil ACSR conductors per phase (approximately 2,560 feet total)
- Approximately 1,000 feet of new control cable trench from new switchyard extension to new MEER to be installed as part of the proposed project.

In addition, four 220 kV double-breaker line positions would be installed as follows:

- Position 10 for the new Pardee 500 kV T/L
- Position 11 left mostly vacant for the future Vincent 500 kV T/L on Segment 2
- Position 12 for the existing Vincent 220 kV T/L relocated from Position 6

- Position 13 for the existing Mesa 220 kV T/L relocated from Position 8

The following equipment would be installed at each of the new 220 kV line positions (10, 12 and 13):

- One 60-foot-high by 45-foot-wide line dead-end structure and foundation
- Three 60-foot tie-downs with 2B-1590 kcmil ACSR conductors
- Three 220 kV capacitor voltage transformers
- Two 220 kV 3000A 40kA circuit breakers and foundations
- Four 220 kV group operated - horizontally mounted disconnect switches with support structures and foundations; one equipped with grounding attachments
- Three 200-foot-long segments of 2B-1590 kcmil ACSR conductors (approximately 600 feet total)

The following equipment would be installed at new 220 kV Line Position 11:

- One 60-foot-high by 45-feet-wide line dead-end structure and foundation
- Two 220 kV group operated - horizontally mounted disconnect switches with support structures and foundations; one at each bus

Note: The two bus disconnect switches are required to minimize outages during the installation of the remaining equipment to terminate the Vincent 220 kV T/L for Segment 2 of the Antelope Transmission Project.

Existing Line Position 8 would need to be upgraded to 3000A rating to terminate the 220 kV generation tie line proposed by a third party as follows:

- Replace three existing 60-foot 1033 kcmil ACSR tie-downs with new 2B-1590 kcmil ACSR
- Replace four existing 1200A rated disconnect switches with new 3000A rated switches
- Replace four existing disconnect switch structures and foundations
- Replace all existing 1033 kcmil ACSR conductors (approximately 150 feet) with new 2B-1590 kcmil ACSR (approximately 300 feet total)
- Reconnect the three existing coupling capacitor voltage transformers to new conductors

Finally, two existing bus disconnect switches and bus leads in Line Position 6 would need to be upgraded to minimize outages during the installation of the remaining equipment to terminate the Substation One, 500 kV T/L during the Segment 3 of the Antelope Transmission Project as follows:

- Replace two existing 1200A rated disconnect switches with new 3000A rated switches
- Replace two existing disconnect switch structures and foundations
- Replace existing conductors between each bus and the bus disconnect switch with new 2B-1590 kcmil ACSR

3.3.1.1.2 <u>Control Room/MEER/IT Building</u>. The existing Control Room at the Antelope Substation does not have enough space to accommodate the proposed addition. A new MEER would be constructed adjacent to the east wall of the existing relay room.

A new MEER/IT building equipped with air conditioner equipment would be installed to house the following equipment:

- Battery Charger
- Batteries
- Light & Power Panel
- AC and DC Distribution Panels
- Circuit Breaker Control Switches
- Protection relays and associated equipment as required

3.3.1.1.3 <u>Lighting</u>. There would be new lighting fixtures installed at the 220 kV switchyard expansion area. The light fixtures would be shielded and directed towards the ground and would be manually operated.

3.3.1.1.4 <u>Substation Expansion</u>. As discussed previously, it would be necessary to expand the existing Antelope Substation by extending the southwest corner of the station as follows:

<u>220 kV Improvements</u>.

- Grade a new area (220 feet by 330 feet) for the new substation expansion area (205 feet by 300 feet)
- Extend west perimeter fence by 205 feet to the south

- Remove 300 feet of southern fence line starting at the southwest corner
- Install a new 300-foot-long segment of fence on the south
- Install 205 feet of new fencing on the east
- The total length of new fence to be installed is 205 + 300 + 205 = 710 feet
- Install approximately 1,000 feet of new control cable trench from new MEER to the four line positions occupying the extended area of the substation
- Install new 350 kcmil copper conductor ground grid to cover the new substation area. The ground grid extends 2 feet outside the 205-foot by 300-foot fenced area on three sides.
- Connect the new grounding grid to the existing station grid

500 kV Expansion.

- Use 31 acres (1,145 feet by 1,185 feet) of property immediately adjacent to Antelope Substation (includes 205-foot by 300-foot section required for 220 kV improvements) (refer to Figure 3-3B).
- Install a new fence around the perimeter of the 500 kV expansion area.
- Property acquisition would also require an additional 200-foot-wide strip around the southerly and easterly boundaries outside of the newly fenced area for future 66 kV line relocations.
- Land requirements are based on the following assumptions:
  - Two 500 kV busses
  - Two 500/220 kV transformer banks rated at 1120 MVA each for a total of 2240 MVA
  - Seven 500 kV line positions
  - MEER
  - Copper conductor ground grid

3.3.1.2 Pardee Substation

The Pardee Substation is an existing 500/220 kV substation that is SCE owned, operated and maintained. The 220 kV switchyard and MEER building are already in place to accommodate Segment 1 of the Antelope Transmission Project. Segment 1 of the proposed project would include installation of equipment at the existing 220 kV Line Position No. 5 to terminate the proposed Antelope-Pardee 500 kV T/L at the existing 220 kV switchyard.

The following sections describe the work required at the Pardee Substation.

3.3.1.2.1 <u>220 kV Switchyard</u>. The following equipment would be installed to terminate the proposed Antelope-Pardee 500 kV T/L at existing Line Position No. 5:

- Three 80-foot tie-downs with 2B-1590 kcmil ACSR conductors
- Three 220 kV capacitor voltage transformers
- Two 220 kV 3000A 40kA circuit breakers and foundations
- Four 220 kV group operated – horizontally mounted disconnect switches to be installed on existing support structures and foundations – one equipped with grounding attachments
- Three 200-foot segments of 2B-1590 kcmil ACSR conductors – Total: 1,200 feet

In addition, 15 transient recovery voltage line-to-ground capacitors and related support pedestals would be installed to upgrade 15 existing 220 kV 50 kA circuit breakers to 60 kA rating.

3.3.1.2.2 <u>Control Room</u>. Install protection relays and associated equipment as required.

3.3.1.2.3 <u>Lighting</u>. There would be no additional lighting fixtures installed at this station.

3.3.1.2.4 <u>Capacitor Banks</u>. No capacitor banks would be required at the Antelope or Pardee Substations for Segment 1.

3.3.2 Substation Construction Plan

3.3.2.1 <u>Antelope Substation</u>

3.3.2.1.1 <u>Grading and Fencing</u>. The proposed Antelope Substation expansion area would be graded and surfaced with untreated crushed rock. The expansion area to be graded is approximately 220 feet by 330 feet on the southwest corner of the existing substation site. New fencing (4,155 feet) would be installed around the perimeter of the future 500 kV switchyard. The estimated vehicle types and duration of use are as follows:

Type of Vehicle	Estimated No. Required	Fuel Consumption Per 8 hr. day	Duration (Days)
980 Loader	1	60 gallons	10
Grader	1	60 gallons	10
Compactor (sheep's foot)	1	30 gallons	10
Water truck	1	30 gallons	10
Survey truck	1	5 gallons	10
Soils Test crew truck	1	5 gallons	10

All new perimeter fencing would be 8-foot-high chain-link topped with barbed wire. Additionally, a minimum of two, 24-foot-wide by 8-foot-high chain-link double drive gates with barbed wire would be installed.

3.3.2.1.2 <u>Water Usage</u>. One water truck would be in continuous usage during the grading cycle of the proposed project. The expected daily consumption for watering the site during the grading stage is as follows:

Number of Trucks	Trips/Day	Gals/Truck	Total Water/Day
1	8	1,000	8,000

3.3.2.1.3 <u>Substation Construction</u>. The construction efforts would occur in accordance with accepted construction industry standards. Initially, the existing substation site would be expanded 1,145 feet by 1,185 feet with 205 feet by 300 feet being improved at this time for the 220 kV substation improvements. Grading and construction of perimeter fences, foundations, and belowground facilities would then be completed followed by installation of the aboveground structures and electrical equipment.

Work by SCE's construction crew or contractors managed by SCE would generally be scheduled during daylight hours, Monday through Friday. Extended hours or days may be required in order to meet schedule requirements. In the event that construction needs to occur outside of the specified hours, a variance would need to be obtained. A guard service would be utilized on weekends and during non-construction hours during the week.

All materials for the proposed substation would be delivered by truck to the site. Material would be staged along the north perimeter fence during construction. Truck traffic would use major streets and would be scheduled for off-peak traffic hours.

3.3.2.1.4 <u>Labor Force Requirements</u>. Both SCE's own construction work force and contractors would perform construction.[1] The number of construction personnel and

[1] Labor force requirements do not include the 500 kV switchyard expansion since timing of this expansion is unknown, the work is not concurrent with or immediately succeeding the 220 kV improvements.

equipment required to construct the proposed substation are currently anticipated to be as follows:

Construction Element	Number of Personnel	Equipment Requirements
Grading Crew	4	(See list above in Section 3.3.2.1.1 [Grading])
Survey Crew	2	1 Survey Truck
Civil Crew	8	1 Office Trailer 2 Crew Trucks 1 Dump Truck 1 5-Ton Truck 1 Ditch Digger 8 Personal Cars 1 Driller 1 Crane 2 Tractors 1 Forklift 1 Trash Dumpster
Electrical Crew	10	1 Office Trailer 1 5-Ton Truck 2 Crew Trucks 2 Carryall Vehicles 1 150-Ton Crane 2 Dumpsters 10 Personal Cars 1 Crane Truck 1 Pickup 1 Forklift 2 Manlifts 2 Support Trucks
Maintenance Crew	5	1 Foreman Truck 2 Crew Trucks 1 Forklift 1 Gas Processing Trailer
Test Crew	2	1 Test Truck

3.3.2.1.5 Post-Construction Cleanup. All construction debris associated with the construction effort would be placed in appropriate onsite containers and periodically disposed of according to all applicable regulations during construction of the proposed substation.

3.3.2.2 Pardee Substation

3.3.2.2.1 Substation Construction. The construction efforts would occur in accordance with accepted construction industry standards. Construction of foundations and belowground facilities would then be completed followed by installation of the aboveground structures and electrical equipment.

Work by SCE's construction crew or contractors managed by SCE would generally be scheduled during daylight hours, Monday through Friday. Extended hours or days may be required in order to meet schedule requirements. In the event that construction needs to occur outside of the specified hours, a variance would need to be obtained.

All materials for the proposed substation would be delivered by truck to the site. Material would be staged along the east perimeter fence during construction. Truck traffic would use major streets and would be scheduled for off-peak traffic hours.

3.3.2.2.2 Labor Force Requirements. Both SCE's own construction work force and contractors would perform construction. Construction personnel and equipment required to modify the Pardee Substation are anticipated as follows:

Construction Element	Number of Personnel	Equipment Requirements
Civil Crew	6	1 Office Trailer 2 Crew Trucks 1 Dump Truck 3 5-Ton Trucks 1 Ditch Digger 8 Personal Cars 1 Driller 1 Crane 2 Tractors 1 Forklift 1 Trash Dumpster
Electrical Crew	8	1 Office Trailer 1 5-Ton Truck 2 Crew Trucks 2 Carryall Vehicles 1 150-Ton Crane 4 Dumpsters 10 Personal Cars 1 Crane Truck 1 Pickup 1 Forklift 2 Manlifts 2 Support Trucks
Maintenance Crew	5	1 Foreman Truck 2 Crew Trucks 1 Forklift 1 Gas Processing Trailer
Test Crew	2	1 Test Truck

3.3.2.2.3 Post-Construction Cleanup. All construction debris associated with the construction effort would be placed in appropriate onsite containers and periodically disposed of according to all applicable regulations during modification of the proposed substation.

3.4 INFORMATION TECHNOLOGY (IT) FACILITIES – SEGMENT 1 (ANTELOPE-PARDEE)

3.4.1 Overview

SCE is proposing to install telecommunication infrastructure for operating the existing substations and protecting the new T/Ls from electrical interruptions. The types of circuits to be installed would include fault protection, Supervisory Control and Data Acquisition (SCADA), telephone, Wide Area Network (WAN) and, if necessary, Remedial Action Scheme (RAS).

3.4.2 Telecommunication Systems

Two telecommunication paths would be provided for redundancy. The primary path would use existing SCE infrastructure between the Pardee and Antelope Substations. The secondary path would be provided by optical ground wire (OPGW), which would be installed on all new T/Ls between Pardee and Antelope.

3.4.3 OPGW Installation

OPGW would be installed as part of the new T/L. Within the substations (Pardee and Antelope) conduits would be constructed to extend the fiber optic cable to the communication rooms. No new roads, grading, or laydown areas, other than those necessary for T/L and substation construction, would be required.

3.4.4 Operation and Maintenance

There would be no change in staffing for existing sites. All telecommunications equipment would be operated and maintained by SCE technicians. Preventative maintenance is typically scheduled every 6 months in order to ensure system reliability and performance.

3.5 PROPOSED PROJECT CONSTRUCTION

3.5.1 Introduction

This section summarizes construction-related details for the overall Segment 1, Antelope-Pardee 500 kV T/L proposed project, including:

- Construction schedule and workforce
- Construction equipment
- Land disturbance during construction
- Hazardous material usage
- Waste generation and disposal

3.5.2 Construction Schedule and Workforce

A summary proposed project construction schedule is presented on Table 3-2. Construction activities for Segment 1 are planned to begin in July 2006 and end in December of 2007.

The combined construction workforce for all Segment 1 proposed project components is anticipated to range from approximately 20 to 120, with an estimated average daily workforce of 50.

3.5.3 Construction Equipment

Construction equipment estimates by proposed project component and activity are presented in Table 3-3.

3.5.4 Land Disturbance During Construction

Estimates of land disturbance due to construction activities (temporary and permanent) are presented in Table 3-1. In summary, construction of the proposed Segment 1 project is expected to temporarily disturb approximately 115 acres and result in the permanent disturbance of approximately 39 acres.

3.5.5 Hazardous Materials Usage and Waste Generation

Construction of the proposed project would require limited use of hazardous materials, including fuel, lubricants, and cleaning solvents. All hazardous materials would be stored,

TABLE 3-2
CONSTRUCTION SCHEDULE

Activity Description	Forecast Start	Forecast Finish	2003	2004	2005	2006	2007	2008	2009
CRT Approval – Permitting & Licensing									
• CRT Approval / CPCN Submission / Permitting & Licensing	Jun-03	Jul-06							
• Preliminary Engineering / PEA Preparation / CPCN Filing		Dec-04							
Regulatory Milestones									
• CAISO Approval		Fall 04							
• CPUC/CPCN Review Process	Dec-04	Jul-06							
• CPCN Approval (12-18 months)		Jul-06							
• Inclusion in FERC Rate Base									
▪ Segment 1: Antelope to Pardee		Dec-07							
Segment 1: Engineering	Dec-04	Jul-06							
Segment 1: R/W & Sub Site Acquisition	Jan-05	Sep-06							
Segment 1: Procurement	Oct-05	Oct-06							
Segment 1: Construction & Testing	July-06	Dec-07							
▪ Removal of Antelope-Pole Switch 74 66 kV Line (and 12 kV relocation)	July-06	Sep-06							
▪ 500 kV T/L Construction	Sep-06	Aug-07							
• Subtransmission Work	Nov-06	Dec-06							
• Antelope Substation	Mar-07	Dec-07							
• Pardee Substation	Aug-07	Dec-07							
Segment 1: Antelope to Pardee In-Service Date		Dec-07							

handled, and used in accordance with applicable regulations, including the Construction Storm Water Pollution Prevention Plan(s) for the T/L segments and substation components.

Construction of the proposed project would result in the generation of various waste materials, including materials associated with removal activities (i.e., Antelope-Pole Switch 74 66 kV line removal) and construction of new T/L and substation modifications at Antelope and Pardee. A summary of estimated waste generation is presented in Table 3-4.

3.6 FACILITY OPERATIONS AND MAINTENANCE

SCE would operate and maintain all Segment 1 related proposed project components (i.e., T/Ls and substation facilities) in accordance with existing SCE procedures and personnel. The proposed project would not require any additional personnel during the operational phase.

TABLE 3-3
CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
500 kV T/L Construction (Antelope/Pardee):							
Survey					**(1 Crew)**		
Truck, Pick-Up	180	Gas	2	3	10 days	25%	1 mile per day
Marshalling Yards					**(1 Crew)**		
Crane, Hydraulic, Rough Terrain, 25 Ton	125	Diesel	1	6	190 work days	50%	Duration of Project
Truck, Semi, Tractor	310	Diesel	1		190 work days	15%	
Trailer, Flatbed, 40'	N/A	N/A	1		190 work days	N/A	
Loader, Front End, w/ Bucket	145	Diesel	1		190 work days	10%	
Forklift, 5 Ton	75	Diesel	1		190 work days	50%	
Forklift, 10 Ton	85	Diesel	1		190 work days	50%	
Truck, Pick-Up	180	Gas	1		190 work days	15%	
Truck, Flatbed, 1 Ton	180	Gas	1		190 work days	15%	
Trailer, Office, 40' - 60'	N/A	N/A	1		190 work days	N/A	
Trailer, Storage, 40'	N/A	N/A	3		190 work days	N/A	
Road Work					**(1 Crew)**		
Crawler, Track Type, w/ Blade (D8 type)	305	Diesel	1	8	30 work days	75%	1 mile per day
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		30 work days	75%	
Truck, Semi, Tractor	310	Diesel	1		30 work days	50%	
Trailer, Lowboy, 30'	N/A	N/A	1		30 work days	N/A	
Motor Grader	110	Diesel	1		30 work days	75%	
Back Hoe, w/ Bucket	85	Diesel	1		30 work days	50%	
Truck, Pick-Up	180	Gas	1		30 work days	75%	
Truck, Flatbed, 1 Ton	180	Gas	2		30 work days	50%	
Foundations					**(4 Crew)**		
Digger, Transmission Type, Truck Mount	190	Diesel	3	20	60 work days	75%	2 structures per day
Truck, Flatbed, 2 Ton	235	Gas	2		60 work days	25%	
Truck, Concrete, 10 Yd	310	Diesel	4		60 work days	85%	
Truck, Flatbed w/Boom, 5 Ton	235	Diesel	2		60 work days	25%	
Crawler, Track Type, Drill Rig, Pneumatic	305	Diesel	1		60 work days	20%	

TABLE 3-3 (CONTINUED)
CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		60 work days	20%	
Truck, Semi, Tractor	310	Diesel	1		60 work days	20%	
Trailer. Lowboy, 30'	N/A	N/A	1		60 work days	N/A	
Back Hoe, w/Bucket	85	Diesel	1		60 work days	50%	
Truck, Dump, 10 Ton	235	Diesel	1		60 work days	25%	
Loader, Front End, w/ Bucket	145	Diesel	1		60 work days	35%	
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		60 work days	75%	
Truck, Mechanics, 1 - 2 Ton	260	Diesel	1		60 work days	75%	
Truck, Pick-Up	180	Gas	2		60 work days	75%	
Truck, Flatbed, 1 Ton	180	Gas	2		60 work days	50%	
Motor, Auxiliary Power	5	Gas	2		60 work days	10%	
Trailer, Storage, 40'	N/A	N/A	3		60 work days	N/A	
Steel (Shake-out, Hauling, Light Assembly, Heavy Assembly, Erection)					**(8 Crew)**		
Crane, Hydraulic, 150 Ton	250	Diesel	1	48	60 work days	50%	2 structures per day
Crane, Hydraulic, Rough Terrain, 25 Ton	125	Diesel	3		60 work days	50%	
Truck, Flatbed w/ Boom, 5 Ton	235	Diesel	2		60 work days	50%	
Truck, Flatbed, 2 Ton	235	Gas	1		60 work days	25%	
Truck, Pick-Up	180	Gas	1		60 work days	75%	
Truck, Flatbed, 1 Ton	180	Gas	5		60 work days	100%	
Trailer, Lowboy, 30'	N/A	N/A	N/A		60 work days	N/A	
Truck, Semi, Tractor	310	Diesel	2		60 work days	20%	
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		60 work days	20%	
Trailer, Flatbed, 40'	N/A	N/A	4		60 work days	N/A	
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		60 work days	75%	
Truck, Mechanics, 1 - 2 Ton	260	Diesel	1		60 work days	75%	
Compressor, Air	75	Gas	3		60 work days	75%	
Conductor (Sheaves, Insulators, Stringing, Deadening, Clipping and Spacing, Anchors)					**(8 Crew)**		
Truck, Flatbed, w/ Bucket, 5 Ton	235	Diesel	3	39	65 work days	75%	0.5 miles per day
Tension Machine	135	Gas	1		65 work days	25%	
Truck, Wire Puller, 3 Drum	310	Diesel	1		65 work days	25%	
Truck, Wire Puller, 1 Drum	310	Diesel	1		65 work days	25%	
Truck, Semi, Tractor	310	Diesel	2		65 work days	75%	

TABLE 3-3 (CONTINUED)
CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
Trailer, Lowboy	N/A	N/A	2		65 work days	N/A	
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		65 work days	75%	
Crawler, Track Type, w/ Blade (D8 type)	305	Diesel	1		65 work days	25%	
Crawler, Track Type, Sagging (D8 type)	305	Diesel	1		65 work days	25%	
Truck, Flatbed, 1 Ton	180	Gas	6		65 work days	50%	
Truck, Pick-Up	180	Gas	3		65 work days	75%	
Back Hoe, w/ Bucket	85	Diesel	1		65 work days	35%	
Digger, Transmission Type, Truck Mount	190	Diesel	1		65 work days	10%	
Truck, Mechanics, 1 - 2 Ton	260	Diesel	1		65 work days	75%	
Crane, Hydraulic, Rough Terrain, 25 Ton	125	Diesel	2		65 work days	35%	
Motor, Auxiliary Power	5	Gas	4		65 work days	10%	
Cleanup & Guard Poles					**(2 Crew)**		
Truck, Flatbed w/ Boom, 5 Ton	235	Diesel	1	6	30 days	50%	1 mile per day
Truck, Flatbed, w/ Bucket, 5 Ton	235	Diesel	1		30 days	50%	
Back Hoe, w/Bucket	85	Diesel	1		30 days	50%	
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		30 days	75%	
Truck, Semi, Tractor	310	Diesel	1		30 days	20%	
Trailer, Lowboy, 30'	N/A	N/A	1		30 days	N/A	
Motor Grader	110	Diesel	1		30 days	75%	
Truck, Flatbed, 1 Ton	180	Gas	2		30 days	75%	
Truck, Pick-Up	180	Gas	2		30 days	75%	
Wreck-Out (Remove Conductors, Structures, Foundations)					**(4 Crew)**		
Truck, Flatbed, w/ Bucket, 5 Ton	235	Diesel	3	30	30 work days	75%	0.75 mile per day
Truck, Wire Puller, 1 Drum	310	Diesel	1		30 work days	75%	
Truck, Semi, Tractor	310	Diesel	3		30 work days	75%	
Trailer, Lowboy	N/A	N/A	2		30 work days	N/A	
Trailer, Flatbed, 40'	N/A	N/A	3		30 work days	N/A	
Truck, Dump, 10 Ton	235	Diesel	2		30 work days	75%	
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		30 work days	75%	
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		30 work days	75%	
Truck, Flatbed, 1 Ton	180	Gas	6		30 work days	75%	

TABLE 3-3 (CONTINUED) CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
Truck, Pick-Up	180	Gas	3		30 work days	75%	
Back Hoe, w/ Bucket	85	Diesel	1		30 work days	75%	
Truck, Mechanics, 1 - 2 Ton	260	Diesel	1		30 work days	50%	
Crane, Hydraulic, Rough Terrain, 35 Ton	150	Diesel	2		30 work days	50%	
Motor, Auxiliary Power	5	Gas	2		30 work days	10%	
Bypass T/L (Install Structures and Conductors)					**(2 Crew)**		
Truck, Flatbed w/ Boom, 5 Ton	235	Diesel	1	12	20 days	50%	0.25 mile per day
Truck, Flatbed, w/ Bucket, 5 Ton	235	Diesel	2		20 days	50%	
Tension Machine	135	Gas	1		20 days	10%	
Truck, Wire Puller, 3 Drum	310	Diesel	1		20 days	15%	
Truck, Wire Puller, 1 Drum	310	Diesel	1		20 days	15%	
Back Hoe, w/ Bucket	85	Diesel	1		20 days	25%	
Digger, Transmission Type, Truck Mount	135	Diesel	1		20 days	25%	
Crawler, Track Type, w/ Blade (D8 type)	305	Diesel	1		20 days	25%	
Crawler, Track Type, Sagging (D8 type)	305	Diesel	1		20 days	10%	
Truck, Semi, Tractor	310	Diesel	2		20 days	50%	
Trailer, Flatbed, 40'	N/A	N/A	2		20 days	N/A	
Trailer, Lowboy, 30'	N/A	N/A	2		20 days	N/A	
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		20 days	35%	
Truck, Flatbed, 1 Ton	180	Gas	3		20 days	75%	
Truck, Pick-Up	180	Gas	2		20 days	75%	
Motor, Auxiliary Power	5	Gas	2		20 days	10%	
Bypass T/L (Removal of Conductors and Structures)					**(2 Crew)**		
Truck, Flatbed w/ Boom, 5 Ton	235	Diesel	2	12	20 days	50%	1 mile per day
Truck, Flatbed, w/ Bucket, 5 Ton	235	Diesel	2		20 days	50%	
Tension Machine	135	Gas	1		20 days	10%	
Truck, Wire Puller, 1 Drum	310	Diesel	1		20 days	15%	
Back Hoe, w/ Bucket	85	Diesel	1		20 days	50%	
Crawler, Track Type, w/ Blade (D6 type)	165	Diesel	1		20 days	25%	
Truck, Semi, Tractor	310	Diesel	2		20 days	50%	
Trailer, Flatbed, 40'	N/A	N/A	2		20 days	N/A	
Trailer, Lowboy, 30'	N/A	N/A	2		20 days	N/A	

TABLE 3-3 (CONTINUED)
CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
Truck, Water, 2,000 - 5,000 Gal	175	Diesel	1		20 days	35%	
Truck, Flatbed, 1 Ton	180	Gas	3		20 days	75%	
Truck, Pick-Up	180	Gas	2		20 days	75%	
Motor, Auxiliary Power	5	Gas	2		20 days	10%	
66 kV Subtransmission Work							
Heavy Truck	235	Diesel	1	8	20 days	60%	4 poles per day
Truck, Wire Puller, 1 Drum	310	Diesel	1		20 days	15%	
Truck, Flatbed, 1 Ton	180	Gas	3		20 days	75%	
Truck, Pick-Up	180	Gas	2		20 days	75%	
Motor, Auxiliary Power	5	Gas	2		20 days	10%	
Antelope Substation							
Grading Element							
980 Loader	305	Diesel	1	4	15 work days	75%	
Grader	110	Diesel	1		15 work days	50%	
Compactor	165	Diesel			10 work days	50%	
Water Truck	180	Gas	1		15 work days	75%	
Survey Truck	180	Gas	1		15 work days	90%	
Soils Test Crew Truck	180	Gas	1		15 work days	50%	
Civil Element							
Crew Trucks	180	Gas	2	8	100 work days	100%	
Dump Truck	180	Gas	1		90 work days	50%	
5-ton Truck	180	Diesel	1		60 work days	50%	
Ditch Digger	75	Gas	1		60 work days	75%	
Driller	305	Diesel	1		30 work days	75%	
Crane	180	Gas	1		30 work days	50%	
Tractor/Backhoe	85	Diesel	2		60 work days	70%	
Forklift	75	Diesel	1		60 work days	50%	
Electrical Element							
Crew Trucks	180	Gas	2	10	140 work days	100%	
5-ton Truck	180	Diesel	1		100 work days	50%	

TABLE 3-3 (CONTINUED)
CONSTRUCTION EQUIPMENT ESTIMATES BY ACTIVITY

Primary Equipment Description	Horse-power	Fuel Type[1]	Primary Equip. Quantity	Estimated Total Full Time Equivalents for this Activity	Estimated Activity Schedule	Usage Time (10 Hr Day)	Estimated Production Per Day
Pardee Substation							
Civil Element							
Crew Trucks	180	Gas	2	6	20 work days	00%	
Dump Truck	180	Gas	1		20 work days	50%	
Ditch Digger	75	Gas	1		20 work days	75%	
Tractor/ Backhoe	85	Diesel	2		20 work days	70%	
Forklift	75	Diesel	1		20 work days	50%	
Electrical Element							
Crew Trucks	180	Gas	2	8	40 work days	100%	
5-ton Truck	180	Diesel	1		40 work days	50%	
Ditch Digger	75	Gas	1		20 work days	75%	
Crane 150-ton	250	Diesel	1		20 work days	50%	
Forklift	75	Diesel	1		40 work days	50%	

1 Note: the following information applies to SCE maintained vehicles that are diesel equipped:

- All diesels burn #2 clear, which is standard in SCAQMD area.
- Street-legal Diesels. Tested annually by SCE Mechanics using a SCAQMD certified apparatus. If vehicle is tested and fails criteria, it is scheduled for service to repair. When testing is successful, testing report is filed in vehicle’s maintenance file. SCAQMD can inspect SCE’s files at their discretion.
- Offroad Diesels. Annual certification by SCAQMD based on Permit to Operate issued by SCAQMD. Permits are unique to each vehicle and depend on engine specifications such as displacement, size, etc. Issued only to vehicles with engines larger than 50 Hp. SCE maintains maintenance records and operating logs. Operating logs detail information such as where equipment was used, how it was used, and how much fuel was consumed.
- Contractor-Maintained Vehicles, Diesel Equipped. SCE may check engine for working fluids and maintain during work usage period. SCE refuels with #2 Clear, which is standard in SCAQMD area. Contractor would have all records at request of inspectors and would be responsible for ensuring compliance with emissions requirements for areas of operation throughout the project areas of construction.

The Antelope and Pardee substations would be operated and maintained in accordance with existing procedures. Operation and maintenance of the proposed Antelope-Pardee 500 kV T/L would involve periodic inspection (e.g., once per year) via helicopter and truck where accessible and acceptable (e.g., to the USFS). Maintenance of the T/L would be performed on an as-needed basis, including maintenance of access roads and erosion/drainage control structures as applicable.

TABLE 3-4
ESTIMATES OF CONSTRUCTION WASTE

Waste Item	Pounds Total	Pounds Reusable on Site	Pounds Recyclable or Disposed
66 kV Antelope-Pole Switch 74 Removal Waste Estimate			
LST Steel	810,080	0	810,080
Insulators	118,950	0	118,950
Conductor, 4/0 CU & 336 ACSR	458,220	0	458,220
Skyline	0	0	0
Hardware from LST Demo.	36,600	0	36,600
Wood from Cribbing, etc.	2,000	0	2,000
Soil/Veg from Crane Pads & R-O-W	6,387,500	5,871,250	516,250
Miscellaneous	5,000	0	5,000
Sanitation Waste	12,432	0	12,432
66 kV Antelope Relocation Waste Estimate			
Insulators & cross arms	8,664	0	8,664
Poles	72,000	0	72,000
Conductor	16,128	0	16,128
500 kV Construction Waste Estimate			
Wood from Cribbing, etc.	160,000	0	160,000
Soil/Veg: Ftgs, Spurs, & Crane Pads	5,197,488	3,638,242	1,559,246
Miscellaneous	40,000	0	40,000
Sanitation Waste	58,368	0	58,368
Concrete	570,000	0	570,000

Antelope Substation

Grading Element			
Soil/Vegetation	13,500,000	13,500,000	0
Sanitation Waste	500	0	500
Civil Element			
Wood	2,000	0	2,000
Concrete	2,000	0	2,000
Sanitation Waste	1,000	0	1,000
Miscellaneous	1,000	0	1,000
Electrical Element			
Wood	2,000	0	2,000
Steel/Aluminum/Copper	30,000	0	30,000
Sanitation Waste	1,500	0	1,500
Miscellaneous	2,000	0	2,000

TABLE 3-4 (CONTINUED)
ESTIMATES OF CONSTRUCTION WASTE

Waste Item	Pounds Total	Pounds Reusable on Site	Pounds Recyclable or Disposed
Pardee Substation			
Civil Element			
Wood	1,000	0	1,000
Concrete	500	0	500
Sanitation Waste	200	0	200
Miscellaneous	200	0	200
Electrical Element			
Wood	1,000	0	1,000
Steel/Aluminum/Copper	5,000	0	5,000
Sanitation Waste	500	0	500
Miscellaneous	500	0	500

3.7 ALTERNATIVES TO THE PROPOSED PROJECT

3.7.1 Introduction

SCE performed a siting and alternatives analysis before selecting the proposed project. The key criteria in the analysis included: 1) maximize use of existing, previously disturbed T/L R-O-W to minimize effects on previously undisturbed land and resources; 2) select route and tower locations with the lowest potential for environmental impacts while still having ability to meet project objectives; 3) select shortest route that is capable of meeting project objectives in order to minimize environmental impacts and project costs and associated costs to ratepayers. This PEA considers the following alternatives:

- No Project Alternative
- T/L Route Alternatives
- Tower, Conductor, and Voltage Options
- Non-Forest Service Land Alternative
- Underground Alternative

3.7.2 No Project Alternative

SCE is filing this application pursuant to CPUC Decision D.04-06-010 Ordering Paragraphs No. 8 and No. 9 which require SCE to file an application seeking a Certificate of Public Convenience and Necessity authorizing construction of the first phase of Antelope transmission upgrades consistent with its 2002 conceptual study and the study group's recommendations within six months of the effective date of this order, seek transmission rate recovery at the Federal Energy Regulatory Commission, and include, to the extent feasible, project with existing interconnection requests in its first phase CPCN. In addition, in Docket I. 00-11-001, an Assigned Commissioner Ruling required SCE to file two separate applications (one CPCN application for Segment 1 and one CPCN application for Segments 2 and 3). *See Assigned Commissioner Ruling Regarding Tehachapi CPCN Filing Requirement* (Oct. 21, 2004). The aforementioned requirements related to the CPUC decision indicate that the No Project Alternative would not satisfy regulatory mandates.

If the No Project Alternative was a viable alternative and it was selected by the CPUC, the environmental impacts associated with the proposed project as well as the benefits would not occur. It is considered likely that were the proposed project not implemented, another transmission project would need to be built, if possible, with potentially greater environmental impacts and fewer benefits to the transmission grid and renewable energy producers in Southern California.

3.7.3 T/L Route Alternatives

3.7.3.1 <u>Alternative 1 (Route Parallels LADWP R-O-W)</u>

Alternative 1 would consist of a new, 22.8-mile-long 500 kV line that is an alternative route to the proposed Antelope-Pardee T/L route between the Antelope Substation and Haskell Canyon (refer to Figures 3-1 and 3-2). The corresponding portion of the proposed route is 20.5 miles long (i.e., 2.3 miles shorter). Alternative 1 departs the Antelope Substation on tubular steel poles by cutting across the existing Antelope-Magunden 220 kV R-O-W and the Midway-Vincent No.3 500 kV R-O-W. The alternative route would use a new 160-foot to 180-foot-wide R-O-W for the next 22.8 miles as it heads towards the Pardee Substation. As Alternative 1 leaves the Antelope Substation, the line heads west. At mile 3.9, it crosses the existing LADWP R-O-W and turns southwest, paralleling the west side of the existing R-O-W.

The line switches to the east side of the LADWP R-O-W at mile 5.7, just north of Andrade Corner. At mile 6.8, the line enters and remains mostly in the Angeles National Forest for the next 14.4 miles. This portion of the R-O-W through the Forest would be 160 feet wide. At mile 8.4 and for the next 2 miles, the line crosses U.S. Department of the Interior (USDI), Bureau of Land Management (BLM), and private property near the community of Green Valley before re-entering the Angeles National Forest. At mile 11.8, the line crosses the Midway-Vincent No.1 and No.2 500 kV T/Ls. The line stays on the east side of the LADWP R-O-W until mile 14.0, where it switches to the west side of the R-O-W at Bee Canyon. At mile 18.9, the line crosses a T/L from LADWP San Francisquito Power House No. 2.

The line exits the Angeles National Forest at mile 21.2 and continues on private property for approximately 1.5 miles. This section of new R-O-W would need to be 180 feet wide. The line crosses the Antelope-Pole Switch 74 66 kV line at mile 22.4. At mile 22.8, Alternative 1 terminates at the intersection with the preferred route. If Alternative 1 were selected, the last 5.1 miles to the Pardee Substation would coincide with the proposed route.

3.7.4 Tower, Conductor, and Voltage Options

3.7.4.1 Introduction

As directed by the CAISO, SCE proposes to build the proposed T/L utilizing 500 kV towers and conductors to meet projected future transmission load needs in this service area. As discussed previously, the proposed Antelope Transmission Project – Segment 1 (Antelope-Pardee) would be energized initially at 220 kV.

3.7.4.2 Alternative 2

The proposed Segment 1 (Antelope-Pardee) T/L includes the provision for use of double-circuit, 500 kV towers between Haskell Canyon and Pardee (mile 20.3 to 25.6; refer to Figure 3-2). Alternative 2 would involve the use of single-circuit, 500 kV towers over the entire length of the preferred Segment 1 route (i.e., mile 0.0 to 25.6, including mile 20.3 to 25.6).

The implications of selecting Alternative 2 are:

- Single-circuit towers would be built on the vacant position of the Pardee-Vincent 500 kV R-O-W from Haskell Canyon to Pardee.
- This alternative would eliminate the possibility of a future second Pardee-Vincent 500 kV line by using up a portion of the vacant R-O-W from Pardee to Haskell Canyon. Given the increase in development between Pardee Substation and Haskell Canyon, it would be very difficult and expensive to acquire a new 500 kV R-O-W in the area for future construction of a second Vincent-Pardee 500 kV line. In addition, acquiring a new R-O-W in the area would require the displacement of existing residences and businesses.

- The visual impact of this alternative is different from the proposed double-circuit alternative. The lower conductor elevation would increase visual impact from vistas close to the edge of R-O-W, but the shorter single-circuit LSTs would decrease visual impact from more distant vistas.
- Along portions of the edges of the R-O-W, the magnetic fields would be somewhat higher as compared with the proposed design due to the proximity of new or existing 500 kV T/Ls to the R-O-W edges.

3.7.5 Alternatives Considered But Eliminated

3.7.5.1 Non-Forest Service Land Alternative

The Non-Forest Service Land Alternative consists of an approximately 50-mile-long 500 kV T/L between the Antelope and Pardee Substations which avoids USFS lands. Utilizing existing T/L R-O-W and corridors has long been acknowledged as a means to reduce impacts of proposed new T/Ls.

SCE has two other existing R-O-Ws in the area, the Pardee-Vincent 500 kV T/L R-O-W and the transmission corridor between the Antelope and Vincent Substations, which could be used in conjunction with each other to provide a possible Non-Forest Service Land Alternative.

The Pardee-Vincent 500 kV T/L R-O-W intersects the Angeles National Forest in two locations: 1) south and southwest of the Vincent Substation for approximately 5 miles; and 2) southeast of Vasquez Rocks Park for approximately 1 mile. This route cannot be considered as a Non-Forest Service Land Alternative without diversion around the USFS properties along this R-O-W.

Diversion around the Angeles National Forest on this route would require approximately 5 miles of new R-O-W through developed neighborhoods in the Acton area before rejoining with the existing Pardee-Vincent 500 kV T/L R-O-W and approximately 1 mile of new R-O-W around the USFS property southeast of Vasquez Rocks Park before again rejoining with the existing Pardee-Vincent 500 kV T/L R-O-W.

In order to utilize the Pardee-Vincent 500 kV T/L R-O-W, SCE would require construction of a new T/L between the Antelope and Vincent Substations. This new T/L would compete with the proposed Segment 2 of the Antelope Transmission Project for the acquisition of new R-O-W and delivery of power between Antelope and Vincent Substations. Segment 2 of the Antelope Transmission Project is required to import additional power from future wind farms in the north Los Angeles and east Kern counties and help comply with the requirements of the Renewable Energy and Renewable Portfolio Standard Programs enacted by the California Legislature in 2002 by providing access to new supplies of renewable energy.

Because both the Antelope-Pardee and Antelope-Vincent paths are needed to import power from renewable resources to comply with the requirements of the Renewable Energy and Renewable Portfolio Standard Programs, utilizing the Antelope-Vincent corridor as an alternative to avoiding USFS land is not an environmentally acceptable option compared to the proposed option. Therefore, this alternative has been eliminated from further consideration by SCE.

3.7.5.2 Underground Alternative

3.7.5.2.1 Summary. The Underground Alternative evaluates the proposed project utilizing underground construction in place of overhead line (OHL) construction. SCE was instructed by the California Independent System Operator to construct the Antelope-Pardee T/L to 500 kV design and construction standards to avoid the constructing and tearing down of multiple 220 kV T/Ls. Any underground construction options must meet the requirement for initial operation at 220 kV and ultimate operation at 500 kV.

Underground construction is typically proposed due to the belief that it would have less impact on the environment than overhead lines. Installation of an underground T/L requires grading and clearing of trees and vegetation along the R-O-W prior to trenching (i.e., similar to pipeline construction). Such construction is much more difficult and results in much more land disturbance than overhead lines especially in hilly, rugged terrain where OHLs can typically span ridgetop to ridgetop.

The land that needs to be kept free for overhead lines is usually limited to the towers, which are generally spaced at least every 1,400 to 1,500 feet apart (range of 800 to 2,000 feet) in mountainous terrain and to the access and spur roads built for their construction and maintenance. Whenever possible, existing roads are utilized to minimize new road construction.

However, in forest areas, trees and other vegetation are required to be cleared before the underground construction begins. While in operation, the land required for operation and maintenance must remain free from secondary surface development or lengthy-rooted trees planted along the line route and only restricted vegetation is permitted above the underground route throughout the life of the proposed project. This contributes to a land use similar to that of a secondary road. Also, duct banks, fluid reservoirs, stop joints and/or retaining vaults are required for certain underground technologies, increasing the need for cleared land and continued all-weather access for operation and maintenance.

The installation of an underground T/L would require more time than construction of an equivalent length of overhead line because of the time required for excavating trenches, constructing the duct banks, fluid reservoirs and/or stop joints and the times of the year available for construction, chosen to limit the impacts on the environment.

Four underground technologies for 500 kV are briefly evaluated herein; refer to Section 3.7.5.2.2 for more detail.

1. High-Pressure Fluid-Filled (HPFF) Cables
2. Solid Dielectric (XLPE) Transmission Cables
3. Compressed Gas Insulated Transmission Lines (CGTL)
4. Self-Contained Fluid-Filled (SCFF)

HPFF transmission cable technology is a viable technical candidate with a proven performance record for use to construct underground T/Ls with system voltages of 220 kV, 345 kV, and 500 kV.

However, given the need for a pressurization/pumping plant, the additional maintenance required for the pumping plant and cathodic protection, the possibility for leaks of the dielectric fluid to the environment and the associated greater impact to the environment associated with these as compared to conventional overhead construction as discussed in more detail below, this technology is eliminated from further consideration.

Solid dielectric transmission cable technology is a proven, viable technology for constructing 220 kV underground T/L. Solid dielectric cables are commercially available at 345 kV and have performed well in recent European installations. 500 kV solid dielectric cables and accessories are beginning to be commercially available; however, their long-term reliability is unproven at this point in time. Given this unknown regarding the reliability, this technology is eliminated from further consideration.

Compressed-gas insulated cable technology is a viable technology for constructing 220 kV, 345 kV, and 500 kV underground T/L. This type of underground transmission system can easily match the power transfer capabilities of overhead lines; however, its use has primarily been limited to short installations (less than 1,000 feet) due to its relatively high cost.

With consideration for the potential release of SF6 gas to the atmosphere and the associated environmental impact along with the high cost of this option, this technology is eliminated from further consideration.

SCFF transmission cable technology is a possible candidate with a proven performance record for constructing underground T/L with system voltages of 220 kV, 345 kV, and 500 kV. However, the current trend around the world is to use cable system types other than SCFF for 220 kV and 345 kV cable systems for applications other than submarine cables. This is primarily due to the complexity and higher maintenance of this cable system type.

Given the complexity to design, install, and operate in the rugged terrain between Antelope and Pardee, the relative unproven reliability of 500 kV cables for long T/Ls as discussed in more detail below, this technology is eliminated from further consideration.

Given the potential for increased significant environmental impact associated with the construction, operation and maintenance of an underground T/L, the unproven reliability for long distance underground T/Ls, and the high cost of these technologies, undergrounding of the T/L from Antelope to Pardee is eliminated as an option.

3.7.5.2.2 <u>Evaluation of Underground Option</u>. The USFS has requested SCE to evaluate undergrounding the proposed T/L across USFS lands in the Angeles National Forest. SCE was instructed by the CAISO to construct the Antelope-Pardee T/L to 500 kV design and construction standards to help accommodate up to 4,400 MW of potential new wind generation north of Antelope Substation and to avoid constructing and tearing down multiple 220 kV T/L. Underground technology options must meet this requirement.

Four different types of transmission cables are commercially available in voltages greater or equal to 500 kV. An evaluation of these four alternatives follows.

<u>High-Pressure Fluid-Filled (HPFF) Cables</u>. This type of cable, which is also called pipe-type or high-pressure oil-filled cable, has historically been the most commonly used transmission cable in the U.S. It has been used for approximately 80 percent of the existing transmission cables in this country. In this design, the three high-voltage cables are contained in a coated and cathodically protected steel pipe.

The pipe provides mechanical protection, prevents the ingress of moisture, and is a pressure vessel for maintaining the 200 pounds per square inch gage (psig) nominal operating pressure on the dielectric fluid that surrounds the cables in the pipe. The primary function of the high pressure dielectric fluid surrounding the cables is to insure that there are no electrical discharges in the oil impregnated paper insulation. This is due to the fact that the high pipe pressure causes any gas voids in the insulation to be compressed and eventually absorbed by the dielectric fluid.

A pressurizing plant is required to maintain dielectric fluid pressure and accommodate pipe volume changes under all load conditions. Therefore, the fluid reservoir in the pressurization unit (sometimes called pumping plant) must be sized so that it can accommodate the dielectric fluid which flows back into it from the cable pipe when the cable is operating at maximum operating temperature. At the other extreme, the reservoir must contain some reserve fluid when the cable is at its lowest temperature and the dielectric fluid flows back into the line pipe. A source of power must be available for each of the required pressurization plants separate from the primary cable system.

Both mineral (petroleum base) oils and synthetic dielectric fluids have been used for the pipe filling fluid. Currently, however, HPFF cable systems use synthetic fluids because of their superior electrical characteristics. These synthetic fluids are either polybutene or alkylbenzene or a mixture of both.

The maximum distance between splices, typically between 1,200 and 2,000 feet, is usually determined by the amount of cable stored on a transportation spool or the maximum pulling tension that may be placed on the cables when they are pulled into the pipe. There are two key maintenance items for this type of cable system that are necessary to ensure that it would operate reliably for 40 or more years. First, the fluid pressurization plant must be monitored on a real-time basis with telemetry. This may also require a redundant communication path for gauges and alarms. It must also be checked on a routine basis to make sure that there are no fluid leaks, and that the controls and equipment are functioning properly. The second very important maintenance item is checking that the cathodic protection rectifier and corrosion protection coating are functioning properly. The cathodic protection is typically monitored on a quarterly basis.

HPFF cable systems with system voltages ranging from 69 kV up to 345 kV have been in commercial operation for over 35 years. HPFF cable systems with rated system voltages up and including 765 kV are commercially available and have passed long-term qualification tests.

The primary advantages of this type of cable system are:

- It has proven to be a very reliable system since it was first developed over 50 years ago. The oil-impregnated paper tape construction is more forgiving of minor manufacturing defects than solid dielectric insulation systems.
- In urban areas it has the advantage that streets are open just long enough for welding and burying the cable pipe.

- The steel pipe, which encloses the cables, offers mechanical protection with no added cost.
- The pipe facilitates removal and replacement of the cable if necessary. With the recent development of a new generation of smaller diameter paperpolypropylene- paper (PPP) insulated cables, this presents the possibility of upgrading to a higher voltage level with the same pipe.
- The self-cooled power transmission capability can be significantly increased by cooling and circulating the dielectric fluid inside of the pipe.
- There is domestic supply of this type of cable up to 500 kV, and US-made PPP cable has passed industry tests for 765 kV.
- The external magnetic field is significantly lower than any other form of high voltage power transmission.

The primary disadvantages of this underground transmission system are:

- The larger volume of dielectric fluid in the cable pipe means that there is the potential for a larger release to the environment compared to other cable types. This is of particular consequence when streams or other bodies of water are in the vicinity of the alignment.
- A pressurizing or pumping plant is required to maintain dielectric fluid pressure under all load conditions. These plants would require secondary sources of power at the distribution voltage level.
- The cable system requires significantly more maintenance than solid dielectric cables due to the routine maintenance associated with the fluid pressurization plants and the pipe cathodic protection equipment.
- The cable system requires approximately one day to restore service if there is a total loss of dielectric fluid pressure.
- The current carrying capacity of the cable system is somewhat lower than the other types of cable systems with the same conductor size due to the close proximity of the conductors and magnetic losses in the steel pipe.
- Relatively high charging current and dielectric losses. For long lines, facilities may be required to compensate for the capacitive charging current.
- The availability of skilled cable splicers for this technology is becoming a problem.
- Multiple cables and duct banks would be necessary for the required power transfer capability.

In summary, the HPFF transmission cable technology is a viable candidate with a proven performance record for use to construct underground T/Ls with system voltages of 220 kV, 345 kV, and 500 kV.

However, given the need for a pressurization and pumping plant, the additional maintenance required for the pumping plant and cathodic protection, the possibility for leaks of the dielectric fluid to the environment and the associated greater impact to the environment associated with these as compared to conventional overhead construction, this technology is eliminated from further consideration.

Solid Dielectric (XLPE) Transmission Cables. This type of cable, which is also called extruded dielectric cable, consists of three independent cables. The cable for each of the three phases consists of a stranded copper or aluminum conductor, and extruded semi-conducting conductor shield, the electrical cable insulation (usually cross-linked polyethylene, XLPE), and extruded semi-conducting insulation shield, a metallic shield or sheath, and a plastic jacket. Solid dielectric transmission cables are frequently manufactured with a lead sheath or some other form of radial moisture seal to prevent the exposure of the cable insulation to water. While solid dielectric transmission cables have operated successfully for many years in some areas without such a moisture seal, it is generally accepted that the long-term reliability of solid dielectric cables would be enhanced by the use of a moisture barrier. This is particularly true for solid dielectric cables for the higher transmission voltages. Other optional features of this type of cable are longitudinal water blocking of the conductor and between the cable core and the metallic sheath. This longitudinal water proofing limits the amount of cable that would be contaminated with water in the case of a “dig in” or in the case of a cable fault.

Although ethylene propylene rubber (EPR) insulation has been used for some transmission class solid dielectric cables, XLPE insulation has been used exclusively for solid dielectric cables with system voltages above 138 kV. Consequently, all future references to solid dielectric cable in this document would be synonymous with XLPE-insulated extra high voltage (EHV) transmission cables.

Solid dielectric transmission cables are manufactured with insulation thicknesses that are from 1.5 to 2 times those of oil-impregnated paper insulation. However, the thickness of XLPE insulation used for a given system voltage has decreased over time with improvements in the cable materials and manufacturing technology.

This type of cable has been available for system voltages up to 138 kV since the early 1970s; however, there was a lack of widespread acceptance in this country because of reliability problems with the cable and accessories for some of the initial installations.

However, this trend has changed in the last 10 to 15 years because of good service reliability which as been observed for most installations outside of the US and for an increasing number of installations in the US. Currently, the number of 220 kV to 230 kV solid dielectric cable installations in the US is also increasing with approximately 50 circuit miles in service

Elsewhere, hundreds of miles of 220 kV to 275 kV solid dielectric cable systems have been installed in numerous countries around the world and tens of miles of 400 kV solid dielectric cables have been installed in Europe, Asia, and the Near East. Japan completed installation of the first long-distance (two circuits, 25 miles long) 500 kV XLPE transmission cable system in late 2002.

As with other types of transmission cables, one of the fundamental requirements for reliable operation of this type of cable system is the elimination of partial discharges in the cable insulation. This is accomplished by very close manufacturing control to eliminate any contaminants or voids in the cable insulation. Also, the semi-conducting layers must be manufactured with very smooth surfaces or discharges may occur at these locations.

The primary advantages of extruded dielectric cables are:

- No dielectric fluid or pressurizing equipment is required.
- The insulation dielectric losses are significantly lower than for oil/paper insulation.
- The charging current or volt-amperes reactive (VAR) generated by the cable are significantly less than oil/paper insulation.
- Circuit restoration is quicker and often simpler than for HPFF systems.
- The current ratings are generally higher for than oil-impregnated transmission cables at system voltages at 220 kV and above.
- The cable system design, operation, and maintenance are less complex than systems with pressurized dielectric fluid.

The primary disadvantages of extruded dielectric cables are:

- It does not have the proven long-term reliability record similar to HPFF or SCFF cable systems for system voltages of 345 kV and above.
- It requires extremely good manufacturing process quality control.
- There is only one US manufacturer of extruded dielectric transmission cables with system voltages of 220 kV.

- The high thermal expansion coefficient of the insulation presents special design problems for the metallic sheath and accessories. This results in an operational and performance problem which directly leads to longevity concerns.
- Special skills and proprietary equipment associated with the cable supplier may be required for cable splicing.
- Multiple cables and duct banks would be necessary for the required power transfer capability.

In summary, solid dielectric transmission cable technology is a proven, viable technology for constructing 220 kV underground T/Ls. Solid dielectric cables are commercially available at 345 kV and have performed well in recent European installations. 500 kV solid dielectric cables and accessories are beginning to be commercially available; however, their long-term reliability is unproven at this point in time. Given this unknown regarding the reliability, this technology is eliminated from further consideration.

Compressed Gas Insulated Transmission Lines (CGTL). The compressed-gas insulated T/L has primarily been used in applications where high power transfer is required, such as short dips in overhead lines or relatively short substation connections (get-aways) to overhead lines.

This type of underground transmission system has been developed with two different configurations. In the three-conductor configuration the three high voltage conductors are contained in a single cylindrical aluminum enclosure. In isolated phase systems the high voltage conductors for each of the three phases are contained in separate cylindrical aluminum enclosures. In both cases epoxy spacer insulators support the high voltage conductor(s) inside of the enclosures that are filled with sulfur hexaflouride (SF6) or a mixture of SF6 and nitrogen (N_2) gases. The first CGTL systems were designed with SF6 gas at pressures from 40 to 60 psig. More recent systems of this type have reduced the SF6 content to 20 percent with the remainder being nitrogen. This change in the insulating gas was due to a combination of increasing cost for the SF6 gas and environmental concerns (depletion of the earth’s ozone layer).

The compressed gas-insulated lines are typically manufactured in straight rigid sections ranging in length from 40 to 60 feet with field welds required to connect the enclosures for adjacent sections. The aluminum enclosure (typically about 19 inches in diameter for a system voltage of 220 to 275 kV) is coated with corrosion protection for applications where the three enclosures are directly buried.

The CGTL can be installed in concrete-covered trenches, directly buried, or installed in tunnels. The primary application for this type of underground transmission is the transfer of large amounts of power at system voltages up to 500 kV. The ampacity rating of CGIT transmission systems is in the order of 3000 to 5000 amperes or 1140 to 1900 MVA at a system voltage of 220 kV.

Relatively short lengths (i.e. less than 1,000 feet) of the 100% SF6 compressed-gas underground T/Ls have been installed in the US, Japan, and European countries for several decades. One 275 kV system, installed in a tunnel with other utilities in Nagoya, Japan, is 2 miles long.

The system voltages for these installations have been from 138 kV up to 765 kV. The first commercial application of the second generation CGTL technology was the construction of a "dip" in an existing 400 kV overhead T/L in Geneva, Switzerland in 2000.

The primary advantages of this type of cable system are:

- Power transfer capabilities that are significantly higher than those for other types of underground transmission.
- Relatively simple system design.
- Relatively low magnetic field levels.
- The charging current or VAR generated by the cable is significantly less than all other types of underground transmission systems.
- Dielectric losses (no-load losses) are very low compared to oil/paper cable systems.

The primary disadvantages of compressed-gas insulated transmission systems are:

- Relatively high cost.
- Environmental concerns about releases of SF6 gas to the environment.
- A relatively high amount of field assembly work is required.
- Less flexibility in avoiding other underground obstacles.
- Larger right-of-way required compared to other underground cable systems.
- System reliability is sensitive to contaminants introduced during field assembly.

In summary, compressed-gas insulated cable technology is a viable technology for constructing 220 kV, 345 kV, and 500 kV underground T/Ls. This type of underground transmission system can easily match the power transfer capabilities of overhead lines; however, its use has primarily been limited to short installations (< 1,000 feet) due to its relatively high cost.

With consideration for the potential release of SF6 gas to the atmosphere and the associated environmental impact along with the high cost of this option, this technology is eliminated from further consideration

Self-Contained Fluid-Filled (SCFF). This type of cable, which is sometimes simply called self-contained cable, consists of three independent cables. The cable for each of the three phases consists of a hollow conductor, which is filled with dielectric fluid, high quality kraft paper (or PPP) insulation, outer shielding, and a lead or aluminum sheath which is covered by a plastic (polyethylene or PVC) jacket. In this construction the metallic sheath serves both as a hermetic moisture seal, and as a pressure containment vessel since the dielectric fluid in the cable is pressurized at 25 to 50 psig. In the case of lead, bronze tapes are frequently required to strengthen the lead sheath and to keep it from deforming due to the cable pressure. The thickness of the oil impregnated paper insulation is approximately the same as used for HPFF cables. SCFF cables systems use low viscosity synthetic cable dielectric fluids, typically alkylbenzene.

The cable may be directly buried in the earth or it may be installed in concrete-encased duct banks to avoid long lengths of open trench. Since elevation changes along the cable route can significantly affect the fluid pressure, fluid reservoirs and stop joints are required along the length of the cable circuit (typically at each splice location) to segregate the cable into several hydraulic zones. If the cable route is relatively level, then the distance between fluid reservoirs is dictated by the pressure drop along the fluid duct during expansion and contraction of the fluid during temperature excursions. In no case, should the pressure be allowed to drop below a minimum level (10 or 15 psig) nor should it be allowed to increase above the maximum allowable pressure determined by the hoop strength of the sheath.

While this type of cable has been used extensively outside of the US, it currently makes up less than five percent of the transmission cable in this country. This cable has been manufactured for system voltages from 69 kV up to 500 kV. There is one relatively short 500 kV SCFF cable installation in the US. Long submarine cable circuits are one application where this type of cable has definite advantages over the other types of cables. This is due to the fact that there are overseas submarine cable factories that have the capability of manufacturing this type of cable in lengths exceeding five miles in length – thus avoiding the necessity of having field- or factory-installed joints.

As in the case of HPFF cables, SCFF cables are designed with quite high electrical stresses and the cable dielectric fluid must be pressurized to suppress ionization – otherwise an electrical breakdown would occur.

The primary advantages of this type of cable system are:

- Good long-term reliability.
- Higher rating than pipe-type cables, if directly buried.
- Domestic supply available.
- Dielectric fluid is present, but in much smaller quantities than HPFF cables.
- Can be manufactured in very long lengths without splices for submarine cable applications.

The primary disadvantages for this cable type are:

- Historically higher maintenance than HPFF or solid dielectric cable systems.
- More complex to design and operate compared to solid dielectric cable systems.
- Concerns about dielectric fluid leaks.
- Relatively high charging current and dielectric losses.
- Higher magnetic fields than HPFF cable systems.
- The availability of skilled cable splicers for this technology is becoming a problem.
- Multiple cables and duct banks would be necessary for the required power transfer capability.

In summary, the SCFF transmission cable technology is a possible candidate with a proven performance record for constructing underground T/Ls with system voltages of 220 kV, 345 kV, and 500 kV. However, the current trend around the world is to use cable system types other than SCFF for 220 kV and 345 kV cable systems for applications other than submarine cables. This is primarily due to the complexity and higher maintenance of this cable system type.

Given the complexity to design, install and operate in the rugged terrain between Antelope and Pardee, the relative unproven reliability of 500 kV cables for long T/Ls, this technology is eliminated from further consideration.

3.7.5.2.3 **Conclusion.** Given the potential for increased significant environmental impact associated with the construction, operation and maintenance of an underground T/L, the unproven reliability for long distance underground T/Ls, and the high cost of these technologies, undergrounding of the T/L from Antelope to Pardee has been eliminated as an option for further consideration.