Appendix B.

Avian Risk Assessment

Appendix B. Avian Risk Assessment

B.1 Introduction

Utility structures can benefit birds by providing perching, roosting, or nesting structures in areas where few natural perches, roost sites, or nest sites exist. Utility structures also can pose a risk to birds through collisions and electrocutions. This report analyzes potential collision and electrocution risks to birds associated with SCE's Tehachapi Renewable Transmission Project (TRTP) located between eastern Kern County and the Los Angeles Basin in southern California (proposed Project). Appropriate mitigation measures are proposed for incorporation into the project and/or conditions of approval to minimize or avoid these risks. Other adverse impacts such as habitat loss and fragmentation, construction-related disturbances, and increased predation on special-status species may also occur. These impacts are addressed in Section 6 of the Biological Specialist Report.

To assess the avian collision and electrocution risks of the proposed Project, it is helpful to understand how such risks compare with similar, human-related, bird mortality sources. Erickson et al. (2005) estimated that annual bird mortality from human-related causes may approach 1 billion birds per year in the United States (Table B-1). Buildings, power lines, and domestic cats were estimated to comprise approximately 82 percent of the mortality, while vehicles, pesticides, communication towers, and wind turbines comprised approximately 16 percent.

Table B-1. Estimated Avian Deaths in the United States by Hazard Type

Hazard	Estimated Annual Deaths*	Percent Composition
Buildings	550 million	58.2
Power lines	130 million	13.7
Cats	100 million	10.6
Automobiles	80 million	8.5
Pesticides	67 million	7.1
Communication towers	4.5 million	0.5
Wind turbines	28.5 thousand	<0.01
Airplanes	25 thousand	<0.01
Other sources (oil spills, by-catch, etc.)	not calculated	not calculated

* Source Erickson et al. 2005.

Estimates of the number of bird fatalities specifically attributable to interactions with utility structures vary considerably. Nationwide, it is estimated that hundreds of thousands to as many as 175 million birds are lost annually to fatal collisions with transmission and distribution lines (Erickson et al. 2001). In California, even general estimates are unavailable, although it is plausible that such collisions result in the deaths of hundreds of thousands of birds each year (Hunting 2002). Power line electrocutions result in additional losses in the range of tens to hundreds of thousands of birds annually in the United States (Erickson et al. 2001). Fatal collisions and/or electrocutions with utility structures have been documented for about 350 avian species nationwide (Manville 1999).

Despite these seemingly high numbers, bird deaths due to collisions and electrocutions associated with electrical utility structures have generally been considered an insignificant source of mortality at the population level (Bevanger, 1994). However, electrical utility structures can adversely impact birds and contribute to additive effects of human-related mortality factors such as collisions with buildings and automobiles and pesticides. Due to local differences in bird species composition, bird concentration and movement patterns, habitats, area topography, facility design, and weather, each impact site is unique. Thus, avian interactions with transmission lines and structures and the risks those interactions impose vary greatly by location within the proposed Project and requires individual evaluation.

Location-specific data in this report were gathered over five days during the fall avian migration period. Although the number of bird species and individuals of those species present within the proposed Project are generally highest during fall migration (Garrett and Dunn 1981), our sample provides only an index of avian species diversity and individual bird abundance at the sites evaluated. Information regarding bird-utility interactions where transmission lines currently exist, exact breeding and wintering bird populations, local flight and foraging patterns, prey populations, and in some cases specific tower and line placement is not available. Gathering such data requires an extensive commitment of time and resources, and the results are often inconclusive. This report, therefore, relies heavily on an assessment of local conditions during the survey period and assumptions about potential risks based on previous studies in California and elsewhere.

B.2 Project Description

The proposed Project includes a series of new and upgraded high-voltage electric transmission lines and substations to deliver electricity from wind farms in eastern Kern County, California to the Los Angeles Basin. The duration of the proposed construction for this project is 55 months and is estimated to begin in May 2010 and last 52 months. The purpose of the proposed Project is to provide the electrical facilities necessary to integrate levels of new wind generation in excess of 700 megawatts and up to approximately 4,500 megawatts in the Tehachapi Wind Resource Area. The major components of the proposed Project have been separated into seven distinct segments (see Figure B-1) to coincide with the development of independently owned wind farms. Six alternatives, including a no project alternative, also are being considered. Additional Project detail is provided in Section 1.2.2 of the Biological Specialist Report and in Section B.7 below.

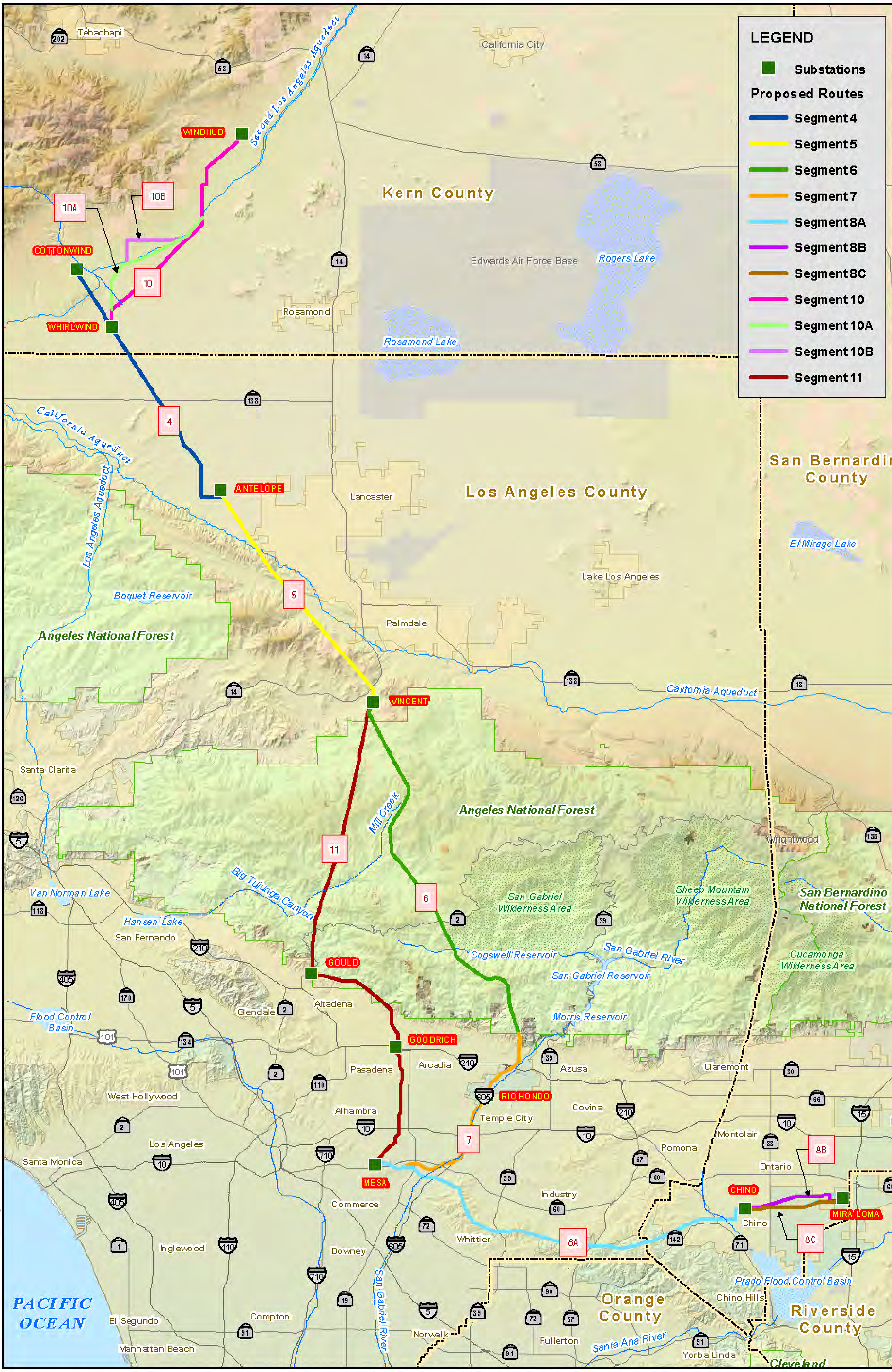
B.2.1 Regional Setting

The proposed Project includes approximately 173 miles of new and existing rights-of-way from the Tehachapi Wind Resource Area in southern Kern County south through Los Angeles County and the ANF and east to the existing Mira Loma Substation in Ontario, California (Figure B-1). Seven preferred route segments and 6 alternatives, including a no project alternative, were evaluated. The proposed Project crosses three biogeographic regions: the Northern Region (Mojave Desert), Central Region (San Gabriel Mountains), and Southern Region (Los Angels Basin). More than 40 vegetation types have been identified in the proposed Project, including Mojave creosote bush scrub, Joshua tree woodland, and desert saltbush scrub in the Northern Region; bigcone Douglas fir-canyon oak forest, Coulter pine forest, and scrub oak chaparral in the Central Region; and coastal sage scrub, southern arroyo willow riparian forest, and disturbed/developed in the Southern Region.

B.4 Methods

B.4.1 Literature Review and Field Surveys

This study was conducted in September 2007. Methods included a literature review of pertinent data on bird collisions and electrocutions associated with utility lines and structures and field surveys to assess local conditions and risks. Field surveys, which focused on collision risks, were conducted 17 through 21 September. Surveys were conducted at times throughout the day, from early morning to late afternoon. Prior to these surveys, sites of potentially increased risk for avian collisions with transmission lines were located on aerial



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N 0 3 6 12 Miles

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Figure B-1
TRTP Location Map

photographs. Locations of these sites are depicted in Figure B-2 (Northern Region), Figure B-3 (Central Region), and Figure B-4 (Southern Region). In selecting these sites, particular attention was given to situations where transmission lines would cross ridgelines, parallel ridgelines, cross rivers or mountain passes, or would be adjacent to freshwater marsh, water, or riparian habitats (Table B-2). Lines crossing or running parallel to ridgelines are a potential threat because birds of prey, vultures, and other soaring birds use thermal updrafts that often form along ridgelines. Daytime migratory birds such as hawks and vultures also follow ridgelines during migration, other species follow rivers and streams during migration, and large numbers of birds are attracted to aquatic habitats. Sites identified using aerial photographs were then surveyed. Sites were evaluated by two qualified ornithologists, equipped with binoculars, for 15 to 60 minutes based on the complexity of conditions encountered. Those sites considered to pose higher potential risks were evaluated for a longer duration than those with fewer potential risks. The level of potential risk was evaluated based on (1) the location of the proposed lines relative to the geographic features identified above, (2) the numbers and types of birds detected at the sites, (3) avian activity patterns observed (e.g., soaring raptors, flocking water birds), and (4) an assessment of the potential for weather variables, such as high winds or fog, to increase the risk.

Table B-2. Type of Risk Associated with Avian Risk Assessment Survey Locations by Region

Survey Location	Type of Risk			
	Line Crosses or Approaches Riparian Habitat	Line Crosses or Approaches Open Water/Wetland Habitat	Line Crosses Exposed Ridge	Line Parallels Ridge
Northern Region				
1	X			
Central Region				
1			X	
2	X			
3				X
4				X
5	X			
6	X			
7			X	
8			X	
9	X			
10	X			
11	X			
12	X			
13				X
14	X			
15	X			
16	X			
17			X	
18	X			
19	X			
20			X	
21			X	
Southern Region				
1	X			
2		X		
3		X		
4		X		
5	X			
6		X		

Table B-2. Type of Risk Associated with Avian Risk Assessment Survey Locations by Region				
Survey Location	Type of Risk			
	Line Crosses or Approaches Riparian Habitat	Line Crosses or Approaches Open Water/Wetland Habitat	Line Crosses Exposed Ridge	Line Parallels Ridge
7		X		
8	X			
9	X			
10		X		

B.5 Results

B.5.1 Literature Review

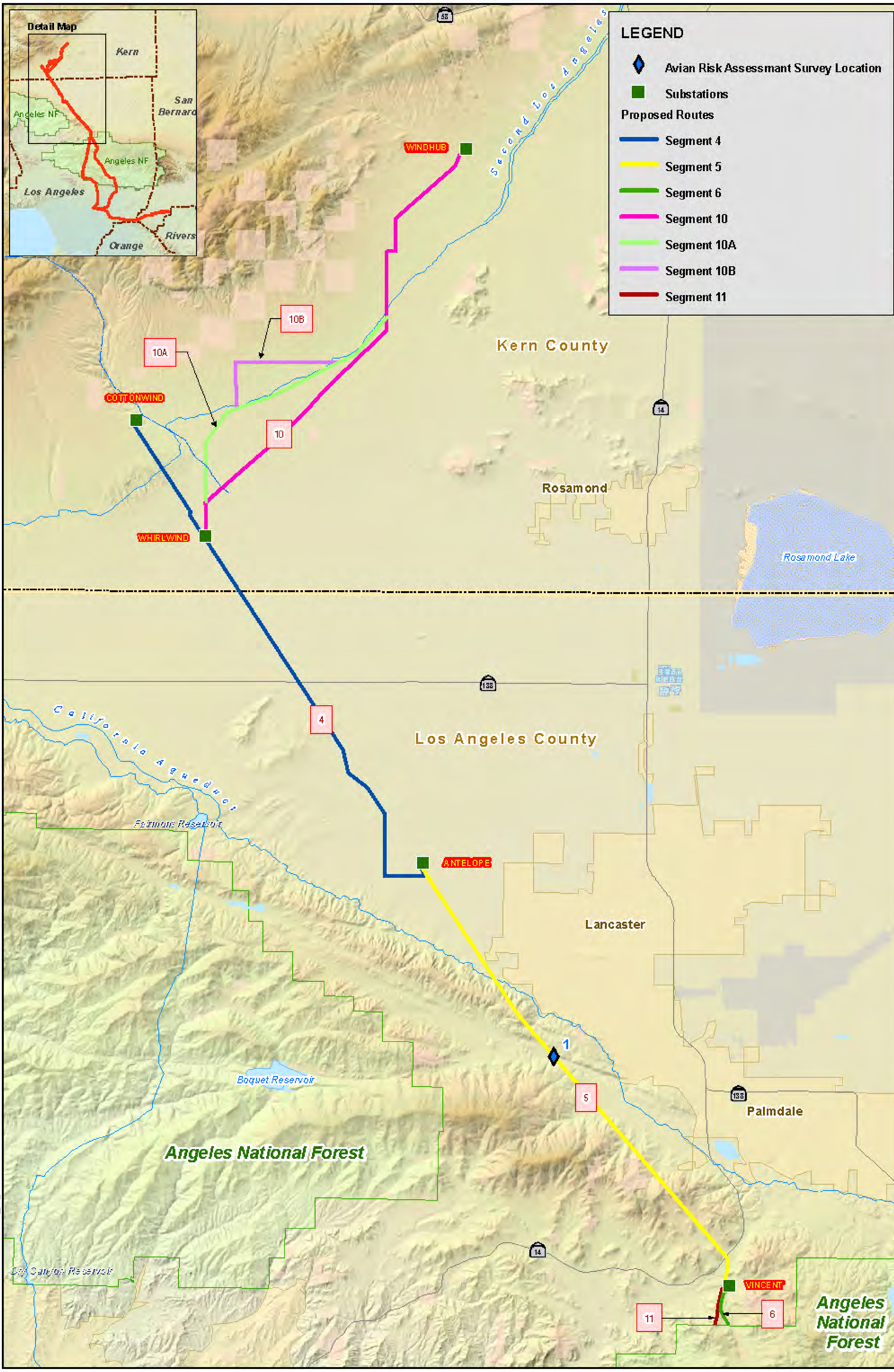
B.5.1.1 Bird Collisions

Avian mortality from collisions with power lines, including both transmission and distribution lines, is well documented (Walsinshaw 1956, Cornwell and Hochbaum 1971, Tacha et al. 1978, Malcom 1982, Faanes 1987, Morkill and Anderson 1991). For most species involved in collisions, such mortality does not have population level effects (Beaulaurier 1981, Brown 1993, Faanes 1987, Hugie et al. 1993). Although rarely affecting healthy populations with good reproductive potential, collision mortality can be biologically significant to local populations (Beer and Ogilvie 1972) and endangered species (Thompson 1978, Faanes 1987). Power lines were the greatest cause of mortality, for example, for fledged whooping cranes (*Grus americana*) in the introduced Rocky Mountain population (Brown et al. 1987). Research on bird mortality caused by collisions with power lines has been published internationally, including in the United States (e.g., Brown and Drewien 1995, Savereno et al. 1996). Potential impacts of transmission lines on bird mortality have been studied extensively along the West Coast in particular (TES 1989, 1990; Willdan Associates 1982; Arend 1970; Meyer 1978; Williams and Colson 1988). The results of these studies show that many different species are involved in collisions, including a disproportionate representation of species with restricted flight performance (See Factors Affecting Risk below).

Flying birds generally depend on free air space for their movements. Although flight in obstructed terrain is a finely tuned balance, with an ever-present risk of collision, several species have evolved sophisticated behavioral and biomechanical adaptations for moving around in structurally complex habitats. A steadily growing number of human-created obstacles have increased the collision hazards for birds, particularly through the erection of overhead wires for energy transmission and telecommunication (e.g., Avery et al. 1980, Trapp 1998). Collision risk is affected by physical, biological, and behavioral factors, as outlined below.

Factors affecting risk

Line placement. Transmission lines that transect or parallel areas concentrating birds (e.g., wetlands, riparian areas) or those separating areas used for different life history functions (e.g., breeding, foraging, roosting) are the most hazardous. Collisions are more probable near wetlands, valleys that are bisected by transmission lines, and within narrow passes where transmission lines run perpendicular to flight paths. Placing transmission lines close to regular flight paths is likely to increase risk simply because of the frequency of crossings made.



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N 0 1.5 3 6 Miles

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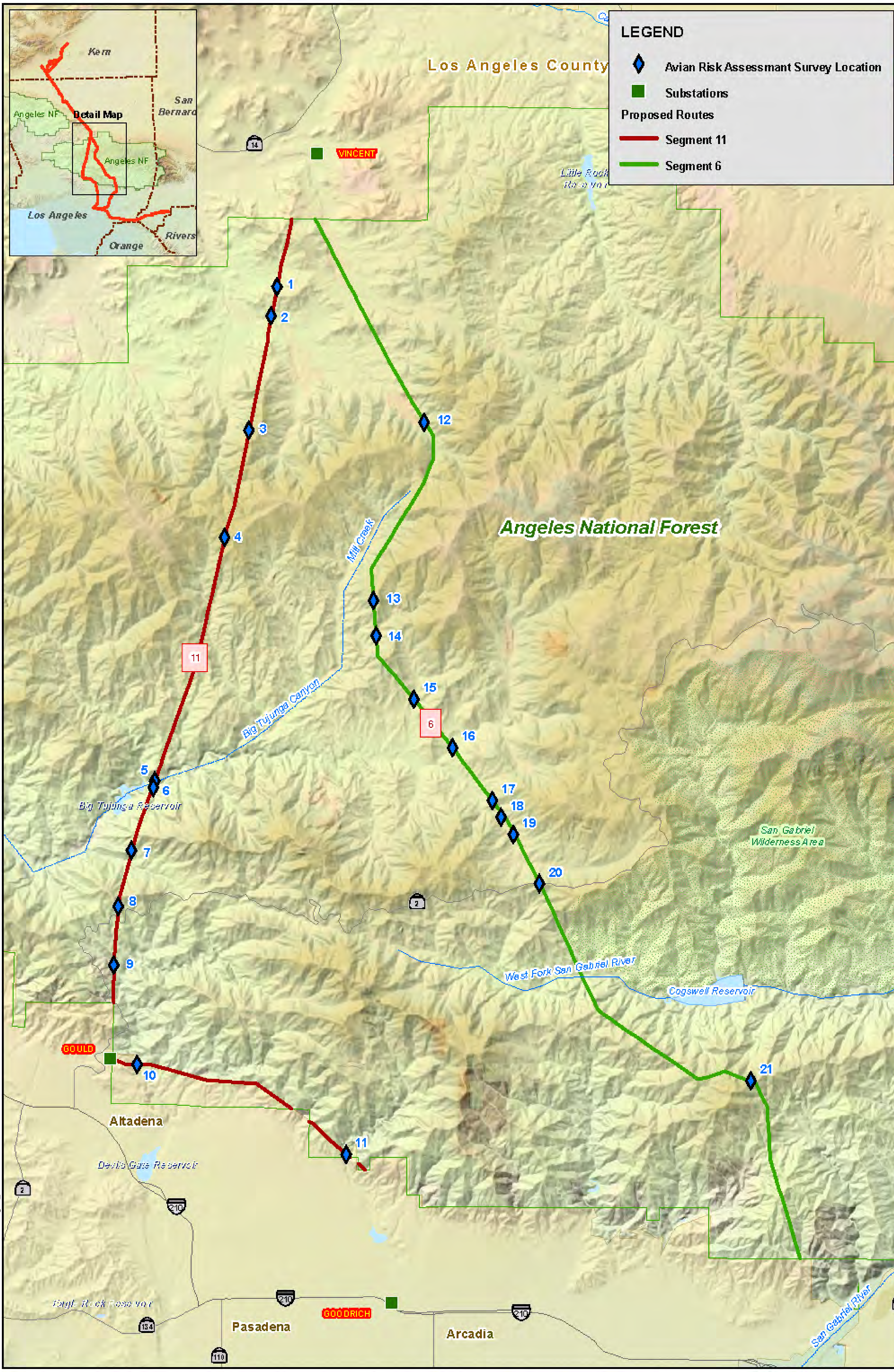
Figure B-2
Northern Region Survey Locations



Prepared for Aspen Environmental Group

N 0 0.9 1.8 3.6 Miles

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Figure B-3
Central Region Survey Locations

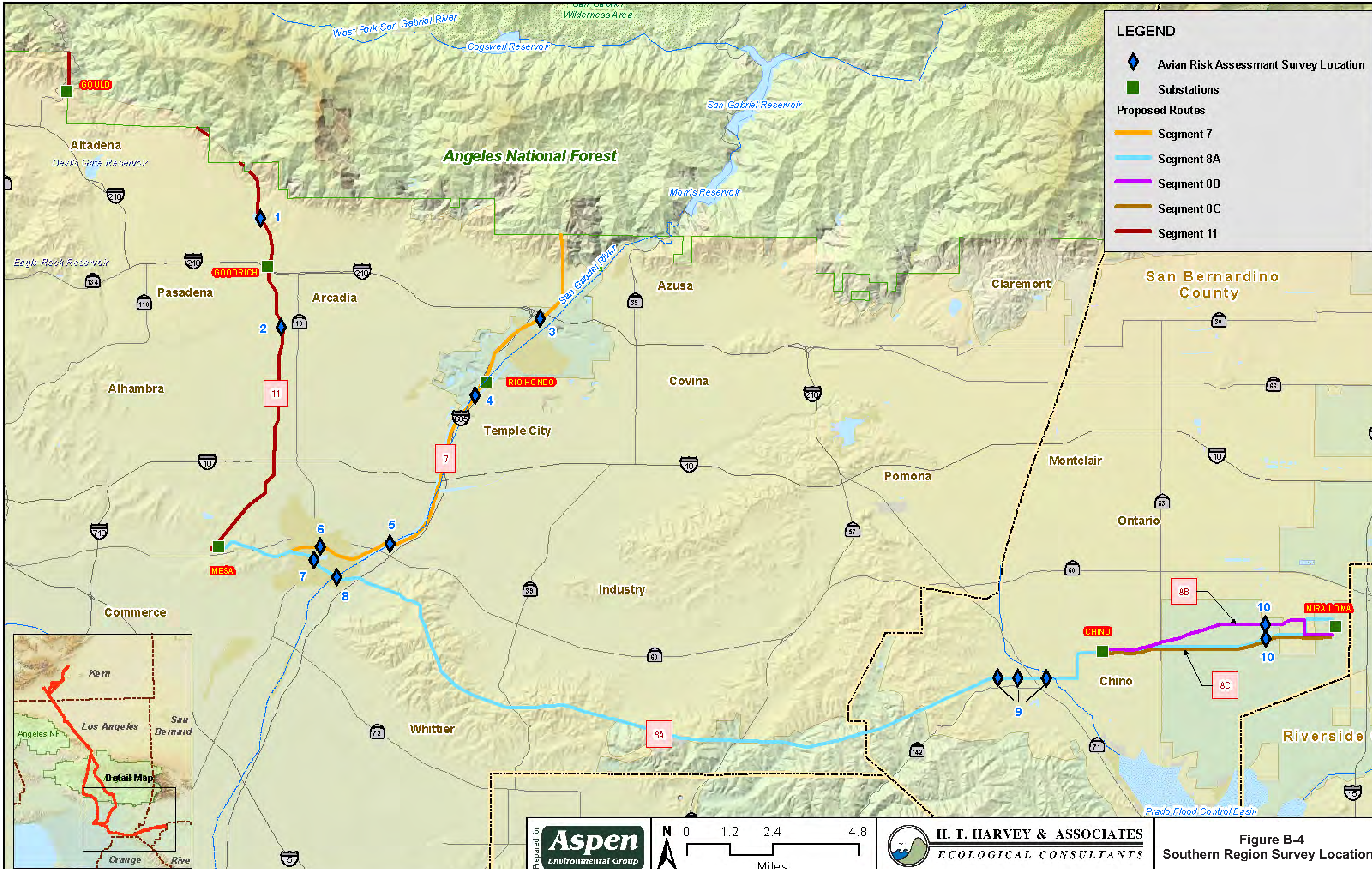

Figure B-4
Southern Region Survey Locations

Line type and configuration. The type and configuration of transmission lines is a factor that influences avian collision risk. Ground wires, which are smaller, less visible, and located above conductors and towers cause the majority of avian collision mortalities (Henderson et al., 1996; Beaulaurier et al., 1982; James and Haak, 1979). The number of cable levels also may influence collision risk, with more levels resulting in higher risk, apparently because only a small change in flight altitude is needed to avoid cables on one level. However, little is known about the influence of power line design on collision rates, and available data are equivocal. For example, Janns and Ferrer (1998) did not find differences in collision mortality between three power lines with different designs.

Weather. Collision risk generally increases with decreased visibility as a result of low light conditions, rain, snow, or fog. High winds can also increase risk by blowing birds into wires. In one study in Colorado, collisions occurred more frequently on days with winds >15 miles per hour (Brown and Drewien, 1995). Migrants also tend to fly at lower altitudes during periods of low clouds, rain, or fog, and such behavior may increase their frequency of encounters with power lines and therefore their risk of collision.

Age. There are a high percentage of juveniles among avian collision victims. Three factors may account for this pattern: (1) juveniles normally constitute the majority of bird populations, especially in fall; (2) juveniles generally have poorer flying abilities than adults; and (3) juveniles generally are less aware of hazards than adults. Although all three factors may contribute to increased collision risk, the latter two are perhaps best documented. The proportion of juvenile Sandhill cranes (*Grus canadensis*) killed by power lines during a study in Colorado, for example, was higher than their proportion in the population (Brown and Drewien, 1995). Juvenile common terns (*Sterna hirundo*) in North Whales reacted late to wires, and many needed a second attempt at clearing them. Juvenile terns were, therefore, more at risk from collision than adults either because of their naivety or because of their poorer flying skills (Henderson et al., 1996).

Flight performance. A bird's flight performance, specifically its maneuverability, has been shown to be one of the most important factors determining the risk of collision with a power line (Bevanger, 1994, 1998; Saverno et al., 1996). Empirical data and theoretical consideration indicate that species with high wing loading and low aspect ratio (i.e., species with large, heavy bodies and comparatively small wings) run a high risk of colliding with power lines. These birds are characterized by rapid flight, and the combination of a heavy body and small wings restricts swift reactions to unexpected obstacles. Within this category, some Anseriformes (ducks, geese, and swans), Pelecaniforms (pelicans and cormorants), Ciconiiformes (herons, egrets, and ibises), and Gruiformes (coots, rails, and cranes) are particularly susceptible to collisions with power lines.

Behavior. Roosting, feeding, breeding, and flying behavior are key collision risk factors. Bird collisions generally occur when: (1) birds cross power lines in daily use areas (e.g., while moving between foraging and roosting habitat), and (2) migrants encounter lines while traveling at reduced altitudes (Brown, 1993). Therefore, collision risk is higher for species whose foraging, breeding, and/or roosting areas are geographically separated and for migrants that fly at low altitudes. Passerines and waterfowl are known to collide with wires during nocturnal migration or poor weather conditions (Avery et al., 1978). However, passerines and waterfowl have a lower potential for collisions than larger birds, such as raptors. Some behavioral factors contribute to a lower collision mortality rate for these birds. Passerines and waterfowl tend to fly under power lines, while larger species generally fly over lines, where they risk colliding with higher ground wires (See *Line type and configuration* above). Also, many smaller birds tend to reduce their flight activity during poor weather conditions (Avery et al., 1978). Aerial hunters such as raptors possess excellent flying abilities. However, they spend a major part of their life in the air, and the probability of crossing power lines (and colliding) is higher compared to ground-dwelling species, which may explain why aerial predators are regularly recorded as collision victims, although in seemingly small numbers. Likewise, gulls are frequent collision victims, presumably because they spend much of their time in the air, are social, and numerous—traits that increase collision risk compared with more solitary, terrestrial species. The influence of social behavior on collision risk is well illustrated by comparing eagles and cranes. Eagles are rarely reported as collision victims probably due to both low exposure (i.e., low number of crossings per day) and their solitary habits. Cranes, on the other hand, are regularly reported as collision victims. Not only are they often exposed to risk by daily flock movements between feeding, breeding, and roosting areas, but possibly also because those birds at the rear of the flock are relatively unaware of oncoming obstacles (APLIC, 1994). Furthermore, reaction studies (James and Haak, 1979) have revealed significant variations in the reaction of birds when approaching a power line, indicating possible differences in perception, even among individuals of the same species. Collision risk also increases during panic flushes when birds are startled by a disturbance or are fleeing from danger.

Although some migrants are susceptible to collision with power lines, most fly well above transmission lines, which generally are below 250 feet above ground level. Except for landing and taking off, few migrants are below about 500-600 feet above ground level (Kerlinger, 1995; Kerlinger and Moore, 1989).

Determining the extent of collisions

A large amount of published and unpublished literature exists on avian collisions with utility structures. However, calculating accurate numbers of bird fatalities associated with these collisions is difficult due to limitations in scope of most mortality studies, as compared to the extensive distribution and extent of these structures. Most studies lack standardized methods for searching and often do not consider sources of bias such as scavenging and searcher efficiency. Many studies are limited to documenting avian collisions within a particular season or at a specific location. For example, many studies are limited to fall migration periods. Furthermore, many of the studies were conducted in response to suspected or actual large mortality events and focus on areas where the number of fatalities may be unusually high. For example, many power line studies involved monitoring fatalities associated with lines near wetlands with high waterfowl use. Estimating the annual fatality rate for any of these sources requires a random, or at least representative, sample of experimental units (e.g., miles of transmission lines) with information replicated across time. However, due to logistical and financial constraints, a large representative sample of experimental units for each source has not been studied.

The actual impact of collisions on species populations, even at a local level, cannot therefore be accurately assessed due to the difficulty in obtaining true measures of mortality rates. The large uncertainties associated with estimates of mortality from one or multiple sources, along with even larger uncertainties in bird populations (e.g., size, reproduction), makes it extremely difficult to understand the biological significance of collision-related mortality on birds at a population, regional, or even local level. Very few studies have attempted to determine the significance of collision-related mortality at a population level of an individual species. Based on an intensive radio-telemetry study of a population of golden eagles at the Altamont Pass wind farm in northern California, it was determined that the wind farm was currently not causing a population-level decline, but the long-term impact was unknown (Hunt, 2002). This study of a relatively small and definable population of eagles was expensive, relatively short-term, and not conclusive. Yet such research and monitoring efforts need to continue and expand so that we can better understand the levels and significance of collision-based mortality and apply the most appropriate and effective mitigation measures. This type of research and monitoring was beyond the scope of the present study.

Managing Risks

Potential for collisions in avian concentration areas can be reduced by management practices such as manipulating habitat to reduce bird flights over lines, using vegetation and topographic features to encourage birds to fly above lines, and reducing human disturbance (Thompson, 1978; Brown, 1993). However, such options may be limited by land use, land ownership, and topography. Options for line modification include undergrounding lines, removing the uppermost ground wire, and line marking (Beaulaurier, 1981). Burying lines underground, although it eliminates collision risks, creates other risks to wildlife habitat and human safety and is often not feasible from technical and economic perspectives. Marking lines with bird flight diverters, which alert birds to the presence of power lines and provide them with more time to avoid the collision, appears to be an effective and relatively inexpensive way of reducing collision mortality (Morkill and Anderson, 1991; Brown and Drewien, 1995). Because mitigation measures only reduce collision mortality, rather than eliminate it, adequate route planning of power lines is especially important. The Avian Power Line Interaction Committee (APLIC), a consortium of investor-owned and independent utilities, government agencies, and private conservation groups, promotes industry and public awareness of avian-power line problems and their solutions through research, product testing, and education. Their recent publications (see www.aplic.org) provide recommended measures to minimize and/or avoid impacts to birds resulting from collisions.

Summary

Bird collisions with power lines generally occur when (1) a power line or other aerial structure transects a daily flight path used by a concentration of birds, and (2) migrants are traveling at reduced altitudes and encounter tall structures in their path (Brown, 1993). Collision rates generally increase in low light conditions, during inclement weather, such as rain or fog, during strong winds, and during panic flushes when birds are startled by a disturbance or are fleeing from danger. Body size, maneuverability, and height that birds fly also contribute to collision risk. Collisions are more probable near wetlands, valleys that are bisected by power lines, and within narrow passes where power lines run perpendicular to flight paths. Some bird species, particularly some waterfowl, are prone to collisions with transmission lines, especially the ground wires at the top of towers (Meyer, 1978; James and Haak, 1979; Beaulaurier, 1981; Beaulaurier et al., 1982; Faanes, 1987). Raptor species are less likely to collide with power lines, perhaps due to their excellent eyesight and tendency to not fly at dusk or in low visibility weather conditions (Olendorff and Lehman, 1986). Smaller migratory birds are at risk but generally not as prone to collision because of their small size, their ability to quickly maneuver away from obstacles, and the fact that they often migrate high enough above the ground to avoid transmission lines. Flocking species with limited maneuverability, such as many water birds, are at higher risk of power line collision than other species, particularly where they encounter power lines in daily use areas, and especially in low light conditions.

B.5.1.2 Bird Electrocutions

Electrocution of birds may take place when a bird touches two conductors or one conductor and a grounded device simultaneously, especially when the feathers are wet. Hence, body size and behavior, such as perching and roosting on poles and wires, are the keys to understanding why and how birds become electrocuted. Birds smaller than an American crow (*Corvus brachyrhynchos*) have a reduced chance of becoming electrocuted because the conductors and grounded wire and devices are generally too far apart. Flocks of birds, such as European starlings (*Sturnus vulgaris*) crossing a power line (and when several roosting birds take off simultaneously) have resulted in short circuits, as the current can pass through several individuals. Due to the differences in distribution and transmission line structure and conductor configurations, electrocutions of even very large birds on transmission lines are rare events (APLIC, 2006). Distribution lines (generally defined as lines carrying less than 69 kV) often have conductors mounted close to and above cross-arms. Poles on distribution lines often have switches, transformers, and other structures where birds could contact wires or metal pieces and be electrocuted. Modern transmission lines, with their greater insulator lengths and distances between metal structures and conductors, generally are not responsible for electrocutions, even in large birds. Electrocution is mainly a problem associated with distribution lines and structures; the risk of electrocution associated with transmission lines is extremely low (APLIC, 2006). Therefore, because of the extremely low risk, there is no further discussion of this topic in this report. For details about utility-associated electrocution risks and bird-safe utility structure designs, see www.aplic.org.

B.5.2 Field Surveys

A total of 32 sites with conditions identified as potentially high risk for collisions were surveyed (Table B-2). These included one in the Northern Region (Figure 2), 21 in the Central Region (Figure 3), and 10 in the Southern Region (Figure 4). Three of these sites (one in the Central Region and two in the Southern Region) were not accessible due to steep topography. These sites were observed from a vantage point above the actual location, and any birds associated with those sites were beyond adequate detection distance. Among the 29 accessible sites, a total of 102 bird species were observed (Table B-3). Three bird species were observed at the one site in the Northern Region. Bird species observed in the Central Region ranged from 2 to 14 per site and averaged 5.4 per site, while those in the Southern Region ranged from 2 to 54 per site and averaged 24 per site. Bird species richness at sites in the Southern Region averaged more than four times higher than sites in the Central Region. This difference results largely from the occurrence of lowland riparian and open water/wetland habitats in the Southern Region, which attract large numbers of species. The greatest number of species observed were at two sites at Legg Lake, where 53 and 54 bird species were noted during field surveys. Several species detected during field surveys are considered vulnerable to line collision based on their limited maneuverability and/or flocking flight behavior (Table B.3). These include pied-billed grebe (*Podilymbus podiceps*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), black-crowned night-heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), mallard (*Anas platyrhynchos*), cinnamon teal (*Anas cyanoptera*), common moorhen (*Gallinula chloropus*), American coot (*Fulica americana*), black-bellied plover (*Pluvialis squatarola*), killdeer (*Chardrius vociferus*), black-necked stilt (*Himantopus mexicanus*), greater yellowlegs (*Tringa melanoluca*), western sandpiper (*Calidrus mauri*), least sandpiper (*Calidrus minutilla*), long-billed dowitcher (*Limnodromus scolopaceus*), ring-billed gull (*Larus delawarensis*), red-winged blackbird (*Agelaius phoeniceus*), and Brewer’s blackbird (*Euphagus cyanocephalus*). Further details about the conditions and risks observed during field surveys are included by region in Section B.7.

B.6 Applicable Laws and Regulations

B.6.1 Federal

In the United States, virtually all native birds are considered migratory, and as such, are protected under the Migratory Bird Treaty Act (MBTA; 16 U.S.C. 703-712). The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute wherein proof of intent is not an element of a “take” violation. The word "take" is defined as “to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." Most actions that result in take (permanent or temporary) of a protected species can be a violation. Specifically, the MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior.

Table B-3. Bird Species Observed During Avian Risk Assessment Surveys

Species Observed by Survey Location	Northern Region	Central Region																					Southern Region									
	1	1	2	3	4	5	6	7	8	9*	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3*	4*	5	6	7	8	9	10
Pied-billed Grebe[1]																								X			X	X	X			
Double-crested Cormorant[1]																								X				X	X			
Great Blue Heron[1]																											X	X	X			X
Great Egret[1]																												X	X			X
Snowy Egret[1]																												X	X			X
Green Heron[1]																												X	X			
Black-crowned Night- Heron[1]																								X				X	X			X
White-faced Ibis[1]																																X
Turkey Vulture		X		X										X				X														X
Mallard[1]																											X	X	X			X
Cinnamon Teal[1]																																X
Sharp-shinned Hawk																												X	X			
Cooper's Hawk						X		X																				X	X	X		
Red-shouldered Hawk																												X	X			
Red-tailed Hawk				X		X						X		X		X																X
American Kestrel																														X		
California Quail																														X		
Common Moorhen[1]																												X	X			
American Coot[1]																								X			X	X	X			X
Black-bellied Plover[1]																																X
Killdeer[1]																											X	X	X	X		X
Black-necked Stilt[1]																																X
Greater Yellowlegs[1]																																X
Western Sandpiper[1]																																X
Least Sandpiper[1]																																X
Pectoral Sandpiper																																X
Long-billed Dowitcher[1]																																X
Ring-billed Gull[1]																												X	X			X

Table B-3. Bird Species Observed During Avian Risk Assessment Surveys

Species Observed by Survey Location	Northern Region	Central Region																					Southern Region									
	1	1	2	3	4	5	6	7	8	9*	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3*	4*	5	6	7	8	9	10
Rock Pigeon																											X	X	X	X	X	X
Band-tailed Pigeon					X																											
Mourning Dove	X	X													X	X	X										X	X	X	X		X
Chimney Swift																														X		
Anna's Hummingbird																											X					
Allen's Hummingbird																														X		
Belted Kingfisher																												X				
Acorn Woodpecker						X	X				X	X							X									X	X			
Red-breasted Sapsucker																				X												
Nuttall's Woodpecker						X	X					X																		X		
Downy woodpecker											X																					
Northern Flicker																			X													
Olive-sided Flycatcher																			X													
Western Wood-Pewee	X		X										X														X	X	X	X		
Willow Flycatcher			X										X			X			X									X	X	X		
Hammond's Flycatcher					X																											
Pacific-slope Flycatcher																				X								X	X			
Black Phoebe						X	X				X													X				X	X	X	X	X
Cassin's Vireo																				X												
Hutton's Vireo											X	X																				
Warbling Vireo						X	X													X								X	X	X		
Steller's Jay																						X										
Western Scrub-jay						X	X		X		X	X	X								X							X	X			
American Crow																												X	X			
Common Raven	X	X			X				X					X		X	X	X			X	X										
American Robin																												X	X			
Tree Swallow																														X		
Barn Swallow																														X		X

Table B-3. Bird Species Observed During Avian Risk Assessment Surveys

Species Observed by Survey Location	Northern Region	Central Region																					Southern Region									
	1	1	2	3	4	5	6	7	8	9*	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3*	4*	5	6	7	8	9	10
Cliff Swallow																														X		X
Oak Titmouse													X									X										
Bushtit												X								X		X										
Red-breasted Nuthatch					X																											
White-breasted Nuthatch						X	X																									
Pygmy Nuthatch					X																											
Bewick's Wren											X						X	X		X												
House Wren												X																				
Marsh Wren																												X	X			
Ruby-crowned Kinglet											X	X																X	X			
Blue-gray Gnatcatcher						X	X																									
Wrentit								X	X		X	X																				
Northern Mockingbird																												X	X			X
California Thrasher									X																		X					
American Pipit																																X
Orange-crowned Warbler			X			X	X										X		X									X	X			
Nashville Warbler																												X	X			
Yellow Warbler						X	X				X	X	X				X		X	X							X	X	X	X		
Black-throated Gray Warbler																												X	X			
Townsend's Warbler																												X	X			
Hermit Warbler																												X	X			
MacGillivray's Warbler											X																	X	X			
Common Yellowthroat																											X	X	X	X		
Wilson's Warbler											X									X								X	X	X		
Western Tanager																X			X	X								X	X	X		
Spotted Towhee					X						X	X									X											
California Towhee						X	X				X	X			X					X			X									
Rufous-crowned Sparrow												X																				

Table B-3. Bird Species Observed During Avian Risk Assessment Surveys

Species Observed by Survey Location	Northern Region	Central Region																					Southern Region									
	1	1	2	3	4	5	6	7	8	9*	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3*	4*	5	6	7	8	9	10
Chipping Sparrow																												X	X			
Lark Sparrow																						X						X	X			
Savannah Sparrow																											X			X		X
Fox Sparrow											X																					
Song Sparrow						X	X																X				X	X	X	X		X
Lincoln's Sparrow																											X	X	X	X		
White-crowned Sparrow																														X		
Dark-eyed Junco																												X	X			
Black-headed Grosbeak																												X	X			
Lazuli Bunting																												X	X	X		
Red-winged Blackbird[1]																											X	X	X	X		X
Western Meadowlark																																X
Brewer's Blackbird[1]																												X	X			
Great-tailed Grackle																												X	X			
Bullock's Oriole																												X	X			
House Finch																											X	X	X	X		
Lesser Goldfinch				X											X													X	X			
House Sparrow																											X	X	X	X		

* = Observed from vantage point above location. Bird species not recorded.
[1] = Species considered vulnerable to line collisions due to limited maneuverability and/or flight behavior.

While the MBTA has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as transmission lines even if all reasonable measures to avoid it are implemented. The Service's Office of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the MBTA to absolve individuals, companies, or agencies from liability if they follow these recommended guidelines, the Office of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals, companies, or agencies who have not made good faith efforts to avoid the take of migratory birds. A violation of the MBTA by an individual can result in a fine of up to $15,000 and or imprisonment of up to six months for a misdemeanor and up to $250,000 and/or imprisonment for up to two years for a felony. Fines are doubled for organizations.

Eagles are further protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668C) and, in instances where a species is federally listed as threatened or endangered, the Endangered Species Act (16 U.S.C. 1531-1544, ESA). Violations of these laws can result in criminal penalties of up to $15,000 and six months imprisonment, or both, for misdemeanor violations and $250,000 and two years imprisonment, or both, for felony violations. ESA provisions protect federally listed threatened and endangered species and their habitats from unlawful take. Under the ESA, "take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any of the specifically enumerated conduct." The Service's regulations define harm to mean "an act which actually kills or injures wildlife." Such an act "may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 CFR § 17.3). The Service regulates activities that may result in "take" of individuals.

B.6.2 State

In California, birds may be further protected by the California Endangered Species Act (Fish and Game Code Section 2050-2097, CESA), special provisions for take or destruction of bird nests or eggs and, in particular, raptor nests or eggs (Fish and Game Code Sections 3503-3503.5), state extension of the MBTA and fully protected species clauses (Fish and Game Code Section 3511-3513), and, to a lesser degree, the California Environmental Quality Act (CEQA; Public Resources Code 21000-21177). Penalties for violation of these laws vary but can result in fines of up to $10,000.

Provisions of CESA protect State-listed threatened and endangered species. California Department of Fish and Game (CDFG) regulates activities that may result in "take" of listed individuals (i.e., "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill"). Habitat degradation or modification is not expressly included in the definition of "take" under the California Fish and Game Code. Additionally, the California Fish and Game Code contains lists of bird species designated as "fully protected" (California Fish & Game Code §§ 3511 [birds]). Such species may not be taken or possessed.

In addition to state-listed species, the CDFG also has produced a list of Species of Special Concern to serve as a "watch list." Species on this list are of limited distribution or the extent of their habitats has been reduced substantially, such that threat to their populations may be imminent. Species of Special Concern may receive special attention during environmental review, but they do not have statutory protection. However, State and federal laws currently protect all of these species.

B.7 Avian Collision and Electrocution Risk Analysis

B.7.1 Collision Risks

B.7.1.1 Northern Region

Environmental Baseline

Much of the Northern Region is open desert characterized by Mojave creosote bush scrub, Joshua tree woodland, and desert saltbush scrub. It supports few bird species compared with the Central and Southern regions. The one site identified as potentially high risk for collision was a span across Amargosa Creek in the southern portion of the region, where a 220-kV transmission line currently exists. The site also was identified as a potentially high wind area because of its location at the interface of mountains and desert, although conditions were calm at the time of the field survey. Three bird species, none of which is considered vulnerable to line collisions, were detected at the site (Table B.3). For details about special-status bird species in the region, see Section 2 of the Biological Specialist Report. There are no important bird migration corridors known from the region.

Collision Risks Associated with the Proposed Project

The proposed Project would involve construction of 37 miles of new transmission lines as well as a new substation in the northern portion of the region. This would introduce a new collision risk to this area. The proposed Project would also involve upgrading 18 miles of existing transmission lines in the southern portion of the region from 220-kV to 500-kV standards. This latter area, therefore, has a current level of risk, which would remain the same. Although the 500-kV towers would be taller than the existing 220-kV structures, there is no evidence to suggest that the taller structures would confer greater collision risk. The new line, though taller, would not present an entirely new obstacle for birds that frequent the area; therefore, no significant increase in collision risk is expected. Although several special-status species are known to occur in the Northern Region (See Section 2 of the Biological Specialist Report), none are vulnerable to collisions. Mountain plover, a California Bird Species of Special Concern, might be susceptible to collisions due to its flocking flight behavior, but apparently it has never been recorded as a collision victim (e.g., Knopf and Wunder 2006), probably because it generally flies below the height of transmission lines.

Because the proposed route for the new transmission lines would not occur in high collision-risk areas, there are few bird species in the region in general, and the collision risk along the existing transmission lines in the southern portion of the region would not change with the proposed upgrade, the overall collision risks from the proposed Project in the Northern Region would be less than significant.

Collision Risks Associated with the Alternatives

Alternative 3 would reroute 16 miles of a new 500-kV transmission lines in the northern portion of the region 0.5 mile farther west. The remainder of this alternative route (which includes 21 miles of additional new lines and 18 miles of rebuilt lines) would be identical to that of the proposed Project and would, therefore, result in substantially similar or identical collision risks as the proposed Project. This alternative traverses the same or similar land uses and habitats as the portion of the proposed Project route. Based on the substantial similarity of the Alternative 3 to the proposed Project, this alternative's collision risks would be similar or identical to those of the proposed Project.

Mitigation Measures

Applicant-Proposed Measure (APM) BIO-9 (Table 4-1 of the Biological Resources Specialist Report for the TRTP) will be implemented as part of the proposed Project and alternatives. This measure states that all transmission structures would be designed to be raptor-safe in accordance with the *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006* (APLIC 2006). No further mitigation is required.

B.7.1.2 Central Region

Environmental Baseline

The Central Region is characterized by mountainous terrain with bigcone Douglas fir-canyon oak forest, Coulter pine forest, and scrub oak chaparral. Sites surveyed include 12 that cross or approach riparian habitat, six that cross exposed ridges, and two that parallel ridges (Table B-2). Although conditions were calm at the time of the field surveys, most of the sites in the Central Region were identified as potentially high wind areas due to the mountain topography. Bird species observed in the Central Region ranged from 2 to 14 per site and averaged 5.4 per site. None of the species detected are considered vulnerable to line collision. The ornithologists who conducted the field surveys noted that the riparian sites did not seem to attract more species than adjacent non-riparian sites and contained relatively few species and individuals, especially for the peak of fall migration. The only species observed in the airspace above the vegetation at any of the sites were red-tailed hawk (*Buteo jamaicensis*) and common raven (*Corvus corax*). Both species were observed to maneuver around the existing 220-kV transmission line when flying in its vicinity. No important bird migration corridors have been identified in the region and no areas in the region are known to attract a concentration of birds.

Collision Risks Associated with the Proposed Project

The proposed Project would involve upgrading 51 miles of existing transmission lines along two segments from 220-kV to 500-kV standards. This region, therefore, has a current level of risk, which would remain the same. Although the 500-kV towers would be taller than the existing 220-kV structures, there is no evidence to suggest that the taller structures would confer greater collision risk. The new transmission lines, though taller, would not present an entirely new obstacle for birds that frequent the area; therefore, no significant increase in collision risk is expected. The proposed Project would also add a new 220-kV circuit on the vacant side of the existing double-circuit structures of the Eagle Rock-Mesa 220-kV transmission lines, between the existing Gould and Mesa substations. The new addition of a 220-kV circuit along this stretch would not present an entirely new obstacle for birds that frequent the area; therefore, no significant increase in collision risk is expected. Although several special-status species are known to occur in the Central Region (See Section 2 of the Biological Resources Specialist Report), none are vulnerable to collisions.

The California condor is of particular concern in the Central Region and warrants further discussion. Condors are not known to regularly use any particular site in the region, but they do occur broadly over the proposed Project during foraging trips. Collisions with electrical distribution structures were a significant mortality source for the reintroduced population of California condors during the first several years of release efforts (Snyder and Snyder 2000). Seven condors died due to collisions (or electrocutions) in California from December 1988 to June 1999 (Meretsky et al. 2000). This threat was thought to have largely resulted from the tendency of young birds to associate with human structures (Snyder and Snyder 2000). This hazard has been greatly reduced by releases of birds that have been trained to avoid perching on mock utility poles fitted with electroshock mechanisms (Snyder and Snyder 2005). All instances of collisions have been with distribution structures, however, and transmission lines have not represented a collision threat to the California condor (J.

Grantham, personal communication). Condors have excellent eyesight (Snyder and Snyder 2005) and do not fly during inclement weather, which may explain why they readily avoid transmission lines.

Because the proposed Project would not introduce new collision hazards in the Central Region, collision risks resulting from the implementation of the proposed Project in the Central Region would be less than significant.

Collision Risks Associated with the Alternatives

Alternative 6 would involve the maximum amount of helicopter construction to upgrade to 500-kV transmission lines on the ANF. All components of the transmission lines would be the same as the proposed Project; only the method of construction would differ. Therefore, based on the substantial similarity of Alternative 6 to the proposed Project, this alternative's collision risks would be identical to those of the proposed Project.

Mitigation Measures

APM BIO-9 (Table 4-1 of the Biological Resources Specialist Report) will be implemented as part of the proposed Project and alternatives. This measure states that all transmission structures would be designed to be raptor-safe in accordance with the *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006* (APLIC 2006). No further mitigation is required.

B.7.1.3 Southern Region

Environmental Baseline

Coastal sage scrub, southern arroyo willow riparian forest and other riparian communities, and barren/developed areas characterize the majority of Southern Region. Sites selected for field surveys included four in riparian habitat and six in open water/wetland habitat. The number of bird species observed during field surveys ranged from 2 to 54 per site and averaged 24 per site, which is four times higher than the average in the Central Region. This difference results largely from the occurrence of lowland riparian and open water/wetland habitats in the Southern Region, which attract large numbers of species. The greatest number of species observed were at two sites at Legg Lake, where 53 and 54 bird species were noted during field surveys. Of the 21 species identified during field surveys that are considered vulnerable to line collision, all were observed exclusively in the Southern Region. None of these species is State or federally listed as threatened or endangered, and only one, white-faced ibis, is a CDFG Watch List species. No other special-status species known from the region is considered vulnerable to line collisions, and no important bird migration corridors have been identified.

Collision Risks Associated with the Proposed Project

The proposed Project would involve upgrading 49 miles of existing transmission lines from 220-kV to 500-kV standards. This region, therefore, has a current level of risk, which would remain the same. Although the 500-kV towers would be taller than the existing 220-kV structures, there is no evidence to suggest that the taller structures would confer greater collision risk. The new transmission lines, though taller, would not present an entirely new obstacle for birds that frequent the area; therefore, no significant increase in collision risk is expected. The proposed Project would also involve rebuilding approximately seven miles of the existing Chino-Mira Loma No. 1 line from single-circuit to double-circuit 220-kV structures. However, the rebuilt double-circuit structures would not present an entirely new obstacle; and, as such, no significant increase in collision risk is expected.

Although the proposed Project is not expected to result in a significant increase in collision risk in the Southern Region compared with baseline conditions, there is a current high level of risk in some areas. High-risk areas are those with high numbers of vulnerable species. Based on field surveys, such sites include Legg Lake, the San Gabriel River, and Cucamonga Creek. With the implementation of the measures identified below, any potential effects can be reduced to less-than-significant levels.

Collision Risks Associated with the Alternatives

Three alternatives have been identified for this region. Alternative 4 includes five route variations in the Chino Hills area, each involving the construction of new double-circuit 500-kV transmission lines through Chino Hills State Park parallel to an existing double-circuit 220-kV transmission lines. Each route variation, and therefore the alternative as a whole, would increase the collision risk in this area. The collision risk would not be doubled, however, because the alternative would not present an entirely new obstacle given its proximity to the existing transmission lines. Chino Hills State Park contains upland habitats with no potential to concentrate large numbers of birds, and no species considered vulnerable to line collisions were detected there during reconnaissance surveys. The collision risks associated with Alternative 4 would therefore be less than significant with the implementation of the measures identified below.

Alternative 5 would place the proposed overhead lines underground for approximately 3.5 miles through the City of Chino Hills. Implementation of this alternative would eliminate the collision risks along this 3.5-mile section. However, because the collision risks along this section are considered low already, any beneficial effects would be minimal. The remainder of this alternative route (which includes 56 miles of rebuilt lines) would be identical to that of the proposed Project and would, therefore, result in substantially similar or identical collision risks as the proposed Project.

Alternative 7 would include two underground 66-kV subtransmission line re-routes along Segment 7 and one overhead re-route of Segment 8A 66-kV subtransmission lines for approximately 1.6 miles around the Whittier Narrows Recreation Area. In the overhead re-route, towers currently exist in much of the re-routed portion, but conductors are not present. As such, implementation of this alternative would present a slightly higher, but not significant, risk of collision in the vicinity of the Whittier Narrows Recreation area. Conversely, compared with the proposed Project, Alternative 7 would not result in a significant decrease in collision risk along the underground re-routes. The remainder of this alternative route would be identical to that of the proposed Project and would, therefore, result in substantially similar or identical collision risks as the proposed Project.

Mitigation Measures

APM BIO-9 (Table 4-1) will be implemented as part of the proposed Project and alternatives. This measure states that all transmission structures would be designed to be raptor-safe in accordance with the *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006* (APLIC 2006). In addition, the transmission lines and ground wires in areas with high levels of collision risk (e.g., spans over Legg Lake, the San Gabriel River, and Cucamonga Creek) should be marked with devices such as bird flight diverters that increase the visibility of the lines.

B.7.2 Electrocution Risk

The likelihood of electrocutions occurring as a result of the proposed Project or alternatives is extremely low for reasons outlined in Section B.5.1.2. Nevertheless, APMs BIO-4 and BIO-9 shall be implemented as part of the proposed Project in accordance with the guidance on raptor protection in *Suggested Practices for Raptor Protection on Power Lines* (APLIC 2006) and *Avian Protection Plan Guidelines* (APLIC/Service 2005).

The Project would have minimum clearances between phase conductors or between phase conductors and grounded hardware, as recommended by APLIC (1996), that are sufficient to protect even the largest birds, and therefore would present little to no risk of bird electrocution. Bird electrocutions resulting from proposed modifications at existing substations to accommodate new transmission line construction and system compensation elements also are not anticipated. Such modifications would present little to no risk of bird electrocution. Therefore, the potential for electrocution of birds by implementation of the proposed Project or its alternatives would be less than significant.

Electrocutions as a result of Project implementation, should they occur, will not substantially reduce the number of State and/or federally protected birds, cause populations to drop below self-sustaining levels, restrict the range, or threaten to eliminate populations. Therefore, electrocution risks to State and/or federally protected birds resulting from Project implementation would be less than significant.

B.8 Literature Cited

Arend, P. H. 1970. The ecological impact of transmission lines on wildlife of San Francisco Bay. Prepared by Wildlife Associates for Pacific Gas and Electric (PG&E). San Ramon, CA. 24 pp.

Avian Powerline Interaction Committee (APLIC). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994, Edison Electric Institute, Washington, D.C.

Avian Powerline Interaction Committee (APLIC). 1996. Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996, Edison Electric Institute, Washington, DC.

Avian Powerline Interaction Committee (APLIC) and U.S. Fish and Wildlife Service (USFWS). 2005. Avian protection plan (APP) guidelines. Available at www.aplic.org.

Avian Powerline Interaction Committee (APLIC). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA.

Avery, M.L., P.F. Springer, and N.S. Dailey. 1980. Avian mortality at man-made structures: an annotated bibliography. U.S. Fish and Wildlife Service. Biological Services Program, National Power Plant Team, FWS/OBS-80/54.

Beaulaurier, D.L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Administration, U.S. Department of Energy, Portland, OR.

Beaulaurier, D.L., P.A. James, P.A. Jackson, J.R. Meyer, and J.M. Lee, Jr. 1982. Mitigating the incidence of bird collisions with transmission lines. In: Third Symposium on Environmental Concerns of Right-of Way Management, San Diego, CA.

Beer, J.V., and M.A. Ogilvie. 1972. Mortality. Pages 125-142. In: Scot, P.M. (Editor) The swans. Houghton Mifflin, Boston, MA.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigation measures. Ibis 136**:**412–425.

Bevanger, K., 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. Biological Conservation 86**,** pp. 67–76.

Brown, W.M., R.C. Drewien, and E.G. Bizeau. 1987. Mortality of cranes and waterfowl from powerline collisions in the San Luis Valley, Colorado. Pages 128-136. In: Proceedings of the 1985 Crane Workshop: Grand Island, NE (J. C. Lewis, Ed.). Platte River Whooping Crane Maintenance Trust.

Brown, W.M. 1993. Avian collisions with utility structures: biological perspective. In: Proceedings of the international conference—Avian interactions with utility structures, September 13-15, 1992, Electric Power Research Institute and Avian Power Line Interaction Committee, Miami, FL.

Brown, W.M., and R.C. Drewien. 1995. Evaluation of two power lines markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23**:**217–227.

Cornwell, G., and H.A. Huchbaum. 1971. Collisions with wires—a source of anatid mortality. Wilson Bulletin 83:305–306.

Erickson, W.P., G.D. Johnson, and D.P. Young Jr. 2005. A summary and comparison of bird mortality form anthropogenic causes with an emphasis on collisions. USDA Forest Service General Technical Report PSW-GTR-191.

Erickson, W.P., G.D. Johnson, M.D. Strickland, and K. Kronner. 2001. Avian collisions with wind turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee, RESOLVE, Inc., Washington, D.C.

Faanes, C.A. 1987. Bird Behavior and Mortality in Relation to Power Lines in Prairie Habitats. U.S. Fish and Wildlife Service General Technical Report 7.

Garrett, K. and J. Dunn. 1981. Birds of Southern California: status and distribution. The Artisan Press, Los Angeles, CA

Henderson, I.G., Langston, R.H.W., and N. Clark. 1996. The response of common terns *Sterna hirundo* to power lines: an assessment of risk in relation to breeding commitment, age and wind speed. *Biological Conservation* 77:185–192.

Hugie, R. D., J. M. Bridges, B. S. chanson, and M. Skougard. 1993. Results of a post-construction bird monitoring study on the Great Falls-Conrad 230-kV Transmission Line. In: Proceedings: Avian Interactions with Utility Structures. Electric Power Research Institute, Palo Alto, CA.

Hunting, K. 2002. A roadmap for PIER research on avian power line electrocution in California. PIER Environmental Area. CEC Publication 500-02-072F. December 2002.

James, B.W., and B.A. Haak. 1979. Factors Affecting Avian Flight Behavior and Collision Mortality at Transmission Lines, Bonneville Power Administration, U.S. Department of Energy, Portland, OR.

Janss, G.F.E., and M. Ferrer. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. *Journal of Field Ornithology* 69:8–17.

Kerlinger, P. 1995. How Birds Migrate. Stackpole Books, Mechanicsburg, PA.

Kerlinger, P. and F.R. Moore. 1989. Atmospheric structure and avian migration. Current Ornithology 6:109–142.

Knopf, F.L. and M.B. Wunder. 2006. Mountain Plover (*Charadrius montanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/21doi:bna.211 on 27 September 2007.

Malcom, J.M. 1982. Bird collisions with a power transmission line and their relation to botulism at a Montana wetland. Wildlife Society Bulletin 10:297–304.

Manville, A.M. II. 2000. The ABCs of avoiding bird collisions at communication towers: the next steps. Proceedings of the Avian Interactions Workshop, December 2, 1999, Electric Power Research

Meretsky, V.J., N.F.R. Snyder, S.R. Beissinger, D.A. Clendenen, and J.W. Wiley. 2000. Demography of the California Condor: implications for reestablishment. Conservation Biology 14:957–967.

Meyer, J.R. 1978. Effects of transmission lines on bird flight behavior and collision mortality, Bonneville Power Administration, U.S. Department of Energy, Portland, OR.

Morkill, A.E., and S H. Anderson. 1991. Effectiveness of marking powerlines to reduce Sandhill Crane collisions. Wildlife Society Bulletin 19:442–449.

Olendorff, R.R., R.N. Lehman, and P.J. Detrich. 1986. Biological assessment: anticipated impacts of the Geothermal public power line on federally listed threatened or endangered species, with emphasis on bald eagle. Bureau of Land Management, Ukiah, California. 72 pp. 1986.

Saverno, A.J., L.A. Saverno, R. Boettcher, and S.M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. Wildlife Society Bulletin 24:636–648.

Snyder, N.F.R., and H.A. Snyder. 2000. The California Condor: A Saga of Natural History and Conservation. Academic Press, San Diego, CA.

Snyder and Snyder. 2005. Introduction to the California Condor. University of California Press, Berkeley, CA

Tacha, T.C., D.C. Martin, and C.G. Endicott. 1978. Mortality of sandhill cranes associated with utility highlines in Texas. Pages 175-176 In: Proceedings of 2nd annual crane workshop, J. C. Lewis, ed. Rockport, TX. National Audubon Society. Colorado State University Printing Service, Fort Collins, CO.

Technical and Ecological Services (TEC). 1989. Bird Mortality in Relation to the Mare Island 115 kV Transmission Line. Progress Report 1988/89 for Pacific Gas and Electric Company.

Technical and Ecological Services (TEC).1990. Bird Mortality in Relation to the Mare Island 115 kV Transmission Line. Progress Report 1989/90 for Pacific Gas and Electric Company.

Thompson, L. S. 1978. Transmission line wire strikes: mitigation through engineering design and habitat modification. In: Impacts of transmission lines on birds in flight: 51–92 (M. L. Avery, Editor). Oak Ridge Associated Universities, Oak Ridge, TN.

Trapp, J.L. 1998. Bird kills at towers and other man-made structures: an annotated partial bibliography (1960–1998). U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Arlington, VA.

Walkinshaw, L.H. 1956. Sandhill cranes killed by flying into power lines. Wilson Bulletin 68:325–326.

Willdan Associates. 1982. Impact of the Ashe-Slatt 500 kV Transmission Line on Birds at Crow Butte Island: Post-Construction Study Final Report. Prepared for Bonneville Power Administration, U.S. Department of Energy, Portland, OR.

Williams, R.D., and E.W. Colson. 1987. Association of western raptors with linear rights-of-way. Proceeding of Western Raptor Management Symposium and Workshop, Boise, ID. 48 pp.