

FEASIBILITY REPORT APPENDICES

Newhall Pass Wildlife Connectivity Design Project

PREPARED FOR

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Resource Conservation District of the Santa Monica Mountains

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Appendices

Appendix A

Site Maps

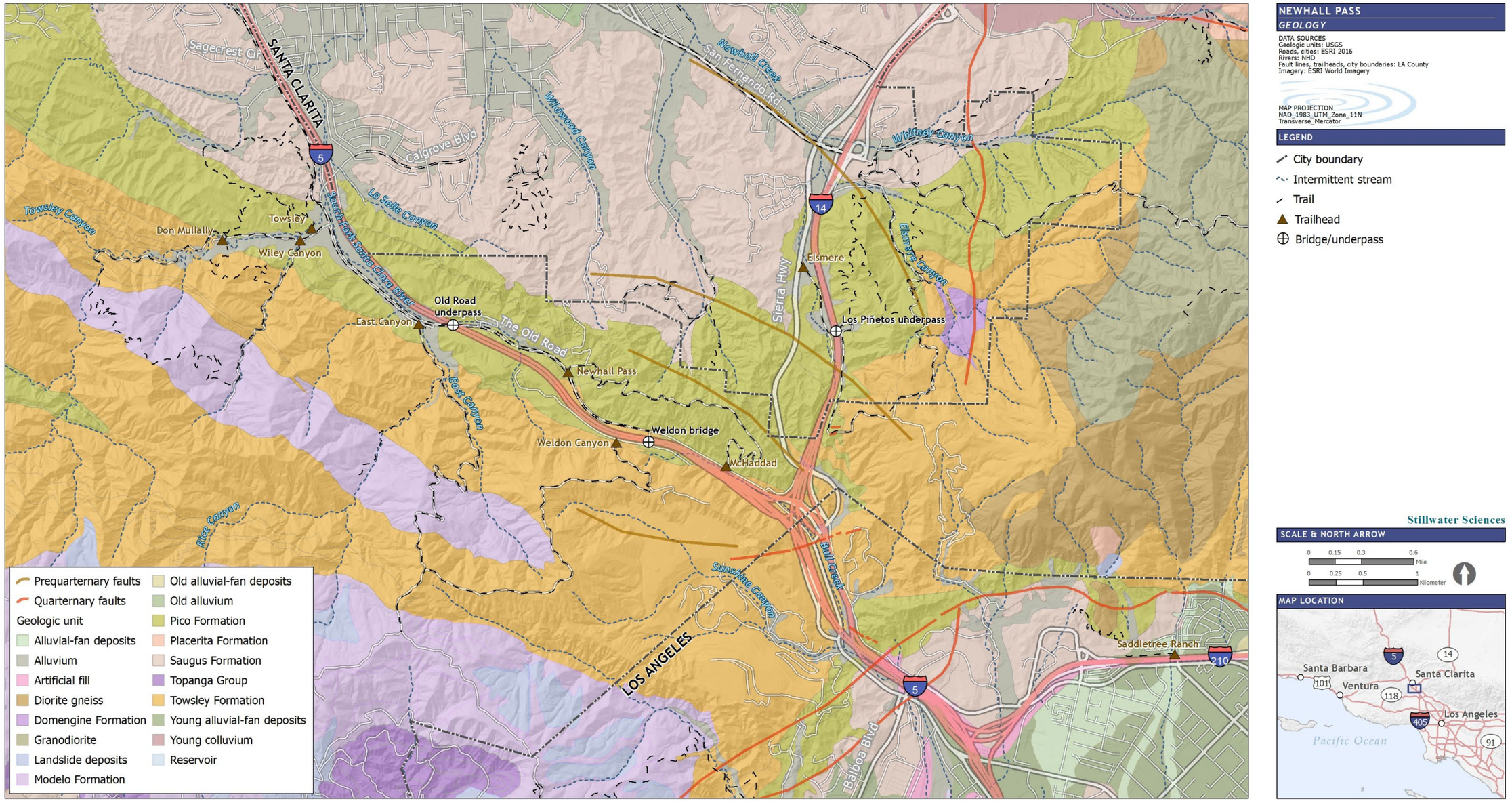


Figure A-1. Geology map.

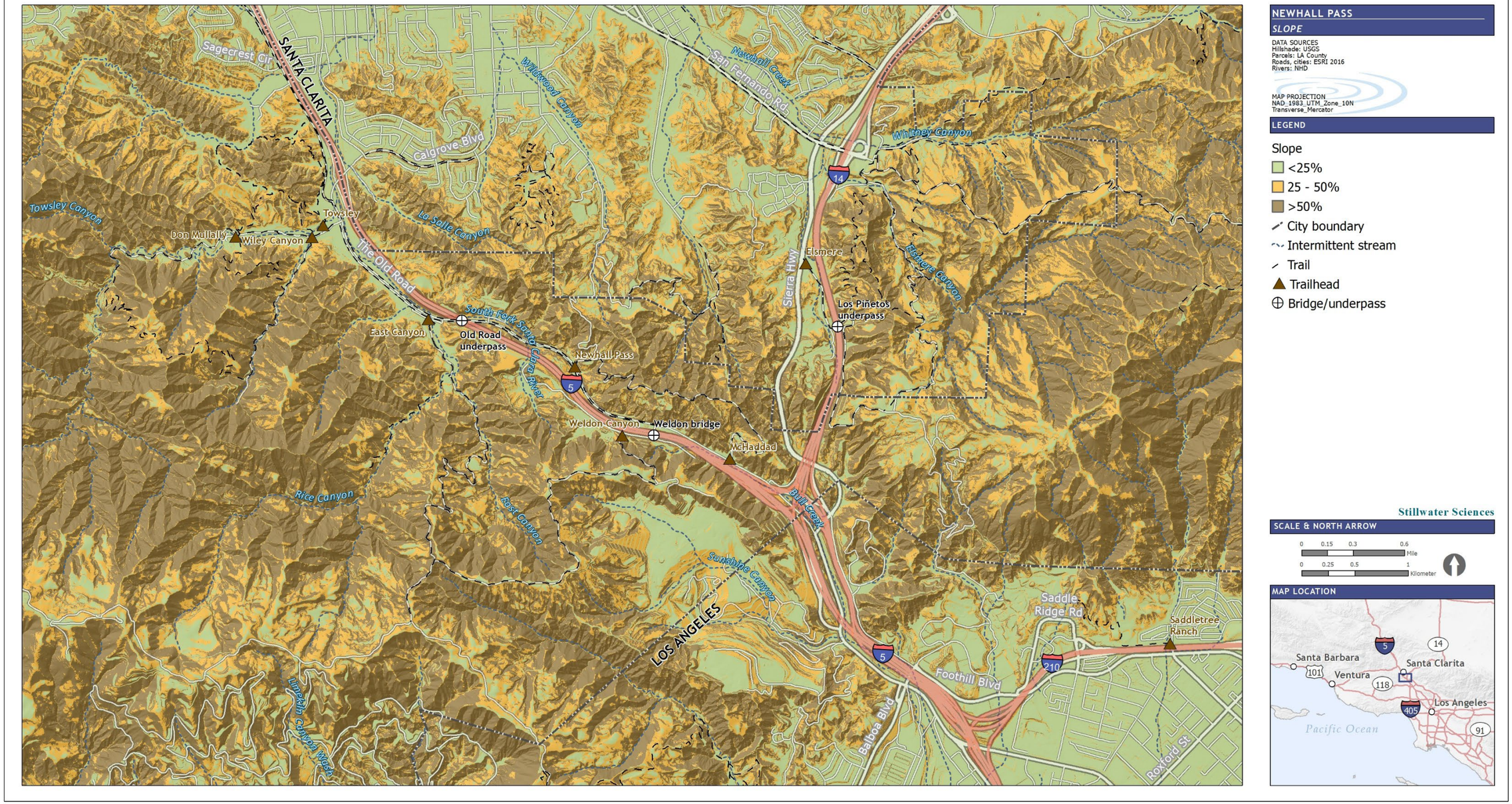


Figure A-2. Slope %.

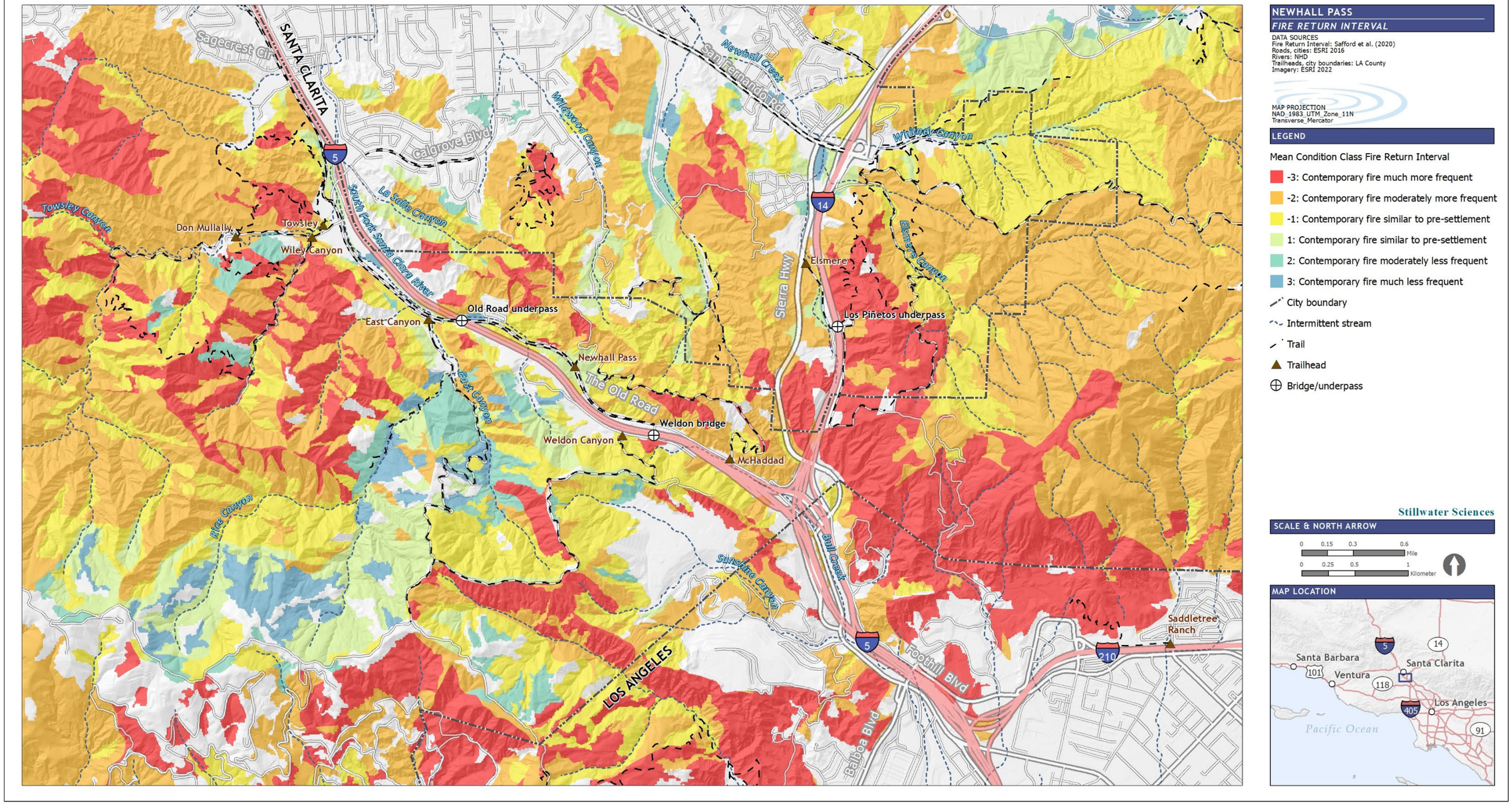


Figure A-3. Fire return interval compared to historic natural conditions.

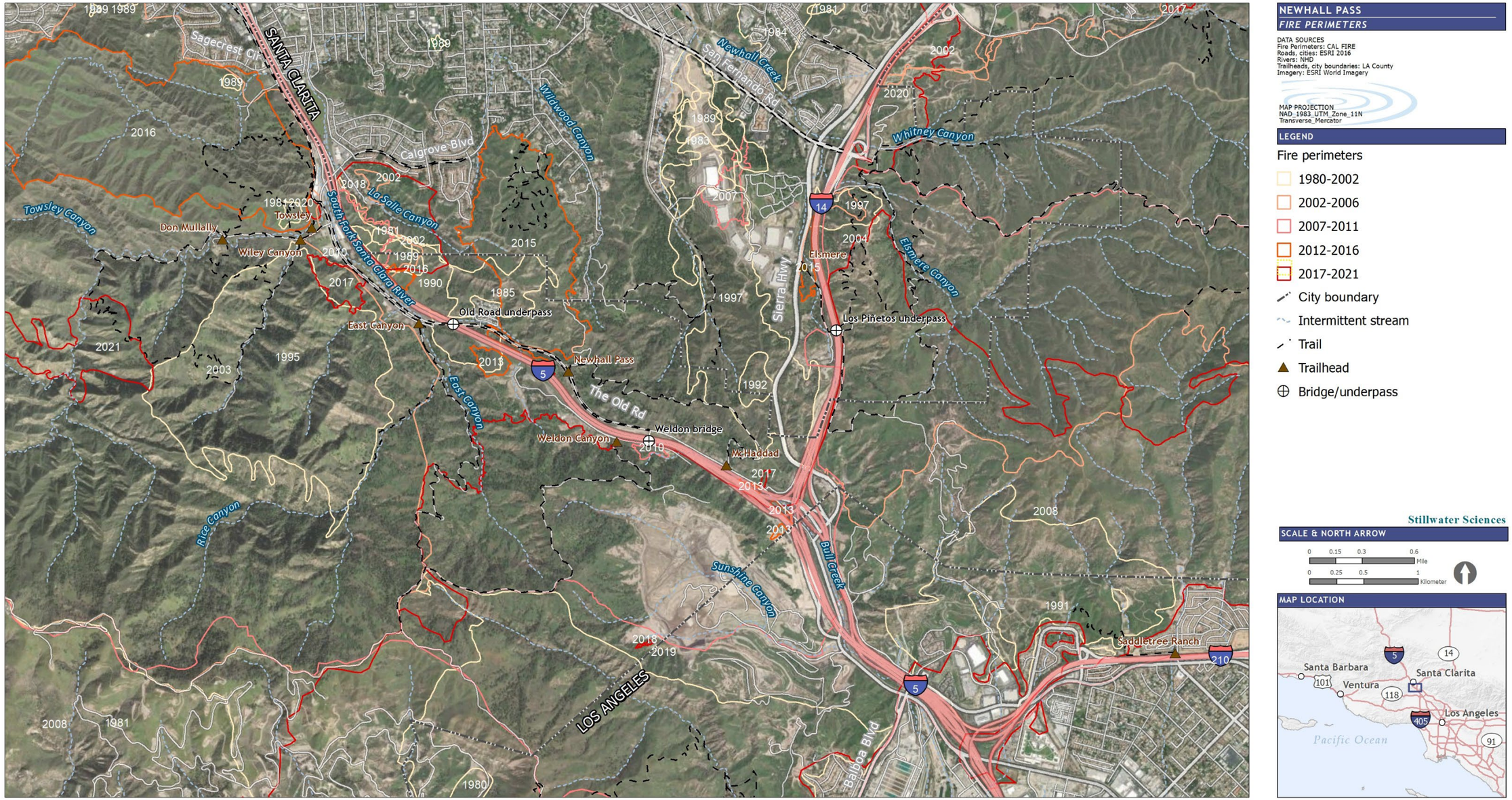


Figure A-4. Past wildfire perimeters.

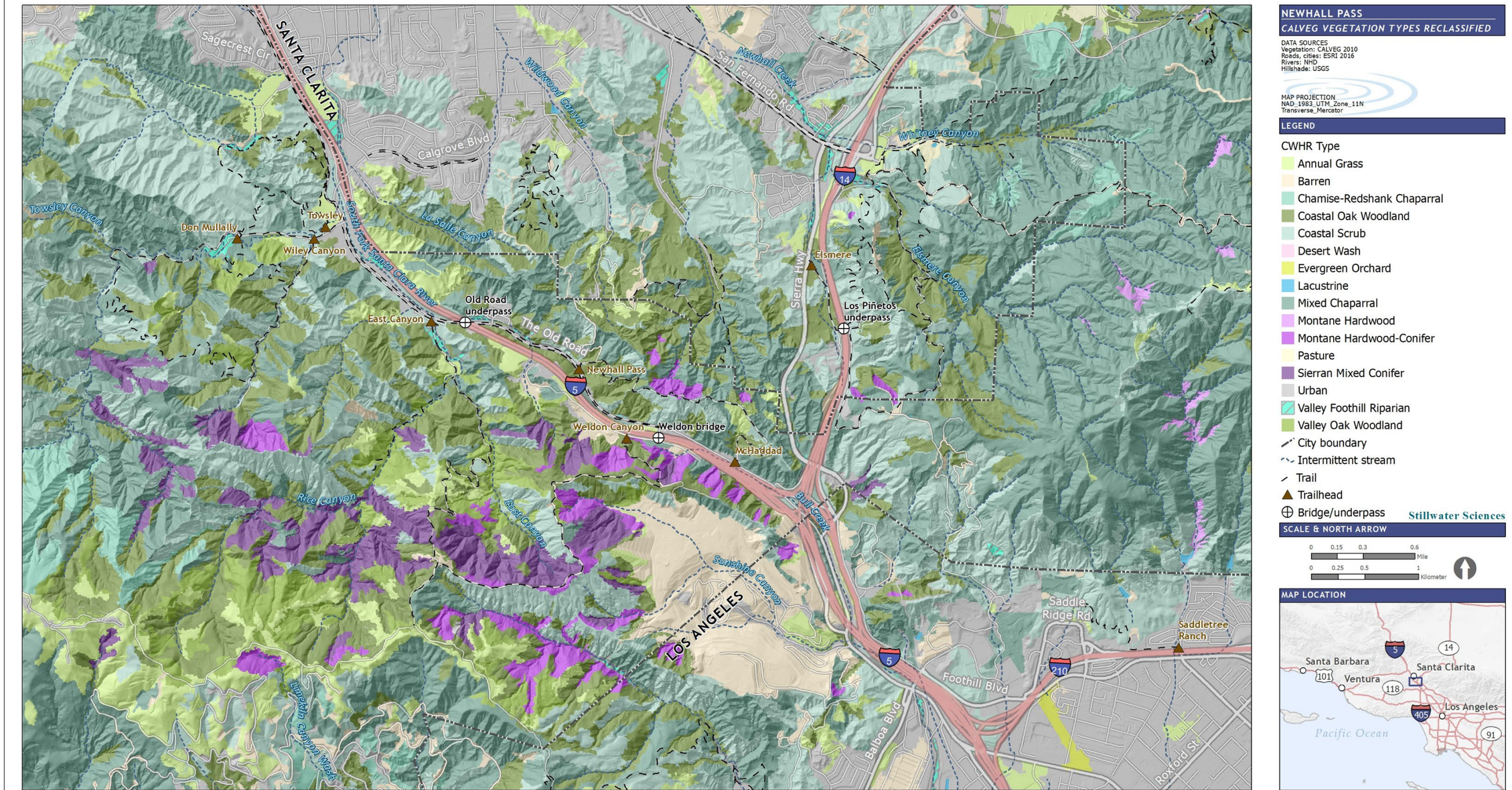


Figure A-5. Reclassified Calveg Wildlife Habitat Relationships dataset.

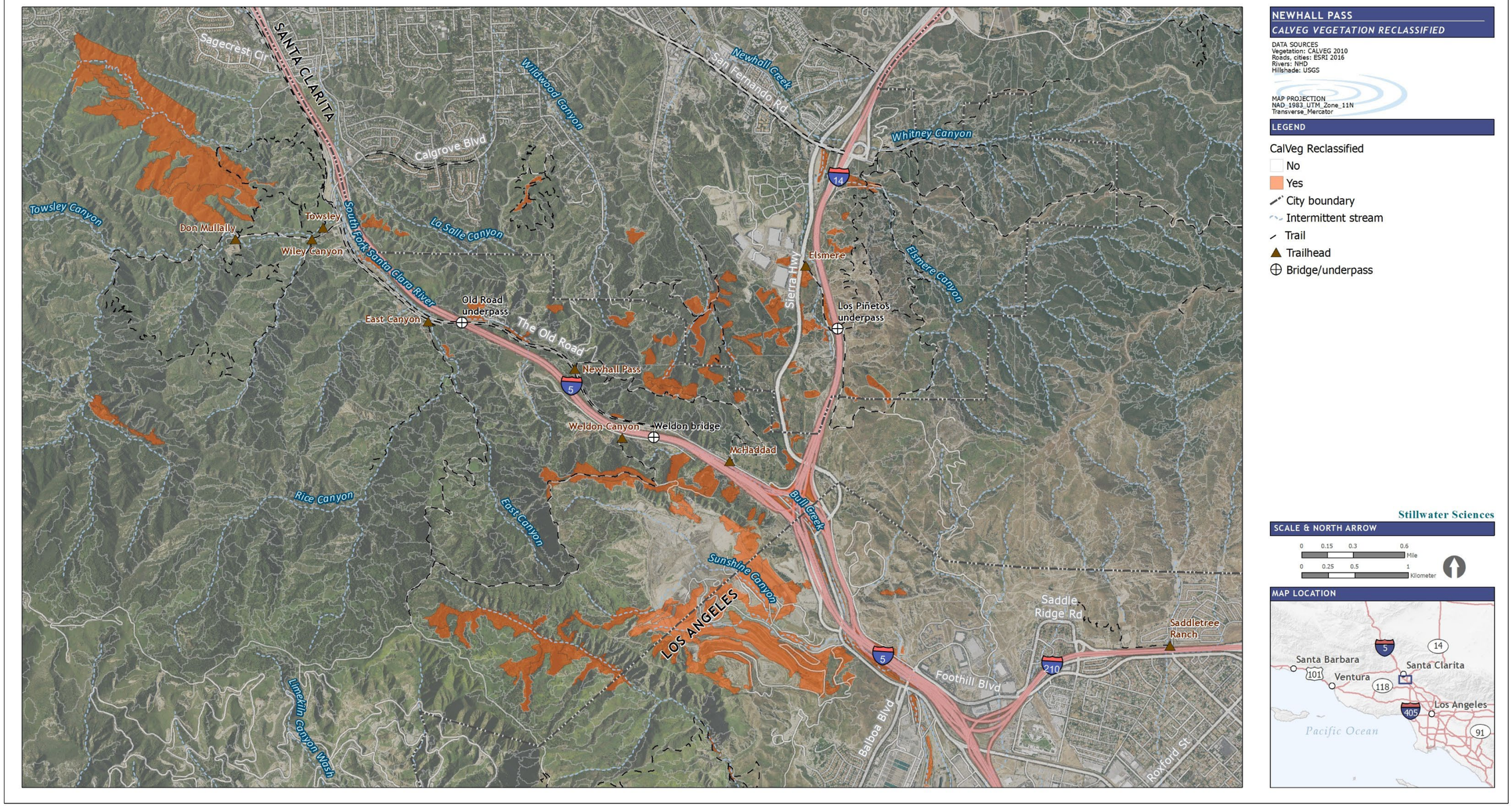


Figure A-6. Maps of areas that were reclassified from Calveg or other datasets through field validation and aerial photo interpretation.

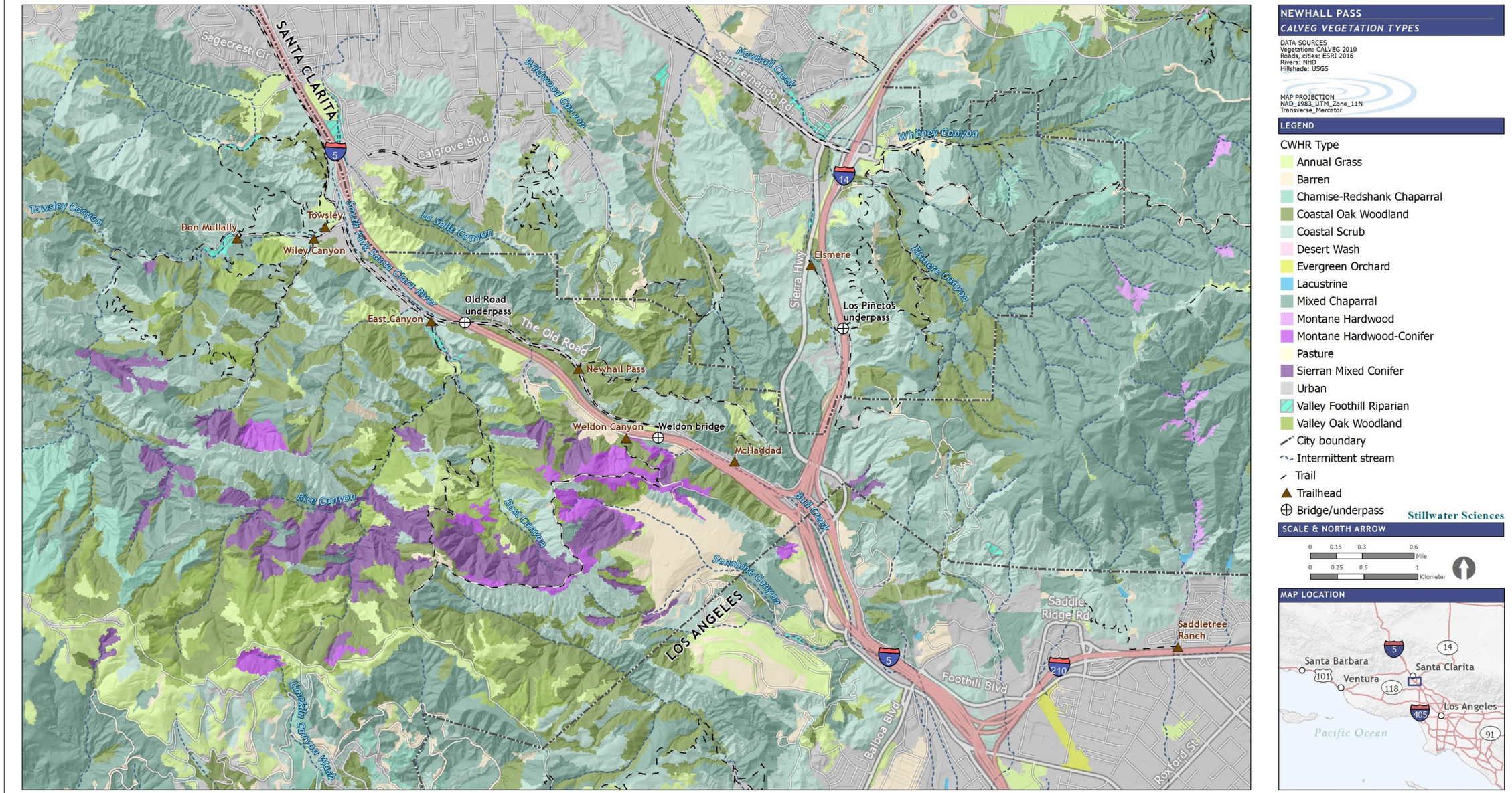


Figure A-7. Original Calveg California Wildlife Habitat Relationships.

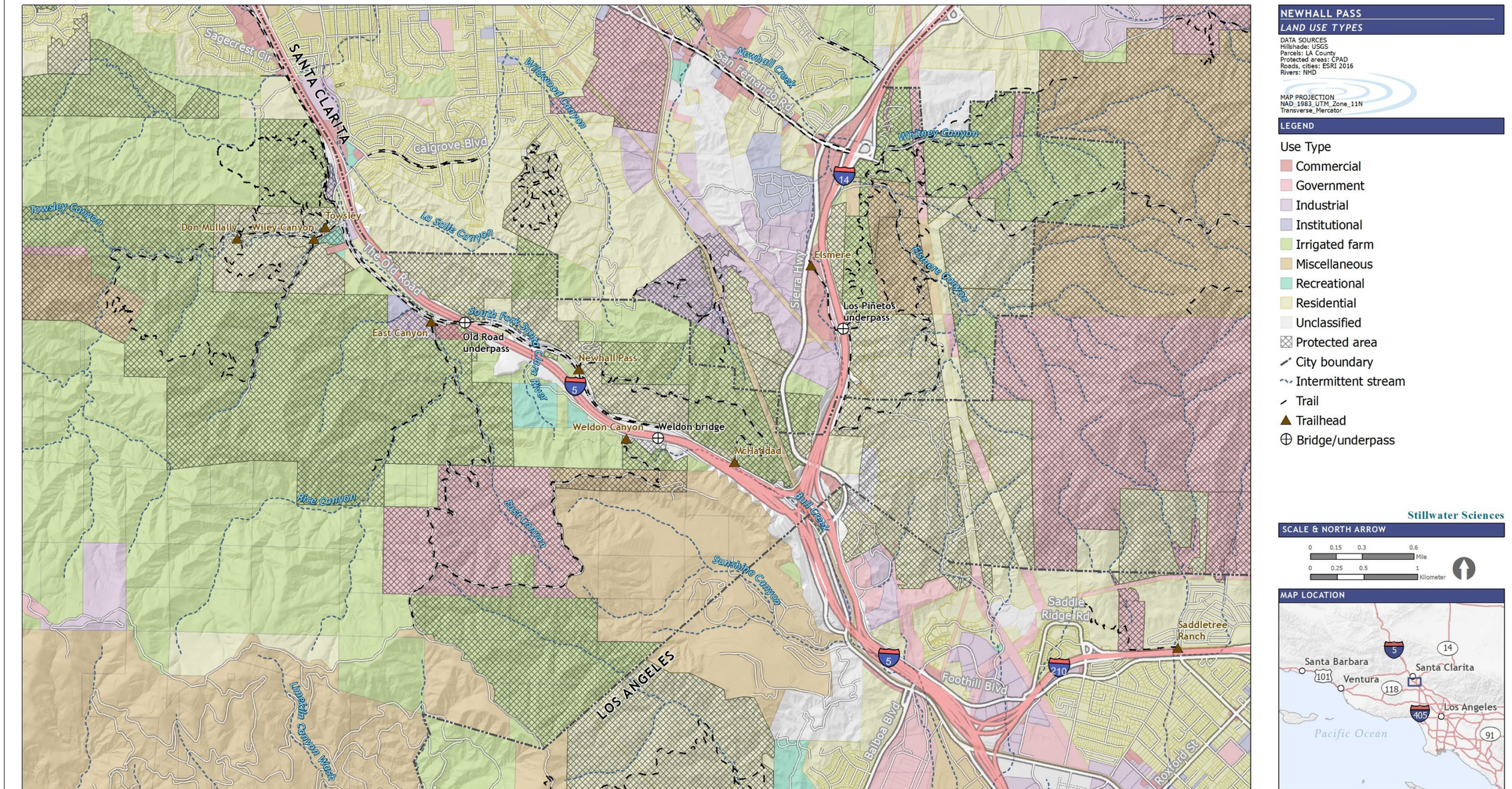


Figure A-8. Land use types.

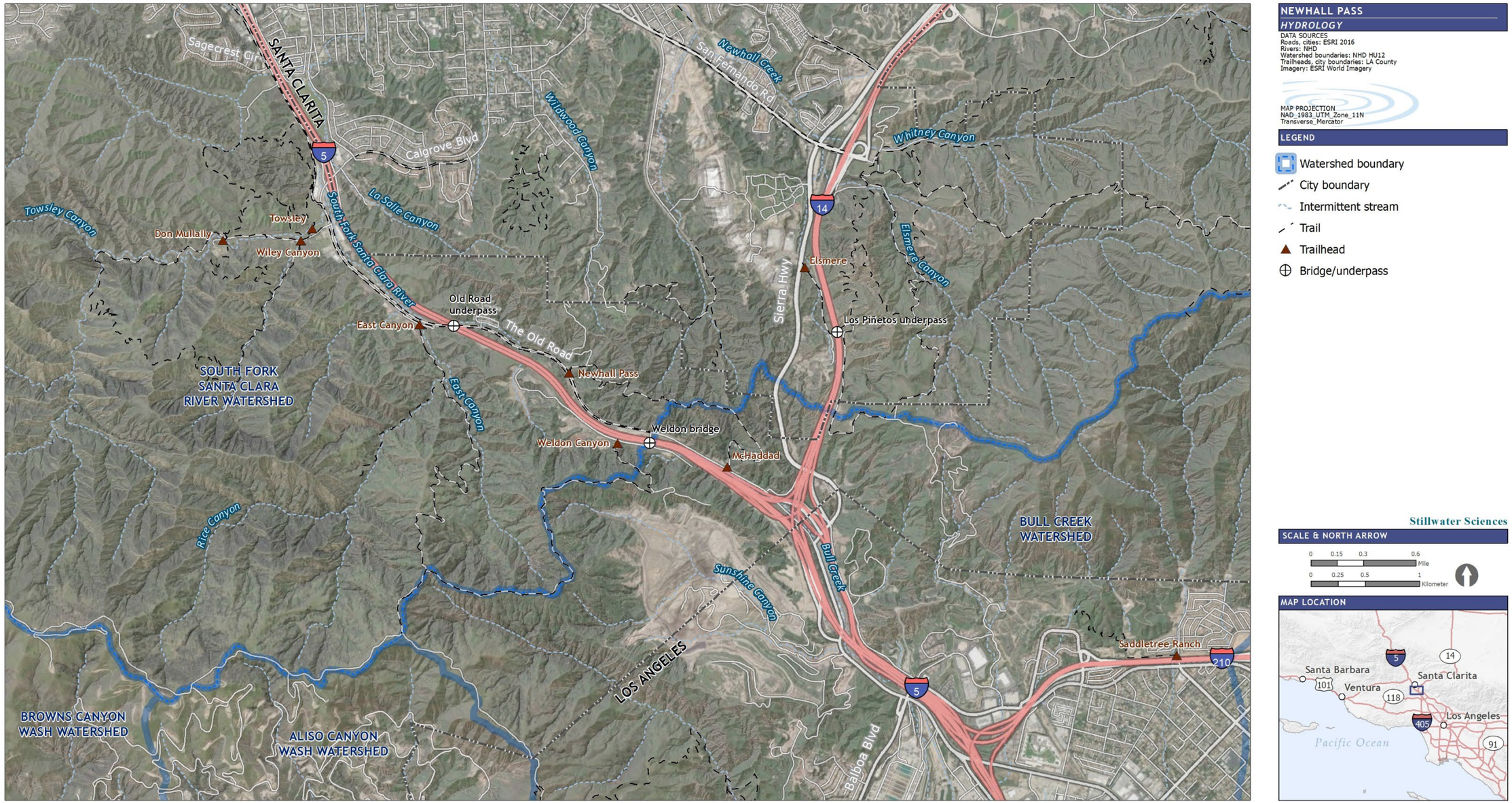


Figure A-9. Hydrology.



Figure A-10. MULC land cover at meter resolution.

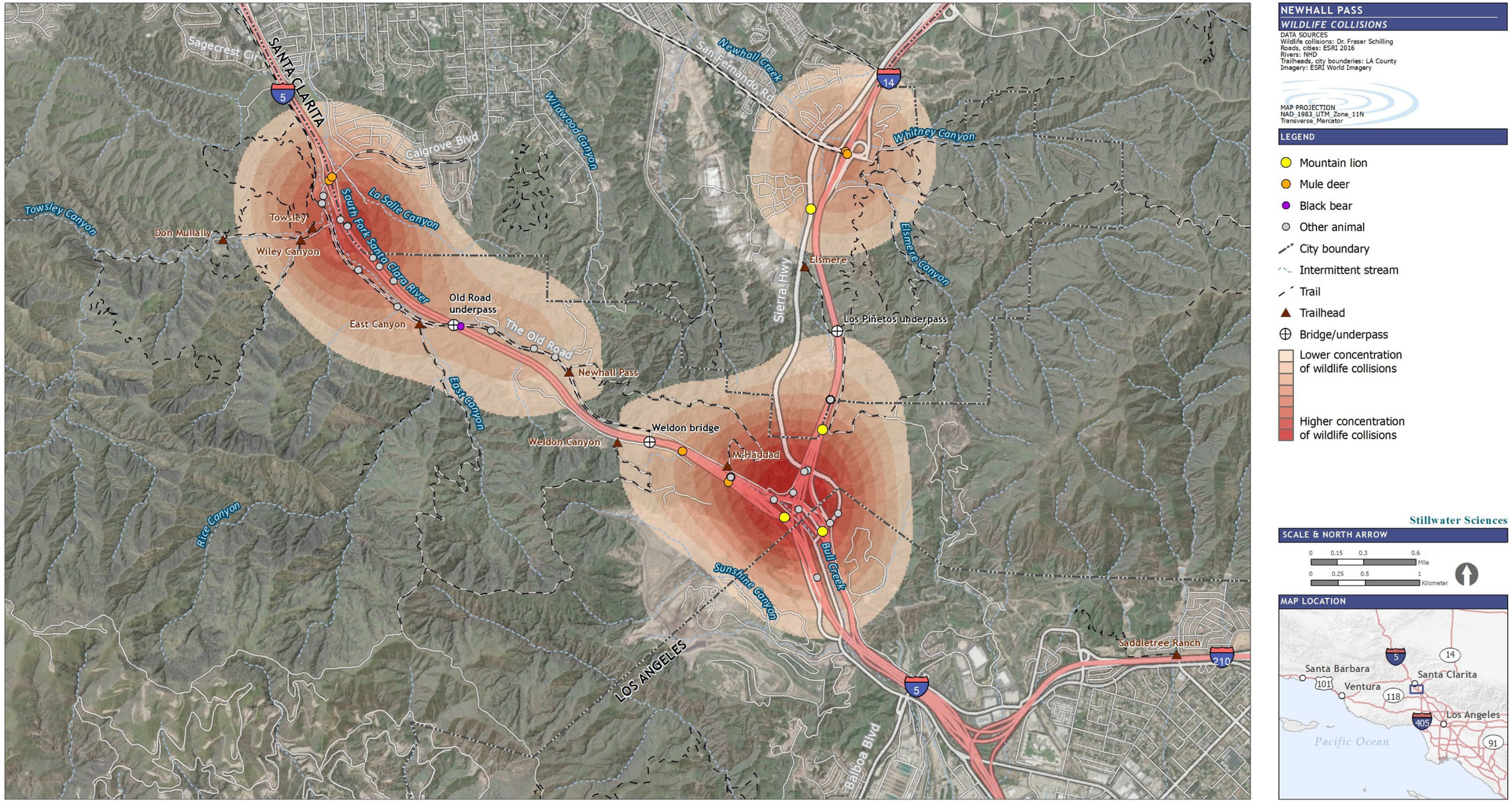


Figure A-11. Wildlife vehicular collisions.

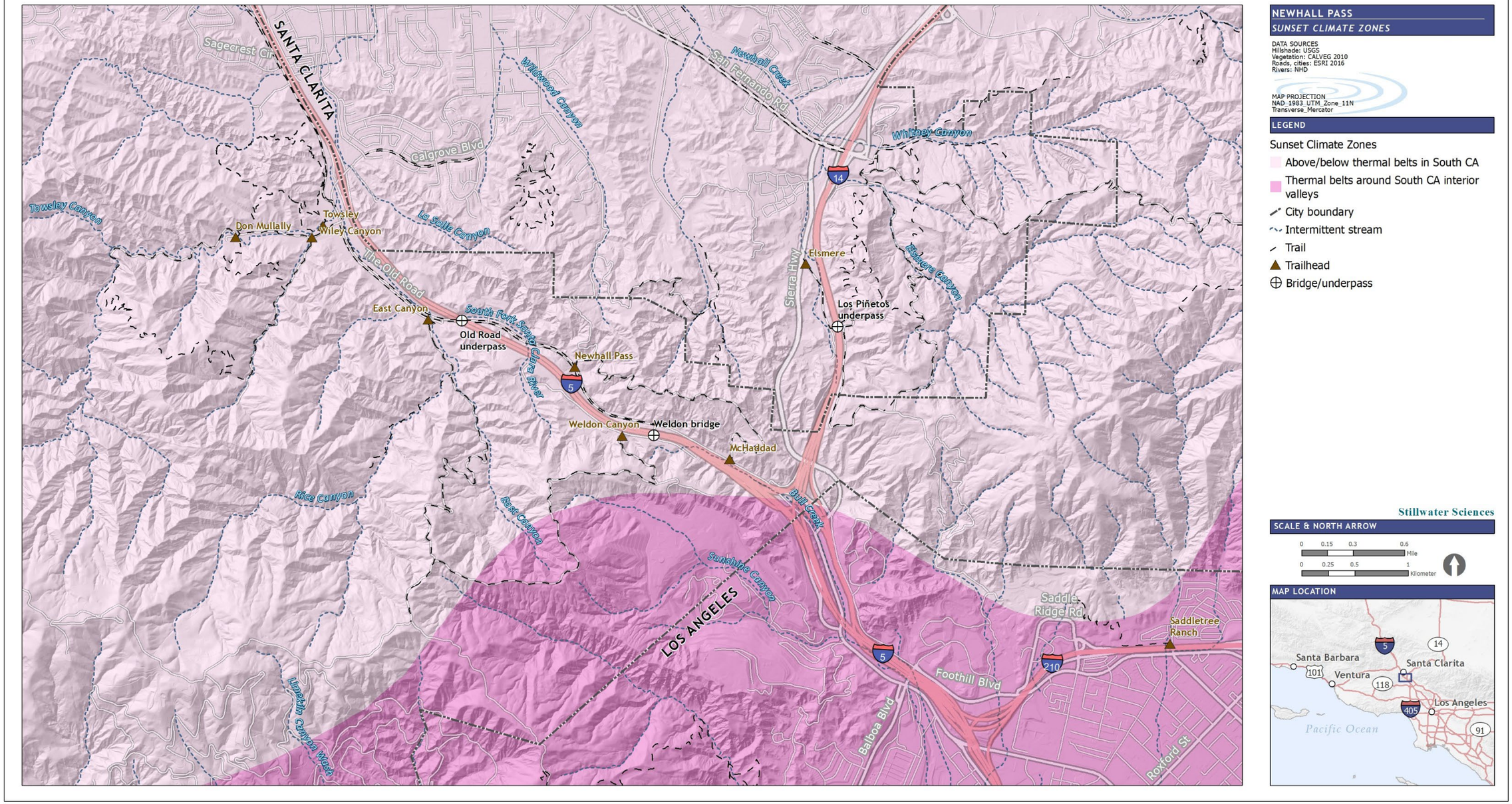


Figure A-12. Sunset climate zones.

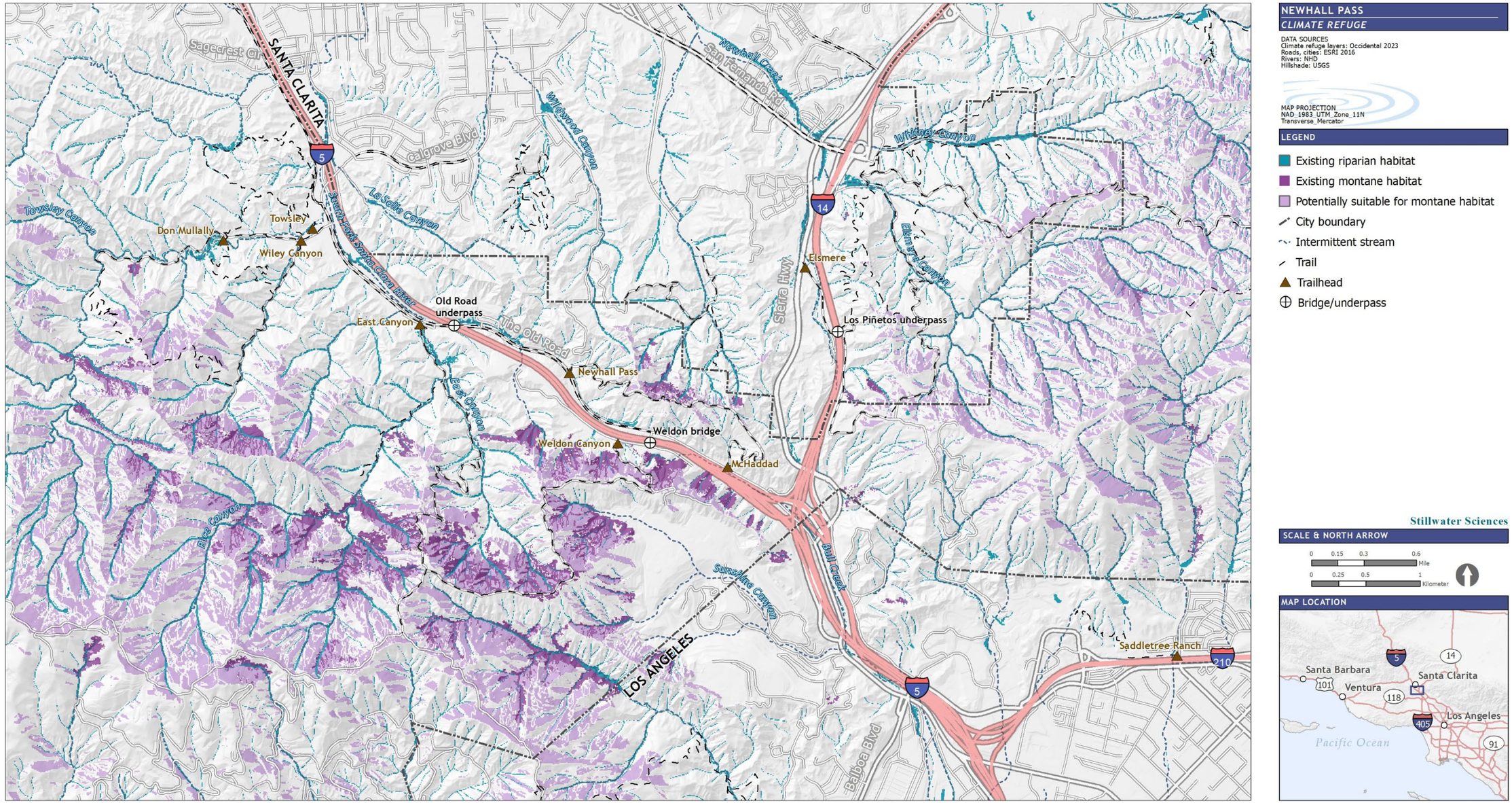


Figure A-13. Location of probable climate refugia. See 4.3: Permanence Criterion 3 for detailed methodology of determining climate refuge value.

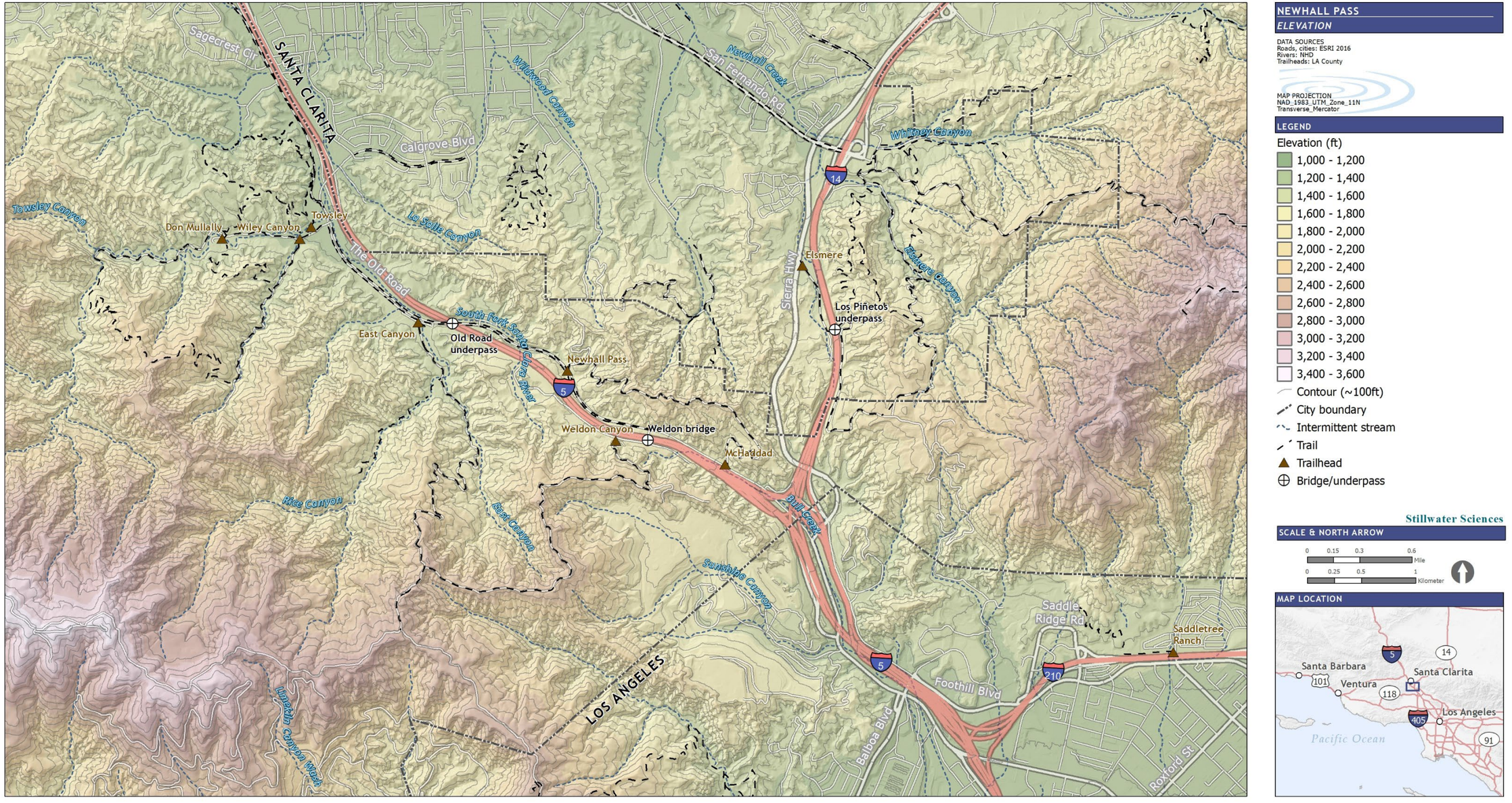


Figure A-14. Elevation

Appendix B

Focal Species and Habitats Literature Review

Focal Species

The term "focal species" refers to a large group of plant and animal taxa that we used to inform crossing location decisions. Our focal species list was based on several factors, including species' mobility, detectability, conservation status, and likelihood of using (or benefiting) from the crossing. This list includes (but isn't restricted to) large mammals; for example, large mammals would almost certainly benefit most from both constructed and passive wildlife corridors, since their movements are frequently hindered by factors that corridors are designed to overcome, such as larger roads and highways, fences, and other built features. However, our list *also* includes species that might utilize habitats associated with the crossing habitat itself (such as a bridge, or riparian corridor).

Some of our focal species are umbrella species, such as brush rabbit (*Sylvilagus bachmanii)*. Owing to their preference for tall, dense stands of native chaparral, the distribution of brush rabbit coincides with that of many chaparral-obligate wildlife species, such as Wrentit, western whiptail, and others. Midsized wildlife focal species include species like brush rabbit. Unlike the ubiquitous desert cottontail (*Sylvilagus audubonii*), the brush rabbit rarely emerges from dense, native chaparral, and is largely absent from urban areas in the region (as readily evident in iNaturalist photo uploads). Though a dominant vegetation type in southern California, chaparral supports a very high diversity of endemic and still-poorly-known wildlife taxa (with new insects still being described, for example). Brush rabbits seem to be absent from smaller fragments of habitat, confined to rugged slopes at the periphery of the Los Angeles Basin. For example, while brush rabbits are still relatively common in the less-developed western Santa Monica Mountains, they have been extirpated from Griffith Park (Cooper and Mathewson 2009). They are likely fairly common in the *Ceanothus* and chamise-dominated evergreen chaparral of the study area, and based on their behavior, would be very unlikely to cross even a secondary road such as Sierra Highway or The Old Road (much less a freeway). With careful planning and plant selection, it seems likely that brush rabbit (and many other chaparral-obligate species) could use a built crossing at Newhall Pass.

We have not selected many birds as focal species, unless they are terrestrial, or tend to frequent dense vegetation (and would be unlikely to cross a freeway). For example, Greater Roadrunner (*Geococcyx californianus*) travels on the ground, favors native vegetation, and rarely flies. We also included California Thrasher (*Toxostoma redivivum*) as a focal species, because while roadrunners favor sparse vegetation and abundant bare ground patches, thrashers tend to prefer the densest chaparral vegetation in an area. Thus, a crossing connecting patches of dense chaparral might be more favorable to a thrasher than a roadrunner.

We also included as focal species that that we see as *indirectly* benefitting from a wildlife crossing at Newhall Pass, in that they won't walk across a bridge or crawl through a culvert. These may include a plant that benefits from the seed dispersal function of a bird or mammal, or even an un-blocked waterway to convey its seeds (such as a bigcone Douglas-fir cone that is carried downstream by rainwater). We generally selected those species with special status or high conservation interest, those occurring and the edge of their range, and for other factors. While we did not model these, they informed some of our inferences and decisions throughout the process (see Appendix for complete list).

While our focal species list consists mainly of wildlife, we recognize that plant conservation is also a priority in this area, which represents a convergence of several distinct ecotopes.

Indeed, several species of plants reach their local elevational and/or physiological limit at Newhall Pass, occurring here at an exceptionally low elevation (e.g., bigcone spruce *Pseodotsuga menziesii and* canyon live oak *Quercus chrysolepis*), particularly far inland (valley oak *Quercus lobata* and southern California black walnut *Juglans californica*), or coastward (rubber rabbitbrush *Ericameria nauseosus*). Regionally important stands of evergreen woodland (including coast live oak woodland, and riparian oak woodland) are found at the Pass, as are locally rare species of conservation interest such as bush lupines (e.g., *Lupinus* cf. *paynei, "Lupinus pasadenensis"*). Rare plants, and native vegetation overall, would benefit from increased exchange of pollinators across the pass.

We recognize that the conservation of plants is necessarily tied to the conservation of wildlife, and vice versa. For example, the western gray squirrel has been shown to be essential for the maintenance of functional coast live oak woodland in the regional, feeding on and dispersing terrestrial fungi found in oak leaf litter, maintaining healthy soil conditions of oak groves (Harvey 1988). Therefore, the restriction of the squirrel's movement—from a barrier such as a freeway, for example—could rob a stand of oaks of their fungi, leading to stand decline. Thus, the re-establishment of connections between patches of oak woodland could counteract this disruption and help ensure the continued survival of oak woodland on either side of the Pass. In this way, oak-associated plant species may indirectly, rather than directly, benefit from a crossing, but could still be considered focal species due to these relationships.

Likewise, while fish would seem like unlikely candidates for focal species associated with a wildlife crossing, Newhall Pass includes the headwaters of the Santa Clara River, one of the major watersheds of southern California, and the largest still-un-dammed (mainstem) river in the region. The canyons draining north from the Pass flow into Newhall Creek and the South Fork Santa Clara River, including East and Rice canyons. While a section of the South Fork Santa Clara River has been concrete lined as it runs through tract homes before reaching the mainstem, this condition could be reversed in the future. Thus, highly mobile native fishes such as arroyo chub (*Gila orcutti*), and perhaps even unarmored threespine stickleback (*Gasterosteus aculeatus williamsonii*) and southern steelhead (*Onchorhynchus mykiss*), were considered as being focal species due to potential habitat present in creeks in the Pass, especially during periods of consecutive wet years.

We incorporated known natural history parameters of selected focal species into our modelling effort and did not incorporate all focal species for modeling species movement through the Pass. Rather, we focused on ones that we had the most information for, and which represented the needs of multiple other species (i.e., a small number of umbrella species were used for modeling, while the focal species list was much larger). For example, gray fox (*Urocyon cinereoargenteus*) is fairly wide-ranging, but it is so difficult to detect (rarely photographed, largely nocturnal), and comparatively little is known about its local ecology (compared with mountain lion). Similarly, largely extirpated species like southern California black-tailed jackrabbit (*Lepus californicus bennettii*) would be ideal to reintroduce to the local ecosystem, but we tried to focus our modeling on species likely to benefit at present or in the near future. Other examples of such species considered but rejected as species to include in models include American badger (*Taxidea taxus*), owing it its rarity and presumed low density (though one was captured on a wildlife camera at Los Piñetos Canyon), Mountain Quail (rare/few records near the pass), western side-blotched lizard and western whiptail (essentially "covered" by coast horned lizard, which was used), and California sister (*Adelpha californica*;

good indicator of oak woodland, but hard to envision it using or particularly benefitting from a bridge/underpass).

The following sections discuss habitat parameters for key focal species and a table of additional parameters and species follows.

Mountain Lion

Mountain lion is found throughout the vicinity of the study area and is a quintessential habitat generalist. While difficult for the layperson to detect, we have included it as an indicator species because it is relatively detectable using game cameras, and because of its enormous cultural importance in the region. It tends to co-occur with mule deer, so including both deer and lions as a single "focal unit" may be an intuitive approach to corridor design. While both are wide-ranging, and both have been shown to utilize freeway overcrossings and underpasses, mountain lions have been shown to be susceptible to genetic bottleneck effects due to road barriers (e.g., within the Santa Monica Mountains). Isolated Mountain lion gene pools can result in male dominance, and a lack of genetic diversity can lead to the extinction of local populations (Riley et al. 2021). Just one successful individual migration event can help maintain genetic diversity, demonstrating the importance of connectivity, even within low-density populations (Riley et al. 2021). And, as lions continue to be killed on roadways throughout the state, they are an ideal focal species for a highway crossing.

Movement Ecology

In Southern California, Mountain lions significantly prefer chaparral and coastal sage scrub but can occupy upland (typically oak woodland) habitat and riparian woodland (Riley et al. 2021, Benson et al. 2016). Adult female Mountain lions are known to inhabit higher elevations but other age/sex groups generally remain at lower elevations (Riley et al. 2021). Sub-adult Mountain lions are most likely to utilize steep slopes while adults avoid them (Riley et al. 2021). They all avoid developed areas, grasslands, and altered open areas (Riley et al. 2021). In a 2020 study (Dunford 2020), Mountain lion did not directly climb up steep slopes.

Lions chose shallower traversal angles (mean inclining path angle 7.3 ± 0.1°, median = 5.5°). Mountain lion also avoided slopes with steep declines (mean declining path angle – 8.3 ± 0.1°, median = − 6.3°). A climbing mountain lion's maximum path angle was 34.3o and a descending Mountain lion's minimum was− 37.0° (Dunford 2020). Generally, larger patches of habitat are believed to be more favored by lions than small fragments in terms of duration of occupancy; however, small fragments in the landscape may be extremely important in facilitating their movement through challenging environments and terrain.

Seasonally, males in West Texas were documented moving at faster speeds than females. Both sexes moved at higher speeds during the hot-dry season and the monsoon season than in the cold-dry season (Karelus et al. 2021). Otherwise, the West Texas lions exhibited no seasonal effects for any other movement metric or home range size (Karelus et al. 2021). In Utah, subadult Mountain lions tended to leave their natal ranges during winter/spring and females dispersed less than 120km (Stoner et al. 2010).

Adult male Mountain lions average 372 km² home ranges while females average 134 km² (Riley et al. 2021). The known minimum home range of a Mountain Lion was 26 km², utilized by P22 (Riley 2014). The maximum documented dispersal distance of a male Mountain lion was 1,067 km and 1,341km by a female (Thompson et al. 2010, Stoner et al. 2007). Mean dispersal distances vary study to study. The mean dispersal distance for males in Beier's study was 63 km, shorter than a previously recorded average of 83 km (Beier et al. 1995, Anderson et al.

1992). Thompson's study of 14 sub adult males and 10 subadult females yielded an average of 274.7 km for the males and 48.0 km for the females (Thompson et al. 2010). Stoner cited other studies that recorded dispersal distances ranging from 14 km to 366 km (Stoner et al. 2010). In Newby's thesis, the mean Euclidean dispersal distance was similar for males (62 km) and females (67.4 km), but in terms of home ranges females dispersed further than males (Newby 2011). Stoner data suggests that female Mountain lions are capable of dispersing cumulative distances equal to or exceeding those of most males leading to greater outcrossing or sex linked traits and providing critical components for recolonization of vacant habitat (Stoner et al 2010).

Stoner found that dispersal routes may be predicated more on habitat orientation and connectivity than on an inherent drive to move in a certain direction away from the natal range (Stoner et al. 2010). In North American Mountain lion populations, dispersing Mountain lions typically leave their natal areas when they are 10-33 months old and before they are sexually mature (Sweanor et al. 2000, Anderson et al. 1992, Logan et al 1996). According to Sweanor, consistent with most polygynous mammals, males disperse more often and consistently farther than females (Sweanor et al. 2000, Hemker et al. 1984). Females Mountain lions often exhibit philopatry (Sweanor et al. 2000). Along with competition from conspecifics, dispersal movements can be shaped by competition from other members of their ecological guild (Newby 2011). Hunting habitat helped dictate dispersal habitat use (Newby 2011). Connectivity assessments regularly consider resident habitat to be a surrogate for disperser habitat, and Newby's findings suggest that this may be reasonable, at least for Mountain lion (Newby 2011). Lions have been known to establish temporary home ranges during dispersal and these areas may be selected to meet security and foraging needs supplied by suitable hunting habitat (Newby 2011, Beier 1995, Sweanor et al. 2000).

As habitat generalists, Mountain lions can survive in diverse biomes, however, they require three essential resources: adequate stalking and security cover, a prey base that includes large ungulates, and landscapes relatively free from anthropogenic disturbance (Newby 2011, Beier 2010, Seidensticker 1977). Dispersing Mountain lions use shrublands and avoid landscape elements such as grasslands or landscaped areas that lack adequate cover (Riley et al. 2021). A study tracking Mountain lion F31 found that its dispersal locations were almost entirely restricted to mid-elevation mountainous terrain that was previously identified as suitable Mule Deer and Mountain lion habitat (Cougar Discussion Group 1999, Stoner et al. 2010). Newby's modeling found that dispersing Mountain lion locations were positively associated with forest, shrub cover, and steep slopes but negativity correlated with high edge density, ruggedness, elevation, distance to edge, and distance to water (Newby 2011).

Mountain lions typically avoid areas with artificial lighting and more than one dwelling per 16 ha (Beier et al. 1995). Lions found dense areas with more than 20 dwellings per ha impassible (Beier et al. 1995). City lights are especially detrimental to Mountain lions around a road undercrossing or near open habitats (Beier et al. 1995). While some native woody vegetation is essential to provide cover for Mountain lions, dense woody vegetation can impede their travel (Beier et al. 1995). Newby's thesis concluded that even the lowest levels of development such as recreational open spaces, urban interface hiking trails, golf courses, and ski runs were avoided by dispersing Mountain lions (Newby 2011).

Dispersing Mountain lions were found regularly crossing under highway bridges built to accommodate watercourses (Beier et al. 1995). They use corridors that are located along natural travel routes and have ample woodland cover (Beier et al. 1995). All travel in corridors and habitat peninsulas occurred at night (Beier et al. 1995). A Mountain lion cannot use a corridor unless its normal travel pattern causes it to encounter the corridor entrance (Beier et al. 1995). At high-speed road crossings, dispersing Mountain lions can utilize underpasses

integrated with roadside fencing (Beier et al. 1995). Beier recommends that a corridor designed for Mountain lion use be greater than 100 m wide if the distance spanned is less than 800 m and 400 m wide for distances of 1-7 km (Beier et al. 1995). Newby states that the presence of high-quality habitat may not be sufficient for connectivity, especially if mortality is high, however, the identification and conservation of good dispersal habitat will be important to the management of spatially structured populations; especially when the number of individuals dispersing annually is small and variable (Newby 2011).

Climate Change

While little-studied, mountain lions would seem to be little-affected by projected climate change, at least directly, since they are able to tolerate areas much drier and hotter than Newhall Pass. However, the loss/reduction of mule deer and other favored prey as a result of climate change (i.e., loss of grass/spring forb cover, loss of shade, etc.) could have cascading effects for lions. In this scenario, the mesic, north-facing slopes in the Newhall Pass area would seem to be ideal refugia for lion (and deer) populations in the area, perhaps even seeing higher use by individuals that once ranged more widely at lower (and hotter) elevations.

The minimum width of an overcrossing that can be used by a Mountain Lion should be 40 to 50m and its recommended to be 50-70m (Clevinger et al. 2011). The minimum width of an underpass is 7m and the minimum height is 4m (Clevinger et al. 2011). It is recommended however that the width exceeds 10m and the height exceeds 4m (Clevinger et al. 2011). While culverts are not Mountain Lions' preferred crossing mechanism, they have been used (Jensen et al 2018). A corridor explicitly designed for a Mountain Lion should exceed 100m in width if the distance spanned is less than 800m (Beier et al. 1995). If the distance spanned is 1 to 7 km, the corridor should exceed 400m in width (Beier et al. 1995).

Western Gray Squirrel

Habitat for western gray squirrels usually includes at least five acres of intact oak-dominated woodland (Barnum 1975). Pines (*Pinus* spp.) are a frequent co-dominant, including planted pines (e.g., on Point Dume, Malibu, and in Griffith Park, Los Angeles Co.). Open understory with abundant leaf litter also appears to be an important feature of occupied gray squirrel habitat, presumably because it supports the fungus the species feeds on and helps disperse (Harvey 1988). Patch size may vary by population, and the type of habitat present, but it appears to have been extirpated in the entire "Hollywood Hills" between Sepulveda Pass and Cahuenga Pass (Cooper and Muchlinski 2015), suggesting that the open space of Franklin Canyon is not large enough to support the species, while Griffith Park, with c. 4,000 acres, is. If we assume that the species is present in the "Y" (between I-5 and Hwy. 14; DSC field notes), and that currently, few animals are moving in or out of this area, then it may be persisting in this habitat patch of approximately 2,500 acres (950 hectares) within the study area.

The role of edge effects on western gray squirrels are little-studied. It persists at the urban edge in many communities in the Los Angeles area (e.g., Monrovia foothills), but presumably only where access to very large habitat patches is available (e.g., the San Gabriel Mountains). Where hemmed-in by urbanization (e.g., Griffith Park, Verdugo Mountains), they are rarely encountered at the urban edge of habitats, and is largely restricted to undeveloped oak woodland habitat (DSC, pers. Obs.). Interactions with the invasive fox squirrel may play a role in this, but research has not shown these two species to be particularly antagonistic toward one another (Ortiz 2022). Rather, fox squirrels will move into areas where gray squirrels are absent (or present), and proliferate, but do not appear to be directly driving them away. Therefore, the primary local conservation priority should be maintaining healthy populations (and oak woodlands), and enabling animals to move from one subpopulation to another.

Western gray squirrels are largely sedentary within their territories, but there appears to be a pattern of fairly long-distance (several hundred meters) dispersal by young animals. Research from Washington state indicates that adult females maintain territories of 46.2 acres (18.7 hectares), and casual observation from southern California suggests this to be the case here as well (Haegen et al. 2005). Because local populations appear to be susceptible to local extirpations (e.g., in the Whittier Hills and Hollywood Hills), it is assumed that barriers such as freeways must play a role in blocking immigration to "rescue" isolated populations before they wink out. The fact that a population has persisted west of Sepulveda Pass/405 Fwy., for example, and not east, suggests that they do not frequently utilize roadways over or under freeways (and are rarely seen on "city streets" in the Santa Monica Mountains region, preferring to travel within natural vegetation, such as along canyon bottoms).

Climate change – increasingly hotter and drier conditions – is expected to have a negative effect on the western gray squirrel, in increasing oak die-off, fire frequency, fire extent, and other factors that would reduce habitat quality and potentially result in direct mortality of individual squirrels. As with many woodland species in the study area, areas of dense, (relatively) mesic woodland are likely acting as refugia for this species, and particularly in the vicinity of the upper pass (e.g., vic. Weldon Ave. bridge), are split by freeways and large roads. However, the discovery of a road-killed individual along Beverly Glen Dr. In an isolated portion of the Santa Monica Mountains with no known population (Longcore 2019) suggests some use of freeway overcrossings/bridges. Wildlife cameras deployed in Fern Dell in Griffith Park revealed usage of fairly small culverts/tunnels by at least one western gray squirrel (Cooper 2014), which suggests that this species would respond to increased opportunities to disperse via these features.

Based on our findings, Western Gray Squirrels would fall under Clevenger's guild of small mammals and is recommended to use a wildlife overcrossing with minimum dimensions of 130-165ft and recommended dimensions of 165-230ft. For small to medium-sized mammal underpasses, it is recommended to have a width, height, and diameter of 1-4ft. For culverts, the minimum dimensions are 1.5ft wide with a clearance of >3ft with a recommended width of >3ft and clearance >4ft (Clevenger et al. 2011).

Black Bear

Throughout California, Black bears inhabit montane hardwood, chaparral, and mixed conifer forests (Brown et al. 2009). They are largely absent in urban areas, except at the periphery of open space (foothills/mountains). The only California habitats that Black bears do not occupy are the highly agricultural central valley and the Mojave Desert (Brown et al. 2009). The average home range for Black bear has been calculated at 119 km² for males and 49 km² for females (Brown et al. 2009), indicating how much undeveloped/open land they need throughout the year.

Black bears are most active during crepuscular periods, moderately active during the day, and least active at night , consistent with other studies where bears were not greatly influenced by human activities (Lewis et al. 2011), but movement rates by bears have been were greatest during morning and evening, moderate at midday during diurnal time periods, and lowest at night (Lewis et al. 2011). However, this may depend on a population's habituation largely because this population in question was not habituated to human food resources (Lewis et al. 2011).

In one study tracking six individual bears, they only used city areas during summer (Lyons 2005). Another study cited in this paper found that black bears may occurred more frequently in low elevations during spring and summer, moving upslope and continued climbing in elevation during fall and winter (Lyons 2005). In spring and early summer, adult males moved

significantly more during the crepuscular time period than they did during late summer and fall (Lewis et al. 2011). Greater movement of males in spring and early summer is likely related to strategies to maximize their fitness (Lewis et al. 2011).These Higher rates during spring and early summer movements could be related to mate seeking or because of the presence of berries on fruiting shrubs during late summer and fall in the areas studied (Lewis et al. 2011); however, in our area, black bears would probably show different seasonal movement patterns.

Black bear dispersal is a three- stage process that includes emigration, movement, and immigration (Costello 2010). Their maximum emigration distances away from natal ranges was shown to be 62 km (Costello 2010). Widely- roaming males (with unknown natal ranges (also known as "floating bears") had a maximum dispersal range of was 68 km (Costello 2010). Rogers (1987) reported very few dispersing females, with a maximum distance of 11 km, suggesting that males would be more likely use wildlife corridors than females, in an effort to complete their longer dispersal movements (a pattern observed with mountain lions in the Santa Monica Mountains) (Rogers 1987). In the same study, Rogers found that every male dispersed, and the farthest distance was 219 km (Rogers 1987). The mean emigration distances from natal ranges peaked at 40 km (Costello 2010), while that of "floating bears"' mean was 46 km (Costello 2010). Dispersal barriers include extensive agricultural zones, lowlands like those in the Central Valley, as well as agriculture developments and urban environments (Brown et al. 2009). As alluded to by (in Rogers)' study, males are dispersers, while females typically remain in natal habitat (Brown et al. 2009).

In an Idaho study, forested areas without associated human development were the preferred habitat conditions for highway crossings by Black Bears (Lewis et al. 2011). Thus, corridor design that utilizes the least-(human)-impacted, darkest, quietest, and most secluded portions of the study area would likely see highest use by black bear. By contrast, crossings where freeway noise and light is highest might be avoided by this species. Given the vast distances black bears disperse, the habitat of the crossing itself would seem to be relatively unimportant, as long as habitat is visible on the opposite side of the crossing. Black bears readily move along fire roads and trails, so these should be considered when comparing crossing locations, and sites not ruled out because of the presence of these features.

While climate change would seem to be a factor in influencing black bear distribution, the species occurs along a very wide climatic gradient (including areas with much hotter summers, and drier winters, than Newhall Pass). Increases in rainfall would likely have little impact on the species, due to its broad ecological tolerance. However, bears are vulnerable to wildfire, being unable to burrow underground or outrun vegetation fires. For this reason, it is possible that years of increased fire frequency has left relatively large areas of the study area – including the southern flank, along the San Fernando Valley, unsuitable for high use by the species. Thus, these areas may be considered potential dispersal routes for bears, if not areas of year-round occupancy.

Additional notes on species

Focal Species Likely to Indirectly Benefit (from improved/conserved habitat; generally sensitive/high-interest species, but unlikely to directly use a crossing)

Wide-ranging
Southern Californica rufous-crowned sparrow (endemic, but favored by frequent fire)
Brush rabbit
American kestrel (localized nester)
California thrasher/Wrentit (similar needs)
Costa's hummingbird (being out-competed by urban-adapted spp.)
Nesting raptors (sensitive to disturbance/encroachment)
Migratory songbirds
Shoulderband snails (*Helminthoglypta* spp.) (**note**: won't show up in iNat; locations obscured)

Occurring near lower or upper elevational limit
Hairy woodpecker (lower)
Bigcone Douglas-fir (lower)
Canyon live oak (lower)
Black cottonwood (lower)
Mountain phacelia (lower)
Valley oak (upper)
Southern California black walnut (upper)
Purple sage (upper)

East/West limits – "biogeographical quirks"
Variable checkerspot (west of pass)
California ringlet (west of pass)
California tortoiseshell (east of pass)
Payne's bush lupine (west of pass)
Pasadena lupine" (east of pass)
Valley oak (north of pass)
San Gabriel oak (Quercus durata var. gabrielensis (east of pass)

Table B-1. Focal species design parameters.

Dispersal/Habitat Needs	Mountain Lion	Mule Deer
Scientific Name	Puma concolor	Odocoileus hemionus
Habitat Guild	Generalist	Generalist
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)
Underpass	Min width 7m, height 4 m reccomended width >10m height >4m (Clevinger et al. 2011)	Min width 7m, height 4 m reccomended width >10m height >4m (Clevinger et al. 2011)
Culvert	Can be used (Jensen et al 2018)	Can be used but extremely rare (Jensen et al 2018)
Corridor Measurments Continues	Beier reccomends that a corridor designed for cougar use be >100 m wide if distance spanned is <800m, and 400m wide for diatnces of 1-7 km (Beier et al. 1995).	feet in height and min 20 feet in width (Gordon and Anderson 2004, Cramer 2013), while length should not exceed 120 feet if possible (Cramer 2013). If exceeding 120 feet, such as 4-lane divided highways, providing an open median may help increase mule deer crossing success by reducing the overall length into 2 shorter sections (Foster and Humphrey 1995, Gagnon et al 2005, Wakeling et al. 2015). Mule Deer use all options, culverts and bridges reccomended to be kept well under 61 m long as the animals traverse the highway. Width should be as wide as possible. Structure height can be as low as 3m high and Mule deer still have success rates above 80% (Cramer 2013)
Home Range Size	min 26 km2 P22 (Riley 2014). F avg 90 km2 summer & 100 km2 winter. M avg 300 km2 summer & 350 km2 winter (Grigione 2002). 372 km2 in adult males and 134 km2 in adult females (Riley et al 2021).	varied between 39–2878 ha for female mule deer across California (Kie et al. 2002)
Dispersal Distance - Max	1,067 km (Thompson et al 2010). 357 linear km or actual distance of 1,341 km (Stoner et al. 2007, Thompson et al 2010).	Migration can range 15-200 km (Sawyer and Kauffman 2011, Lendrum et al, 2012, Sawyer et al 2016, Caldwell 2021)
Dispersal Distance - Mean	63 km this study 85 km in a cited study (Beier et al. 1995) (Anderson et al 1992: 61, 66). Subadult F 48.0 km (Thompson et al 2010). Subadult M 274.7 km (Thompson et al 2010). Range 14km-366 km (Stoner et al. 2010). M 62 km and F 67.4 km(Newby 2011).	15.2-25.7km (males) and 12.2-36.9km (females) (Bunnell and Harestad 1983; Hamlin and Mackie 1989; Pease et al. 2009).

Dispersal/Habitat Needs	Mountain Lion	Mule Deer
Dispersal Habitat Preferences	elements without cover (grass- lands, landscaped areas) (Riley et al. 2021). Will use corridors that are located along natural travel routes, have ample woody cover, include an underpass integrated w roadside fencing at high-speed road crossings, lack artificial outdoor lighting, and have <1 dwelling un 16 ha. (Beier et al. 1995). Most disperal locations of cougar F31 restricted to mid-elevation mountainous terain previously identified as suitable Mule Deer and Cougar habitat (Cougar Discussion Group 1999, Stoner at al 2010). Survive in diverse biomes but require three essential resources: adequate stalking and security cover, a prey base including large ungulates, and landscapes relatively free from anthropogenic disturbance (Beier 2010, Seidensticker 1977,Newby 2011).	"Deer may be preferentially dispersing to areas that are environmentally similar to their area of birth by gauging temperature, precipitation, elevation, or seasonality directly: (Pease et al 2009).
Dispersal Habitat Barriers	City lights which are especially detrimental in a road undercorssing or in open habitats (Beier et al. 1995). Dense areas (>20 dwellings/ha) impassible but low density housing (~1 dwelling/16 ha) okay (Beier et al. 1995). Vegeation can't be too dense (Beier et al. 1995). Even low level development, such as recreational open spaces (e.g., urban interface hiking trails, golf courses, ski runs) were avoided by dispersing pumas (Newby 2011).	Barriers can include fences, canals, housing developments, wind, solar, gas, and oil energy developments, transmission lines, mines, railways, and roads. "When built improperly, fences can substantially hinder mule deer movement and cause mortality (Howard 1991, Harrington and Conover 2006)." (Wakeling et al. 2015)
Dispersal Strategies	Habitat orientation and connectivity > drive to move away from the natal range (Stoner et al. 2010). In Utah, subadults left natal ranges in winter/spring and females dispersed <120km (Stoner et al. 2010). F Cougars are capable of dispersing cumulative distances equal to or exceeding those of most males (Hemker et al 1984, Stoner et al 2010).Dispersers typically leave their natal areas when they are 10-33 months old and before sexual maturity (Sweanor et al. 2000, Anderson et al 1992, Logan et al 1996). Mmales disperse more often and consistently farther than females (Anderson et al 1992). Females often exhibit philopatry (Sweanor et al. 2000). Hunting habitat found to be an important mechanism modulating disperser use (Newby 2011). Specifically space use was found to be positively related to (1) steep slopes, (2) forest, and (3) shrub cover; and negatively related to (4) elevation, (5) terrain ruggedness, (6) distance to water, (7) distance to forest edge, and (8) edge density (Newby 2011). Connectivity assessments often use resident habitat as a surrogate for disperser habitat (Newby 2011). Pumas sometimes establish temporary home ranges during dispersal (Beier 1995, Sweanor et al 2000,	In spring, elevation had a large effect on deer distribution...associated with shallower slopes (Marhsal et al. 2010); "in summary, deer use within home range could be distinguished from random locations by elevation and slope throughout the year" (Marshal et al. 2010)

Dispersal/Habitat Needs	Mountain Lion	Mule Deer
Habitat Preferences - Positive	Most often found in chapparal and coastal sage scrub. Next most often found in upland (mostly oak woodland) followed by riparian woodland. Adult females selected higher elevations, but no other age/sex groups did. (Riley et al. 2021)	Upland vegetation adjacent to wooded riparian, orient toward rangeland and rough topography (Wood et al 1989; Whittaker and Lindzey 2004, Hygnstrom et al. 2008)
Habitat Preferences - Negative	Developed areas, grasslands, altered open areas. Adults avoided steep slopes. especially adult males. Sub adults more likely to use steep slopes. (Riley et al. 2021)	presence of water without forage and cover (Marshal et al. 2010); cattle-grazing (Loft et al. 1987); lack of forage and cover (Loft et al. 1987)
Diel Activity and Daily Movement	Nocturnal (Beier 1995). LA region mountain lion prefer to hunt in Chaparral or coastal sage scrub (Benson et al. 2016). Mountain Lions feed on their primary prey farther from development relative to availibility (Benson et al. 2016).	Study on female mule deer daily patterns indicated they used habitats on more southerly and easterly aspects, with lower daytime canopy cover, closer to open roads, and with greater daytime herbage. Velocities were extremely low during midday. (Ager et al. 2003)

Dispersal/Habitat Needs	Mountain Lion	Mule Deer
Movements - Seasonal	*West Texas data* Males move at faster average speeds than females and speeds for boths exes were higher in the hot-dry and monsoon seasons than in the cold-dry season. Otherwise no seasonal effect for any other movement metric or home range size (Karelus et al. 2021)	In the spring prior to peak fawning season (late may to early june) maternal aggresions occurs to encourage previous generations of young to disperse. Fall dispersal occurs primarily in males due to breeding season induced social pressures. (Hawkins et al. 1971; Kammermeyer and Marchinton 1976; Marchinton and Hirth 1984; Ozoga and Verme1985; Tiersen et al. 1985; Ozoga and Verme 1986; Dusek et al. 1989; McCoy et al. 2005; Shaw et al. 2006; Hygnstrom et al. 2008); used lower elevations in spring and higher elevations during the rest of the year (Marhsal et al. 2010)
Corridor Use	bridges built to accommodate watercourses (Beier et al. 1995). Cougars (dispersers and adults) usually avoided large and small culverts under freeways 2-lane rural highways(Beier et al. 1995).All travel in corridors and habitat penissulas occured at night(Beier et al. 1995). A cougar cannot use a corridor unless it's normal travel pattern causes it to encounter the corridor entrance(Beier et al. 1995). The presence of high quality habitat may not be sufficient for connectivity, especially if mortality is high, however, the identification and conservation of good dispersal habitat will be important to management of spatially structured populations; especially when the number of individuals dispersing annually is small and variable (Newby 2011).	Mule deer prefer large passages. Crossing is negatively correlated with passage length and positively correlated with cross-sectional area. Affirmed deer can cross passages beneath highways (overpasses and underpasses work). Deer were only encountered at passages surrounded significantly by natural habitat. (Ng et al. 2001). Wider structures > narrower structures.
Climate Suitability	See specific (not generalist) habitat guilds	
Slope (and aspect if defined)	Positively associated with forest, shrub cover, and steep slopes; negatively correlated with high edge density, ruggedness, elevation, distance to edge and distance to water (Newby 2011). See figure on p. 82 (Newby 2011). "During the study, pumas never climbed directly up steep slopes. Instead, they climbed steep slopes by tra- versing and choosing shallower path angles (mean inclin- ing path angle 7.3 ± 0.1o, median = 5.5o). Pumas also avoided walking down steeply declining slopes directly (mean declining path angle − 8.3 ± 0.1o, median = − 6.3o). The maximum path angle for a climbing puma was 34.3o; the minimum for a descending puma was − 37.0o (Fig. 1c)" (Dunford 2020)	effect of slope was strong in all seasons -- deer tended to select shallow slopes in spring and steep slopes during the rest of the year [Desert mule deer study in Imperial Valley, CA] (Marhsal et al. 2010)

Dispersal/Habitat Needs	Mountain Lion	Mule Deer
Citations	Riley et al. 2021; Beier et al. 1995; Blakey et al. 2022; Peterson et al. 2021; Thompson et al 2010; Karelus et al. 2021; Benson et al. 2016; Stoner et al. 2010; Sweanor et al. 2000; Newby 2011; Thorne et al. 2006	Kie et al. 2002; Marshal et al. 2010; Loft et al. 1987
Other Notes		home-range size in mule deer was expected to vary with an array of landscape and other variables such as season, reproductive status, and availability of food and water, we explained much of the variation in home-range size with metrics related specifically to heterogeneity of habitats (Kie et al. 2002)

Dispersal/Habitat Needs	Black Bear	Bobcat
Scientific Name	Ursus americanus	Lynx rufus
Habitat Guild	Generalist	Generalist
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)
Underpass	Min width 7m, height 4 m reccomended width >10m height >4m (Clevinger et al. 2011)	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice
Culvert	Can be used (Jensen et al 2018)	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m (Clevinger et al. 2011); 3.5 feet in diameter, concrete (20-East) (Phillips et al. "A Wildlife Linkage for the Highway 101 Corridor")
Corridor Measurments Continues	>50 m wide (Brennan et al. 2022)	X
Home Range Size	119km^2 for males and 49km^2 for females (Amstrup and Beecham 1976; Brown et al. 2009).	2km^2, 4.2 km2 (Lawhead 1984). Varying from 2km^2 to over 100km^2; 9.1km2 avg (Lawhead 1984). final home ranges averaged 63.1 +- 34.8km^2 (Johnson et al. 2010).
Dispersal Distance - Max	62 km (Costello 2010). floating bears max was 68km (Costello 2010). 219 km (Rogers).	20-288 linear km *South-Central Indiana (Johnson et al. 2010)
Dispersal Distance - Mean	40 km (Costello 2010). Floating bears 46 km (Costello 2010)	natal ranges avg 14.6 +- 2.1km^2 * South-Central Indiana and juveniles departed their natal ranges abruptly, initially traveling 9.7 +- 1.0 km to initiate dispersal attempt (Johnson et al. 2010)

Dispersal/Habitat Needs	Black Bear	Bobcat
Dispersal Habitat Preferences	X Not a lot of information, but it seems their regular habitat preferences carry over	Streams, riparian areas (Smith et al. 2020). Demographic and environmental factors may influence dispersal (Johnson et al. 2010). Urban development effect strongest in a population where stream habitat has been lost to development... suggesting riparian corridors may help mitigate reduced connectivity in urbanizing areas (Kozakiewicz et al. 2019). Bobcats in areas with relatively broad tracts of natural habitat may be better able to avoid urban areas because of more alternative route availibility.Territories adjacent to urban and highway barriers tend to be smaller and more densely distributed... thus juveniles from more urbanized areas may be required to disperse greater distances through potentially less suitable habitat (Kozakiewicz et al. 2019)
Dispersal Habitat Barriers	Central Valley lowlands, agriculture, and urban developments (Brown et al. 2009)	Roads, traffic, and urbanization (Smith et al. 2020) Urban habitat fragmentation(Kozakiewicz et al. 2019)
Dispersal Strategies	Males are dispersers while female typically remain in natal habitat (Schwartz and Fraanzman 1992; Elowe and Dodge 1989; Brown et al. 2009). Three stage process: emigration, movement, and immigration (Costello 2010)	Males make longer distance movements than females (4.5km vs 1.2km) (Lawhead 1984)

Dispersal/Habitat Needs	Black Bear	Bobcat
Habitat Preferences - Positive	Throughout California Black Bear inhabit montane hardwood, chaparral, and mixed conifer forests (California Dept of Fish and Game 1998; Brown et al. 2009).	Riparian (Smith et. al 2020, Lawhead 1984), dense understory (Lyren 2001); "riparian habitat may be preferred because of available food, water, good cover, ease of travel, or the prevalence of rocky ledges usable as rest sites" (Lawhead 1984); topographic roughness had a positive effect on gene flow for Southern California bobcats (Kozakiewicz et al. 2019). Bobcat order of compositional preference (>> indicates a significant difference between habitats): coast live oak >> coastal sage scrub > valley oak > grassland >> development > chamise chaparral > northern mixed chaparral (Fariás 2012). Higher elevation in summer (1,852.6)and lower in winter (1,365.5m) *Idaho (Koehler et al. 1989). Used all aspects equally in summer (Koehler et al. 1989).
Habitat Preferences - Negative	The only habitats that exclude Black Bear populations are the highly agriculture central valley and the Mojave Desert (Brown et al. 2009).	extensive grasslands (may be due to insufficient cover for successful hunting, scarcity of preferred prey, or both (Lawhead 1984); sensitive to habitat fragmentation and urbanization (Johnson et al. 2010); urban land cover (measured as impervious surface) had negative effects on gene flow in SoCal bobcats (Kozakiewicz et al. 2019).
Diel Activity and Daily Movement	Most active during crepsuscular periods, moderately active during the day and least active at night which is consident with other studies where bears were not greatly influenced by human activities (Lewis et al. 2011). Movement rates by black bears were greatest during morning and evening, moderate during diurnal time periods, and lowest at night *this was largely because this population in question was not habituated to human food resources* (Lewis et al. 2011).	Crepuscular and nocturnal hours (Dunagan 2019). 24 hour movements for males & males travel longer distances than females (Lawhead 1984)

Dispersal/Habitat Needs	Black Bear	Bobcat
Movements - Seasonal	In one study tracking six individual bears, they only used city areas during summer (Lyons 2005). Another study cited in this paper found that black bears occured more frequently in low elevatyions during spring and summer and continued climbing in elevation during fall and winter (Lyons 2005). In spring and early summer, adult males moved significantly more during the crepsecular time period than they did during late summer and fall (Lewis et al. 2011). Greater movement of males in soring and early summer is likely related to strategies to maximize their fitness (Lewis et al. 2011). Higher rates during spring and early summer could be related to mate seeking or because of teh prescense of berries on fruiting shrubs during late summer and fall (Lewis et al. 2011).	Seasonal movement changes in places with dramatic seasonal changes, but season information regarding SoCal is lacking
Corridor Use	In an Idaho study, forested areas without associated human development were the preferred habitat conditions for highway crossings by Black Bears (Lewis et al. 2011).	"where feasible, vegetated underpasses should be constructed to link natural habitat that is being fragmented by road and highway construction. Such underpasses would also reduce the number of animals killed on highways; could help prevent the local extirpation of large and rare species such as mule deer, bobcat, and mountain lion" (Soule et al. 1988). "telemetry and genetic studies have indicated occational crossing of major roads (in LA area) by bobcats, mostly facilitated by culverts or underpasses (Kozakiewicz et al. 2019);
Climate Suitability	See specific (not generalist) habitat guilds	
Slope (and aspect if defined)	Females generally used middle or high elevations during summer and lower elevation sin autumn. Bears spent less time on northern and northeastern aspects than expected based on availability, and used flatter terrain less than expected and moderately sloping terrain more than expected [Study done in Arkansas] (Clark et al. 1993)	avoided topographic slopes greater than 5 degrees, preferred flat areas (<2 degrees slope), and avoided steeper portions (>5 degrees) [study done in Maine]; bobcat use of topographic slope may have been influenced by variation in understory stem density (Litvaitis et al. 1986)

Dispersal/Habitat Needs	Black Bear	Bobcat
Citations	Lyons 2005; Brown et al 2009; Gantchoff et al. 2019; Costello 2010; Rogers pp 75 Mamallian Dispersal Patterns; Lewis et al. 2011; Lewis et al. 2011; Clark et al. 1993	Soule et al. 1988, Smith et al. 2020, Lyren 2001, Lawhead 1984; Johnson et al. 2010; Kozakiewicz et al. 2019; Fariás 2012; Litvaitis et al. 1986)
Other Notes	https://books.google.com/books?hl=en&lr=&id=wLmHVB-tB5AC&oi=fnd&pg=PA75&dq=black+bear+dispersal+&ots=E8OdEEzpfc&sig=-jR-dHL7oEr_6ArsB93G_DrBPOY#v=onepage&q&f=false	

Dispersal/Habitat Needs	Merriam's Chipmunk	Black-bellied Slender Salamander
Scientific Name	Tamias merriami	Batrachoseps nigriventris
Habitat Guild	Generalist	Generalist
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	X
Underpass	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice
Culvert	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m
Corridor Measurments Continues	X	X
Home Range Size	~300m (May ADW)	10 meters (expert)
Dispersal Distance - Max	X	X
Dispersal Distance - Mean	X	X

Dispersal/Habitat Needs	Merriam's Chipmunk	Black-bellied Slender Salamander
Dispersal Habitat Preferences	X	availability of downed wood and leaf litter to create cool microclimates (Cooper 2008)
Dispersal Habitat Barriers	X	Urbanization (Delaney et al. 2021)
Dispersal Strategies	X	X

Dispersal/Habitat Needs	Merriam's Chipmunk	Black-bellied Slender Salamander
Habitat Preferences - Positive	moderate shrub cover (Karasov-Olson & Kelt 2019), mature chaparral (Quinn 1990). Occupies habitats with a wide range of climates that have trees, shrubs, logs, stumps, snags, rocks, and litter (Best & Granai 1994). The habitat principally is brush, as in extensive chaparral covered slopes wixed with oak and pine forests or thickets along streamsides and around rock outcroppings (Best & Granai 1994). "Of 129 night shelters, 127 faced east or within 30° of east; of the exceptions, one faced west and one faced north, but had three entrances in the same log that faced eastward" (Best & Granai 1994)	Associated with Canyon live oak and foothill pine cover. Almost always found under logs, downed branches, or under leaf litter (Block 1998); inhabits mostly oak woodlands but also found in chaparral, grasslands, streamsides, and oak and pine forests (California Herps); occupancy increased within greater proximity to human-made water sources (Miles 2014); abundance was greater in forested habitats and mixed forest or developed landcover (Miles 2014)
Habitat Preferences - Negative	Grassland (Dan)	occupancy was negatively correlated with elevation such that this species was predicted not to occupy sites above 33m in elevation (Miles 2014)
Diel Activity and Daily Movement	Diurnal. Two daily foraging intervals are seperated by a midday rest. In midsummer, the first foraging period spans 3.5 h of continous activity by adults and a loger period for nonadults. Second period occurs in midafternoon and ends when the chipmunk abruptly stops searching for food and rushes to night shelter. Afternoon foraging is done more leisurely than in the morning (Best and Granai 1994). Rarely does Merriam's chipmunk go >300 m from the night shelter. The distance traveled depends upon foraging areas; thus, there is seasonal variation in distance moved during the day. T. merriami begins its early morning foraging at sites located ~ 18 m from the night shelter, and then moves upslope as it forages. One foraging site was 397.5 from the night shelter (Best and Granai 1994). Its daily food gathering often takes T. merriami into chaparral that extends into oak woodlands or grows in adjacent communities. Night shelters are not located in chaparral shrubs; rather, T. merriami returns in late afternoon to oak woodlands (Best	active on rainy/wet nights, but retreats underground when soil dries (California herps...find cite)

Dispersal/Habitat Needs	Merriam's Chipmunk	Black-bellied Slender Salamander
Movements - Seasonal	Active in winter througout much of range (excluding the upper edge of its elevational range that gets cold and snowy). In autumn activities include increased mobility, intensive feeding, harvesting, and caching, increased aggresive chases, choosing a shelter site, decrease in hours abroad, and autumnal quuiescence. Winter activities include emergence from autumnal quiescence, pit digging, concentration of males into groups, high levels of male-male tolerance, marking trails, precourtship, courtship, male display, copulation, and gestation. In spring, activities include arrival of wanderers, continued mating, courtship chases, copulations, gestation, gathering of nesting materials, parturition, rearing of young, postpartum heat, transfer of young, independent activity of young, and decreased activity of adult males. In summer, litter mates no longer travel together, adults molt and gain body mass, mobility of adults begins, there is summer quiescence, young females mature, and dispersal of young begins (Best and Granai 1994). In spring and summer, ca. 920/0 of diurnal activity occurs at the foraging ground.	X
Corridor Use	In the east* "Chipmunks crossed the entire range of gap sizes and there was no evidence of a threshold in connectivity" and can use fencerow corridors (Bowman and Fahrig). Fencerows need some hospitable habitat (Bennett et al 1994).	X
Climate Suitability	See specific (not generalist) habitat guilds	
Slope (and aspect if defined)	Any slope with adequate cover (Dan)	occupancy was negatively correlated with elevation such that this species was predicted not to occupy sites above 33m in elevation (Miles 2014)

Dispersal/Habitat Needs	Merriam's Chipmunk	Black-bellied Slender Salamander
Citations	Borchert & DeFalco 2016; Karasov-Olson & Kelt 2019; Quinn 1990; Best & Granai 1994	California Herps; Block 1998; Cooper 2008; Delaney et al. 2021; Miles 2014
Other Notes		"noise volume was a factor in the top model of salamander abundance..." (Miles 2014). susceptible to increased mortality from polluted runoff associated with roadways and urban drainage (Miles 2014, as cited by Barrett & Price 2014)

Dispersal/Habitat Needs	Western Gray Squirrel	Brush Rabbit
Scientific Name	Sciurus griseus	Sylvilagus bachmani
Habitat Guild	Pine oak woodland	Scrub
Overpass	X	European Rabbits used overpasses in the netherlands (Corlatti 2008)
Underpass	Use underpasses (Brehme 2022)	X seems they will use, but no specifics
Culvert	*Eastern Gray Squirrel used culverts with a mean width and height of 2.44 m by 1.9 m and a mean length of 43.36 m (Sparks et al 2017).	3.5 feet in diameter, concrete (20-East) (Phillips et al. "A Wildlife Linkage for the Highway 101 Corridor")
Corridor Measurments Continues	X	X
Home Range Size	Home range *in Washington* (95% fixed-kernel) estimates for females averaged 18.7 ha. Core use areas averaged 4.39 ha (Haegen et al. 2005).	F avg 69, m avg 115 (Connell 1954)
Dispersal Distance - Max	5116 m (Haegen et al. 2005).	"Investigators have reported cases of emigration in the cottontail tabbit. Dalke and Sime (1938) found four rabbits from 1 to 2.4 miles from where they were marked as juveniles" (Shields 1960).
Dispersal Distance - Mean	Rates for males and females were similar. Mean dispersal distance was 2862 m (Haegen et al. 2005).	Distances traveled by emigrating juveniles varied from 562 feet to 1,156 feet (Shields 1960).

Dispersal/Habitat Needs	Western Gray Squirrel	Brush Rabbit
Dispersal Habitat Preferences	Same as habitat preferences. Riparian corridors or through trees (Dan)	X
Dispersal Habitat Barriers	X ask Dan? Presumably lowlands without trees	X
Dispersal Strategies	Washington* 20% of juv squirrels dispersed from the study grid where they were captured (Haegen et al. 2005) Three of 6 dispersing individuals died within 6 months of moving; 2 disappeared (likely due to radio failure), and one established a home range 2.7 km from the capture grid (Haegen et al. 2005).	High population density is the most probable reason for movement of animals from the area (Shields 1960). Some males make long movements in search of mates (Shields 1960). Population pressire is the most likely cause of emigration of animals, particulary juveniles from an area (Shields 1960).

Dispersal/Habitat Needs	Western Gray Squirrel	Brush Rabbit
Habitat Preferences - Positive	"common and widespread in oak- and pine-dominated areas of the hills and mountains of southern California (Wilson and Reeder 2005)" Cooper & Muchlinski 2015. Research by Barnum (1975) documented the presence of gray squirrels "only in stands with > 5 acres of mature oaks and < 430 yards from water." Areas supporting <5 acres of oak with no conifers therefore may be inadequate habitat to support western gray squirrels in Southern California. (King 2004). Most frequently associated with pines and oaks both of which are associated with hypogeous fungi which is another staple food of WGS (Haegen et al. 2005).	openings near shrubs (Quinn 1990). Maximum range diameter: 556 adult males, 569 adult females, 325 juvenile males, 500 juvenile females. Minimum range diameter: : 50 adult males, 38 adult females, 25 juvenile males, 31 juvenile females. Mean range diameter: : 278 adult males, 149 adult females, 131 juvenile males, 191 juvenile females (Shields 1960). Brush rabbit mobility affected by cover, food supply, breeding season, popualtion pressure, and possibly weather (Shields 1960). Bush lupine, thje major escape cover used by Brush rabbits in the study area is also the staple food (Shields 1960). They are usually found within a few yards of lupine cover throughout the year besides at times in dry summer months(Shields 1960).
Habitat Preferences - Negative	Declining below around 457, particulary in areas where it has come into contact with Fox Squirrel (Cooper et al. 2015).	"Brush rabbits do not venture far from dense cover, usually brushy habitat, but open fields of tall grasses and forbs adjacent to dense brush provide foraging opportunities." (Phillips 2022)
Diel Activity and Daily Movement	Morning activity begins after sunrise and without major presence of human activity continues until the heat of the day (between 2Pm and 5PM). It picks back up during the evening hours (5PM-7PM). All Squirrels return to their nests for the night by sunset (King 2004)	X

Dispersal/Habitat Needs	Western Gray Squirrel	Brush Rabbit
Movements - Seasonal	During summers when acorns are less available they sepnd less time foraging and the much more time traveling in search of food. Daily travel increases in search of buried acorns. Foraging activities increase from summer lows to higher levels during teh fall as a result of acorn mast production. As fall transitioned to winter, foraging increased and shifted from burying acorns to searching for and recovering acorns that were buried the previous season. Spring brought an abundance of new vegetation growth and the emergence of flowers leading to the highest proportional levels of time spent foraging (King 2004)	Male ranges increased during the breeding season while those of the female decreased in size. Home ranges of most of the animals centered about 40 feet inside t the brush, but rabbits were trapped throughout the chaparral and th of fecal pellets indicated that, at least in winter, the rabbits foraged joining grassland up to 70 feet from the brusbh (Connell 1954).
Corridor Use	X	X
Climate Suitability	"Using a RCM-based future climate scenario, we found that potential ranges of two California endemic oaks, Quercus douglasii and Quercus lobata, shrink considerably (to 59% and 54% of modern potential range sizes, respectively) and shift northward" (Kueppers 2005).	Increase in fire frequency (Dan)
Slope (and aspect if defined)	Canyon bottoms in study area (Dan) Likely to prefer North facing.	Any slope with adequate cover (Dan)

Dispersal/Habitat Needs	Western Gray Squirrel	Brush Rabbit
Citations	Cooper et al. 2015; King 2004; Haegen et al. 2005	
Other Notes		

Dispersal/Habitat Needs	Kangaroo Rat	California Quail
Scientific Name	Dipodomys spp.	Callipepla californica
Habitat Guild	Scrub	Scrub
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	X
Underpass	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice	Use underpasses (Caldwell et al. 2019). "California Quail, CaliforniaThrashers,and Bewick's Wren have been observedin stripsless than10 m inwidth,andwe believe that corridors half this width probably would be effective as long as the chaparra lwas dense and formed a nearly continuous cover" (Soule et al 1988).
Culvert	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m	X
Corridor Measurments Continues	X	"To our knowledge ,there have been no studies of this issue,but our own observations suggest that most,if not all, of the chaparral-requiring species can use relativelynarrowstripsof vegetation" (Soule et al 1988).
Home Range Size	M avg 0.33ha and F avg 0.31ha (Behrends et al. 1986); avg 20m *Stephens Kangaroo Rat (Price et al. 1994)	"Home ranges during laying (6-77ha) and incubation (1-19ha) were larger in Oregon than those reported during laying (5-10ha) and incubation (104ha) in central California…differences in habitat between the areas may have accounted for the differences in habitat use" (Kilbride et al. 1992)
Dispersal Distance - Max	0 to 265 m M and 0 to 158 m F (Jones 1989). Giant Kangaroo rat sibling pair was found 5.52 km apart and 10 half siblings were found from 0-19.64 km apart (Alexander 2016).	X dispersal of translocated birds, but not relevant
Dispersal Distance - Mean	Many banner tailed kangaroo Rat adults spent entire lives within 50 m of their first breeding residence. Very limited travel (Waser et al 1991); the median lifetime distance moved by M first captured as adults was 46.5m and 25m for F, juv M were 61.5m and 50m for F (Jones 1989)	X

Dispersal/Habitat Needs	Kangaroo Rat	California Quail
Dispersal Habitat Preferences	X	Coastal scrub; open, grassy areas adjacent to scrub (Soule et al. 1988)
Dispersal Habitat Barriers	Water (Grinnell 1919); urbanization, dense grassland vegetation *Stephens Kangaroo Rat (Price et al. 1994)	X
Dispersal Strategies	X	"Poor dispersal"

Dispersal/Habitat Needs	Kangaroo Rat	California Quail
Habitat Preferences - Positive	flat, sparsely vegetated annual grassland or Riversidean coastal sage scrub, having less than ~15% shrub cover *Stephens Kangaroo Rat (Price et al. 1994)	Coastal scrub, "may make use of open habitats" (Soule et al. 1988)
Habitat Preferences - Negative	aversion to shrub cover *Stephens Kangaroo Rat (Price et al. 1994)	Urbanized lowlands (Garrett, Birds of Baldwin Hills)
Diel Activity and Daily Movement	nocturnal; nightly movements detected males ≤146 m and females ≤123 m from home-range centers (Jones 1989); males concentrated their activity in areas of a bout 0.67 ha, or roughly 92m in diameter, females concentrated their activity in areas of 0.17ha or about 46m in disameter (Jones 1989)	Feed on ground, don't fly far (Soule et al. 1988)

Dispersal/Habitat Needs	Kangaroo Rat	California Quail
Movements - Seasonal	"Rather than occurring at a particular age or season, movements in D. meriiami may occur in response to changes in resource distributions or in the social environment" (Jones 1989); "most lifetime-dispersal distances were within the radii of familiarity indicated by radiotelemetry" males moved ≤125m during their lifetime, and females moved ≤100m during their lives (Jones 1989)	"Chaparral-requiring species rarely fly far" (Soule et al. 1988)
Corridor Use	X	Seen using strips <10m (Soule et al. 1988)
Climate Suitability	Increase in fire frequency (Dan)	
Slope (and aspect if defined)	Flat areas or grassy rolling hills. Low slopes (Dan)	X Very wide ranging

Dispersal/Habitat Needs	Kangaroo Rat	California Quail
Citations	Jones 1989; Behrends et al. 1986; Price et al. 1994; Grinnell 1919; Kofron & Villablanca 2016	Soule et al. 1988; Garrett, Birds of Baldwin Hills; Kilbride et al. 1992
Other Notes	activity and frequent moves to new burrows may contribute to the ability of the D. merriami to shift home ranges (Jones 1989). Table 5 p 39 Alexander 2016. "in the absense of fire, the early seral stage of coastal dune scrub (optimal habitat) have matured to later successional stages of vegetation, which are denser and with substantially fewer annual food plants, and which negatively impact kangaroo rats and change the diversity of the small mammal community with a likely increase in competition" *Morro Bay kangaroo rat (Kofron & Villablanca 2016)	

Dispersal/Habitat Needs	Greater Roadrunner	Blainville's Horned Lizard
Scientific Name	Geococcyx californianus	Phrynosoma coronatum
Habitat Guild	Scrub	Scrub
Overpass	X	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)
Underpass	WIll use (Brehme 2022)	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice
Culvert	Will use (Painter 2007); 3.5 feet in diameter, concrete (20-East) (Phillips et al. "A Wildlife Linkage for the Highway 101 Corridor")	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m. Flat tailed horned lizards used culverst in Arizona (). Dark culverts were used more frequently (nine crossings) than culverts with skylights (three crossings). The 36-inch diameter culverts were used most frequently (six crossings), and the 24-inch diameter culverts were used least frequently (two crossings).
Corridor Measurments Continues	X	x
Home Range Size	a mean minimum convex polygon home range of 43.0ha (Montalvo et al. 2014) [West TX study]; averaged 28-50ha in previous studies in South TX by Folse 1974, Arizona by Calder 1965, and southern California by Bryant 1916...but sizes variable depending on resource availability (Montalvo et al. 2014). "Crooks et al. (2001) estimated that a minimal fragment size of 157 ha was needed to insure a 95% probability of roadrunner occurrence after 100 years of isolation."	Varies by year and season (0.0058-0.14km^2). Avg around 5 ha (Hult 2015). Min around .6. Small home range (Wenner 2020). "A single acre may contain 3-20 horned lizards (Brattstrom 2013).
Dispersal Distance - Max	X	1000m *Greater Short horned and Desert Horned* (Inman et al 2020)
Dispersal Distance - Mean	X	100m *Greater Short horned and Desert Horned* (Inman et al 2020)

Dispersal/Habitat Needs	Greater Roadrunner	Blainville's Horned Lizard
Dispersal Habitat Preferences	Grassland, mesa-ridge, chaparral (Montalvo et al. 2014); chaparral, open, grassy areas adjacent to scrub (Soule et al. 1988)	Grasslands, coastal sage scrub, pine forest; along major rivers and tributaries that pass though the Los Angeles Basin; extends out into the desert in pinyon-juniper and desert chaparral (occasionally associated with Joshua Trees); sandy areas of flood plains and major rivers (Brattstrom 2023)
Dispersal Habitat Barriers	Bare ground, habitat loss, degredation, urbanization (Montalvo et al. 2014)	central urban areas (but "does occur in pockets within that city"); urbanization; complex topographies
Dispersal Strategies	"Poor dispersal"	vegetation community, microclimate, soil composition, and topography have influenced functional connectivity over geologic timescales; have small ranges and are unable to navigate complex topographies (Wenner et al. 2022). Small dispersal distance (Wenner 2020)

Dispersal/Habitat Needs	Greater Roadrunner	Blainville's Horned Lizard
Habitat Preferences - Positive	Grassland, ridge, chaparral (Montalvo et al. 2014, Garrett, Birds of Baldwin Hills, Soule et al. 1988)	habitat must provide heat, basking sites, egg-laying sites, the opposite sex, and enough space to carry out normal behavior (Brattstrom 2023); prefers loose, sandy soils for burrowing, burrows and shrubs for refugia, and open areas for thermoregulation (Wenner et al. 2022). Native chapparall and shrubs(Wenner 2020). Sparse vegetation and open ground with sandy substrata (Wenner 2020). Grasslands to coastal sage scub to pine forest (Brattstrom 2013).
Habitat Preferences - Negative	Bare ground, flatland (Montalvo et al. 2014)	habitat "islands"; presence of Argentine ants (these ants are not eaten by CHLs and reduce the populations of the native ants that are eaten by CHLs) (Brattstrom 2023, Wenner et al. 2022)
Diel Activity and Daily Movement	Feed on ground in open or grassy areas adjacent to chaprral habitat, where they return for cover (Soule et al. 1988)	small dispersal distance (Wenner et al. 2022).Avg daily movements (mean = 45.0; range = 10–220 m... similar to previous studie: Fair and Henke (1999) avg movement of 36.5 m/day (range = 0.0–246.7 m), and Whitford and Bryant (1979)avg of 46.8 m/day (range = 9–91 m) (Stark et al. 2005_. Activity of adult lizards is influenced by multiple factors, such as the thermal environment, need for food, and mating condition (Stark).*Stark data is on Texas Horned Diurnal

Dispersal/Habitat Needs	Greater Roadrunner	Blainville's Horned Lizard
Movements - Seasonal	X	home-range size varies considerably by year and season (0.0058-0.14km^2) (Wenner et al. 2022)
Corridor Use	X	Likely do not move across impervious surfaces (Wenner 2020). Moves in short bursts with a tendency to remain still when threatened (Wenner 2020). Dispering individuals would be highly vulnerable to road mortality (Wenner 2020).
Climate Suitability	Increase in fire frequency (Dan)	
Slope (and aspect if defined)	Presumably some preference for south facing because that's where coastal sage scrub is more likely to develop (Dan). If anything prefers no slope--like flatter areas (Dan). Low slopes (Dan).	Ridges and steep canyons inhibit gene flow (Wenner 2020). Restricted by rugged terrain (Brattstrom 2013).

Dispersal/Habitat Needs	Greater Roadrunner	Blainville's Horned Lizard
Citations	Montalvo et al. 2014; Soule et al. 1988; Garrett, Birds of Baldwin Hills	Brattstrom 2023, Wenner et al. 2022
Other Notes	"The ecology of roadrunners, including home-range requirements, is not well documented. Existing literature is somewheat dated and observational in nature (Bryant 1916, Calder and Schmidt-Nielsen 1967, Folse 1974) and the reported results are highly variable likely because of differences in local resource availability, geography, rainfall, soil type, and land use (Ford 1983)" (Montalvo et al. 2014)	Table 5 and 6 (Wenner 2020) Thesis. Sea level to 2348 m (Brattstrom 2013).

Dispersal/Habitat Needs	Western Toad	Ringtail
Scientific Name	Anaxyrus boreas	Bassariscus astutus
Habitat Guild	Riparian	Generalist
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)
Underpass	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice
Culvert	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m
Corridor Measurments Continues	X	
Home Range Size	X	Avg M 462 ha and avg F 94 ha (Harrison 2012). 21-63 ha (Correa et al. 2014). M avg 43.4 ha F avg 20.3 ha (Toweill & Teer 1980)
Dispersal Distance - Max	2,720 m (Bull 2009); 13km (Myers 2020)	X
Dispersal Distance - Mean	"Estimated mean distance at which female toads were found away from the center of the breeding pond was 721.46 m (SE = 167.21); the estimated mean distance for males was 218.15 m (SE 142.19)" (Muths 2003). *Boreal Toad	X

Dispersal/Habitat Needs	Western Toad	Ringtail
Dispersal Habitat Preferences	standing water, wetland areas and shallow, vegetated margins of lakes (Myers 2020)	Adapts to disturbed areas and frequently found in human habitation (Barja & List 2006).
Dispersal Habitat Barriers	habitat fragmentation (Stuart et al. 2004); clearcuts (deMaynadier & Hunter 1995 & Knapp et al. 2003, as cited in Deguise & Richardson 2009)	Cropland areas (Correa et al. 2014)
Dispersal Strategies	"Toadlets dispersed up to 2,720 m from the breeding site within eight weeks of transformation in one of three study areas in northeastern Oregon during 2006–2008. Toadlets traveled an average of 84 m/day and dispersed along drainages with intermittent or permanent water associated with streams, seeps, and marshy areas. Juveniles were detected 1,070-2,720 m from the breeding sites in all study areas." (Bull 2009)	Can disperse through anthropogenic land-cover matrices (Correa et al. 2014)

Dispersal/Habitat Needs	Western Toad	Ringtail
Habitat Preferences - Positive	riparian, wetland, upland scrub (Jennings et al. 2019); forests, wetlands, open meadows, and occationally in disturbed areas such as clearcuts, ditches, and gravel pits (Deguise & Richardson 2009, as cited by Muths 2003 & Bartelt et al. 2004)	Riparian, canyons, rocky slopes, dense brush, nearby water (Quinn 1990). Used a variety of den settings: rocks, trees, shrubs, rocks and shrubs, and holes in the ground (Harrison 2012). Males used trees and rocks more and shrubs less than females(Harrison 2012). Not tied to water as often thought (Harrison 2012).
Habitat Preferences - Negative	X presumably areas away from water	"Flashfloods may make these areas more dangerous and the competition from other species may make riparian areas less profitable to ringtails." (Ackerson & Harveston 2006)
Diel Activity and Daily Movement	0.25-290m daily and up to 1,976m within a month (Myers 2020)	Strictly noctural and utilize dens daily (Harrison 2012).

Dispersal/Habitat Needs	Western Toad	Ringtail
Movements - Seasonal	males: 0.9km from breeding site to summer home range, females: up to 2.4km from breeding site to home range (Myers 2020)	Females moved least in summer and most in autumn, but males showed no seasonal trend in movements(Harrison 2012). In summer and autumn, ringtails used rocks more and shrubs less than expected, and in winter ringtails used rocks less and shrubs and holes in the ground more than expected(Harrison 2012); "In the Edwards Plateau region, Toweill and Teer (1980) discovered that ringtails shift home ranges in accordance with the seasons, with females having more wildly separated home ranges" (Tiedt 2011) "Sample sizes of ringtails in winter and summer were too small to compare seasonal ranges. However, winter ranges were larger than summer ranges." "Mean summer range size was 0.28+-0.163km^2. Mean winter range was 0.63+-0.219km^2" (Ackerson & Harveston 2006)
Corridor Use	observed in culverts (Myers 2020)	X
Climate Suitability	"As droughts become more frequent and more severe under anthropogenic climate change, water stress due to diminished subsurface supplies may threaten the health and function of semi-arid riparian woodlands, which are assumed to be largely groundwater dependent" (Kibler 2021). More extreme weather events like more requent and intesne flooding and higher intesnity droughts (Easterling 2000+	
Slope (and aspect if defined)	X Probably low because of decrease in abundance away from water (Dan)	"The slope surrounding dens averaged 35.1 +-11.8%, with 90.6% of ringtail dens occurring on slopes between 30-60%" (Ackerson & Harveston 2006)

Dispersal/Habitat Needs	Western Toad	Ringtail
Citations	Myers 2020; Stuart et al. 2014; Jennings et al. 2019; Deguise & Richardson 2009	Perez-Flores et al. 2021, Quinn 1990; Harrison 2012; Barja & List 2006; Correa et al. 2014; Tiedt 2011; Ackerson & Harveston 2006
Other Notes		(1978), Towel & Beer (1982), Lacy (1983), Yarchin (1994), and this study were probably attributed to the method used, topography of study area, or resource abundance and distribution" (Ackerson & Harveston 2006). Smallest ranges reported in riparian forest habitat (Lacy 1983; Wyatt 1993) E.g., 0.05-0.14 km2 (12-35 acres), reported in one 8 month study in a California riparian forest (Lacy 1983) Between 0.05 and 3.49 km2 (12-862 acres), based on calculated estimates reported from population studies in Arizona, California, Texas, and Utah

Dispersal/Habitat Needs	Gray Fox	Western Whiptail
Scientific Name	Urocyon cinereoargenteus	Cnemidophorus tigris
Habitat Guild	Generalist	Generalist
Overpass	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)	Min width 40to50m, reccomended 50-70m (Clevinger et al. 2011)
Underpass	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice	Reccomended=min: width 0.3-1.2m, height 0.3-1.2 m *If designates for small to medium sized mammals... otherwise, the large mammal dimensions suffice
Culvert	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m	Min width 0.5 m, min clearance >1m. Reccomended width >1m, clearance >1.5 m
Corridor Measurments Continues		
Home Range Size	75 ha (Yearsey et al 1980, Deuel et al 2017). Most range mins at 100km (Dueul et al 2017). appx 8 km2, Tucker 1987, Harrison 1997	
Dispersal Distance - Max	24 km *Alabama(Nicholson et al. 1985).	
Dispersal Distance - Mean	120 ha (Quinn 1990).	

Dispersal/Habitat Needs	Gray Fox	Western Whiptail
Dispersal Habitat Preferences	X	
Dispersal Habitat Barriers	Roads and irrigaton ditches can influence dispersal direction and movements (Harrison 1997). Times of day and habitats where risk of predation is high (Fariás 2012).	development (California Herps...find their citation)
Dispersal Strategies	Juvenile females did not display a tendency to leave the natal area in Alabama (Nicholson et al. 1985).	

Dispersal/Habitat Needs	Gray Fox	Western Whiptail
Habitat Preferences - Positive	Mature chaparral, open chaparral, riparian, canyons, rocky places, woodlands, dense brush, climbs into trees and shrubs (Quinn 1990). Can use anthropogenic structures, such as abandoned houses for dens (Harrison 1997). Gray foxes may have preferred northern mixed chaparral because their common small-mammal prey were species typical of brushy habitats (eg dusky footed woodrat) and it was least useed habitat by sympatric coyotes and bobcats (Fariás 2012). Gray fox order of compositional preference (>> indicates a significant difference between habitats): northern mixed chaparral >> coastal sage scrub > coast live oak >> chamise chaparral >> valley oak > grassland >> development (Fariás 2012).	hot and dry open areas with sparse foliage - chaparral, woodland, and riparian areas (California Herps...find their citation); shrub habitats (Miles 2014)
Habitat Preferences - Negative	The threshold for avoidance of residential areas appears to be between 50 and 125 residencies/km2 (Harrison 1997). "Gray foxes have been reported to live in developed areas and open habitats, but in our study, gray foxes did not use development and selected against open habitats" (Fariás 2012).	forest habitats, herbacious habitats (Miles 2014)
Diel Activity and Daily Movement	Vixens were found resting 20m-0.8km away from the immediate den site during most of the weaning period (Nicholson et al. 1985). Movement activity of three vixens increased in the late afternoon once they moved to their dens (Nicholson et al. 1985). Females left den sites between sunset and dark and returned during the night presumably with food for pups (Nicholson et al. 1985). A second pre dawn trip was usually mad (Nicholson et al. 1985). Male foxes monitored demonstrated an affinity for the den site but were not observed making repeated trips back to the den site and rather foraged in the same general area but seperate from females (Nicholson et al. 1985). Mainly were crepuscular and nocturnal with a daily activity rate of 6-% in the summer dry season and 56& in the winter wet season *SoCal study* (Fariás 2012)	

Dispersal/Habitat Needs	Gray Fox	Western Whiptail
Movements - Seasonal	They may reduce activiity at daytime and increase activity at nighttime during the dry season (when compared to the wet season) as stategy to avoid heat stress, or to follow activity patterns of prey (Fariás 2012).	
Corridor Use	Gray foxes can use areas bisected by major roadways if culverts are provided. Irregularly shaped areas of otherwise suitable habitat may not be as useful to foxes as more simply shaded areas. Corridors should be provided and maintained in order to allow efficient travel within home ranges (Harrison 1997).	
Climate Suitability		
Slope (and aspect if defined)		

Dispersal/Habitat Needs	Gray Fox	Western Whiptail
Citations	Quinn 1990; Nicholson et al. 1985; Harrison 1997; Farías et al. ; Rubalcava-Castillo et al. 2020	
Other Notes		

Dispersal/Habitat Needs	Arroyo Chub
Scientific Name	Gila orcuttii
Habitat Guild	Riparian (aquatic)
Overpass	
Underpass	
Culvert	
Corridor Measurments Continues	
Home Range Size	
Dispersal Distance - Max	
Dispersal Distance - Mean	

Dispersal/Habitat Needs	Arroyo Chub
Dispersal Habitat Preferences	
Dispersal Habitat Barriers	dams, channelization, urbanization (O'Brien & Barabe 2022)
Dispersal Strategies	

Dispersal/Habitat Needs	Arroyo Chub
Habitat Preferences - Positive	slow-moving sections of cool to warm (10–26°C) streams dominated by sand and silt substrates (O'Brien & Barabe 2022); found fish in pools with gravel, cobble, and boulder substrates, illustrating the diversity of habitat used by this species (Feeney & Swift 2008)
Habitat Preferences - Negative	habitat loss, urbanization, water development, flood control, and the introduction of invasive species (O'Brien & Barabe 2022)
Diel Activity and Daily Movement	

Dispersal/Habitat Needs	Arroyo Chub
Movements - Seasonal	Spawning generally occurs in June and July, but the eggs of females ripen in small batches (Tres 1992), allowing spawning to occur anywhere from February through August (O'Brien & Barabe 2022)
Corridor Use	
Climate Suitability	drought-caused extirpation (O'Brien & Barabe 2022)
Slope (and aspect if defined)	

Dispersal/Habitat Needs	Arroyo Chub
Citations	O'Brien & Barabe 2022; Feeney & Swift 2008
Other Notes	

Appendix C

Connectivity Modeling Methods and Results

Connectivity Modeling Methods

Connectivity modeling uses spatially explicit landscape data to predict how wildlife might move across the landscape, creating a data layer of landscape conductance akin to the movement of energy on a circuit board through a series of resistors (McRae et al. 2016). This approach allows us to predict functional connectivity for a species based on the habitat and dispersal needs of each species. In addition, it provides a way to test how various configurations of wildlife bridges and corridor remediation would contribute to overall connectivity. Omniscape (Landau et al. 2021) is one method that is commonly used for quantifying functional landscape connectivity. This method uses a moving window approach to calculate conductance across an entire landscape. Each pixel in the landscape is visited as the center of a moving window, and at each pixel connectivity is calculated to all other pixels within a set radius. All resulting individual connectivity calculations are merged into a landscape wide connectivity map of the landscape showing cumulative current flow across the landscape.

For each focal species we first identified source habitat and barriers or resistance to dispersal based on an extensive literature review. These variables included urban development/land use, slope, aspect, elevation, habitat classification, freeways and other major roads, existing underpasses and overcrossings, culverts and channels, light pollution, and noise pollution. We compiled a set of geographic datasets that cover our study area and had data relevant to our variables (Table C-1).

Table C-1. Geographic datasets used in analysis.

Dataset Name	Year	
EPA MULC (Meter-scale Urban Land Cover)	2016	High resolution land cover classifications
USDA Calveg	2002-03	Coarse scale California Wildlife Habitat Relationship (CWHR) classifications of vegetation cover
LARIAC LIDAR DEM	2016	High resolution LA County wide aerial elevation data
OpenStreetMap (OSM)	2023	Bridges, roads, buildings, land use areas, culverts, channels, tunnels
VIIRS Light Pollution	2023	Remotely sensed light pollution
BTS National Transportation Noise Map	2018	Modeled highway and rail noise pollution

For all raster data we used a resolution of 10 meters because this was the finest resolution for which we had high quality data while still being computationally feasible. For all landscape data, we set an extent to twice the area of our focal area to include as a buffer because connectivity models are prone to edge effects (Anderson et al. 2012). The buffer was cropped from the final output prior to analyses to remove areas where edge effects would be present.

We combined the categorical datasets (MULC, Calveg and OSM) into a single landcover raster dataset covering our study area. Calveg contains coarse scale polygons (2.5-acre minimum) that describe the dominant CWHR vegetation type present in each polygon such as Coastal Oak Woodland or Montane Chaparral but was last updated in 2003 in our study area. MULC does not include specific vegetation types or alliances but rather broad scale land cover classifications such as barren, grass, shrub, tree, impervious and water, but is a much higher resolution than Calveg at 1-meter pixel resolution. We used aerial imagery, field surveys and fire history footprints to correct habitat types in our study area and then re-mapped the MULC land cover pixels into more specific CWHR categories using our corrected Calveg dataset (Table C-2).

Before combining with Calveg, we renamed some values in MULC. We renamed the Tree class to Mixed Trees – Chaparral as MULC does not accurately detect a difference between Trees, Chaparral and tall Shrubs. We also changed the name of Shrub to Mixed Shrub – Scrub. Barren – Soil was renamed to Grassland as most areas MULC called Barren turned out to be Invasive Annual Grassland based on our review.

Table C-2. Calveg and MULC combination rules.

Calveg Type	MULC Type	Resulting Type
Coastal Oak Woodland Montane Hardwood Valley Foothill Riparian Desert Wash Sierran Mixed Conifer Valley Oak Woodland Evergreen Orchard Montane Hardwood-Conifer Montane Riparian	Tree	Calveg
Chamise-Redshank Chaparral Mixed Chaparral Montane Chaparral	Shrub or Tree	Calveg
Coastal Scrub Desert Scrub Sagebrush	Shrub or Tree	Calveg
Barren	Any	Calveg
Urban	Tree	Urban Tree
Montane Riparian Valley Foothill Riparian	Woody Wetland	Calveg

After combining MULC and Calveg, we add the physical infrastructure layers from OSM on top of the landscape. This gives us a single land cover raster that can be used to define both source habitat and resistance values for each focal species.

We compiled a list of the relevant categorical variables found across our map layers that would be selected for use in habitat and resistance value calculation for each focal species (Table C-3). We then took each focal species and created a list of relative weights for source habitat and resistance. Weights for mountain lion are included as an example. Source weights of 1 mean the pixels in the study are treated as source habitat when creating source habitat raster maps, and a weight of 0 means that pixel is not viable source habitat. Resistance weights are relative values where 1 is low resistance (increases current flow) and resistance increases as with the value. In this case our highest resistance landscape feature are freeways which we set at 500. Values are set according to our literature review.

Table C-3. Categorical variables used to define habitat and/or resistance values.

Dataset	Variable	Mountain Lion Source Weights	Mountain Lion Resistance Weights
Calveg CWHR	Coastal Oak Woodland	1	5
Calveg CWHR	Montane Hardwood	1	5
Calveg CWHR	Valley Foothill Riparian	1	1
Calveg CWHR	Desert Wash	1	1
Calveg CWHR	Sierran Mixed Conifer	1	5
Calveg CWHR	Valley Oak Woodland	1	5
Calveg CWHR	Evergreen Orchard	0	10
Calveg CWHR	Montane Hardwood-Conifer	1	5
Calveg CWHR	Montane Riparian	1	1
Calveg CWHR	Chamise-Redshank Chaparral	1	1
Calveg CWHR	Coastal Scrub	1	1
Calveg CWHR	Desert Scrub	1	1
Calveg CWHR	Mixed Chaparral	1	1
Calveg CWHR	Montane Chaparral	1	1
Calveg CWHR	Sagebrush	1	1
Google Satellite	Underpass (Dirt) (hand-traced)	0	50
Google Satellite	Barren (hand-traced)	0	50
MULC	Unclassified	0	0
MULC	Open Water	0	0
MULC	Developed	0	100
MULC	Trees	1	5
MULC	Shrub	1	1
MULC	Grassland	0	50
MULC	Pasture	0	50
MULC	Woody Wetlands	1	1
MULC	Emergent Wetlands	1	1
OSM	Overcrossing	0	200
OSM	Underpass	0	200
OSM	Building	0	0
OSM	Road	0	100
OSM	Culvert	0	400
OSM	Landfill	0	50
OSM	Freeway	0	500
OSM	Pipeline	0	100

We also used species-specific minimum habitat patch size parameters to filter out isolated patches of contiguous viable habitat that are below a threshold for use as source habitat (Table C-4).

Table C-4. Minimum patch sizes used to define source habitat.

Species	Minimum Patch Size (Meters)
Mountain lion	1000
California tree frog	10

We created a set of resistance raster maps to describe landscape permeability for each species based on the assigned weights. For each continuous variable we identified the maximum cost and predicted relationship between that variable and movement. We then transformed each variable using the ResistanceGA R Package (Peterman 2018) (Table C-5).

Table C-5. Continuous variables used to define resistance values.

Dataset	Variable	Mountain Lion Maximum Cost	Mountain Lion Transformation
LARIAC	Slope	500	Inverse-Reverse Monomolecular
VIIRS	Light pollution	50	Inverse-Reverse Monomolecular
BTS	Highway noise	50	Inverse-Reverse Monomolecular

Freeways were set at the highest relative resistance value of 500, or as nearly complete barriers to wildlife movement for all species except at existing under-or-overcrossings since wildlife are unlikely to cross I-5 or SR 14 successfully and our intention is to direct wildlife away from crossing at unsafe locations where wildlife-vehicle collisions could occur.

Omniscape was run on the Occidental College computing cluster utilizing a high RAM node for increased speed. We used a block size of 17. The radius of the moving window used for each species was 200, except for montane which was set to 400. Our resistance rasters included 2 million pixels and each analysis took approximately 5-20 minutes to complete using 35 workers.

Results

Generalist Habitat – Under baseline conditions, connectivity for the generalist habitat was observed to be extensive throughout the Santa Susanas west of I-5, within the Gates King Open Space between the highways, and throughout the San Gabriels east of SR 14. Notably, connectivity was reduced in areas experiencing frequent fires along the freeways and along the southern facing slopes of both ranges, making southern routes for connectivity less desirable. All alternate crossing scenarios led to increased mean cumulative current relative to the baseline, although Weldon North had the largest increase. Along SR 14, Beale's Cut North showed the greatest increase in connectivity.

Montane Habitat – Baseline connectivity of montane habitat illustrates pathways along the highest elevations and north-facing slopes of the study area. To the West, pockets of montane habitat and bigcone Douglas-fir are visible from I-5 with current moving toward the intersection of I-5/SR 14 just north of the Sunshine Landfill. In between I-5 and SR 14 in the Gates King Open Space small patches of montane habitat are isolated by the freeways. To the east, connectivity of Montane habitat is sparser and flows primarily through Elsmere Canyon up to SR 14 ending near Beale's Cut North proposed crossing location. Because connectivity of

montane habitat is greater in the Santa Susanas, Weldon North provides the largest increase in mean cumulative current for the alternate crossing scenarios. However, along SR 14, Beale's Cut North, Beale's Cut South, and Sierra Under/Over all provide equivalent increases in connectivity.

Oak Woodland Habitat – Extensive oak woodland habitat in the Santa Susanas to the west of I-5 and throughout the Gates King Open Space between I-5 and SR 14 resulted in strong connectivity throughout both of these regions with very sparse connectivity east of SR 14 in the San Gabriels. Due to proximity of oak woodlands near to and extending in both directions from Weldon North, this alternate crossing location showed the greatest increase in mean cumulative current. Across SR 14, Weldon North and Los Piñetos provided the largest increases in mean cumulative current relative to the other SR-14 alternate crossing locations.

Shrub/Scrub Habitat – Baseline connectivity for scrub habitat emphasized the southern edges of the Santa Susanas and San Gabriels where increased fire frequency prevents taller vegetation from establishing, as well as Elsmere and Placerita Canyon along SR 14. As such, Beale's Cut North, Los Piñetos, and Beale's Cut South had the greatest connectivity under the alternate crossing location scenarios. However, while Beale's Cut North and Los Piñetos both had similar levels of mean cumulative current, Beale's Cut North showed the greatest increase relative to baseline conditions. Along I-5, both Old Road and Weldon North result in similar levels of mean cumulative current, likely due to the primary scrub habitat in this area being located further to the northwest than either of these crossing locations.

Riparian Habitat – Connectivity in the baseline riparian model highlights both the unique intersection of watersheds and the barrier effects of the freeways on the main streams and arroyos throughout the study region. Channelization of streams along and culverts under the freeways maintain water flow but disrupt ecological connectivity. Notably, the South Fork of the Santa Clara River is bisected by I-5 and Old Road, limiting connectivity that extends through East and Rice Canyons. Bull Creek runs along and under the southern arm of I-5, bisected by both freeways in multiple locations. To the east, Placerita and Newhall Creek are disrupted by SR-14. Mean cumulative current was increased under all alternate crossing scenarios, with the Old Road crossing having the greatest increase. It is important to note however that the increases in connectivity observed are dependent upon the assumption that riparian connectivity is re-established at the alternate crossing locations, which due to design constraints may not be possible at all locations. Thus, priority should be given to locations where undercrossings are possible and would allow for improvements to riparian connectivity, such as at Old Road.

Overall Results – When considering all habitats collectively, consensus in changes of connectivity helps identify crossing locations with potential to improve connectivity for multiple habitats and species. Increases in mean cumulative current were the greatest at Weldon North for Generalist, Montane, and Oak Woodland habitat. Along SR-14, Beale's Cut North showed increases in mean cumulative current for multiple habitats, particularly Generalist and Shrub/Scrub, although Beale's Cut South, Los Piñetos, and 14 Sierra all either lead to improvements in connectivity or have existing connectivity for some habitats. Riparian connectivity was the outlier, with Old Road providing the largest increase in mean cumulative current.

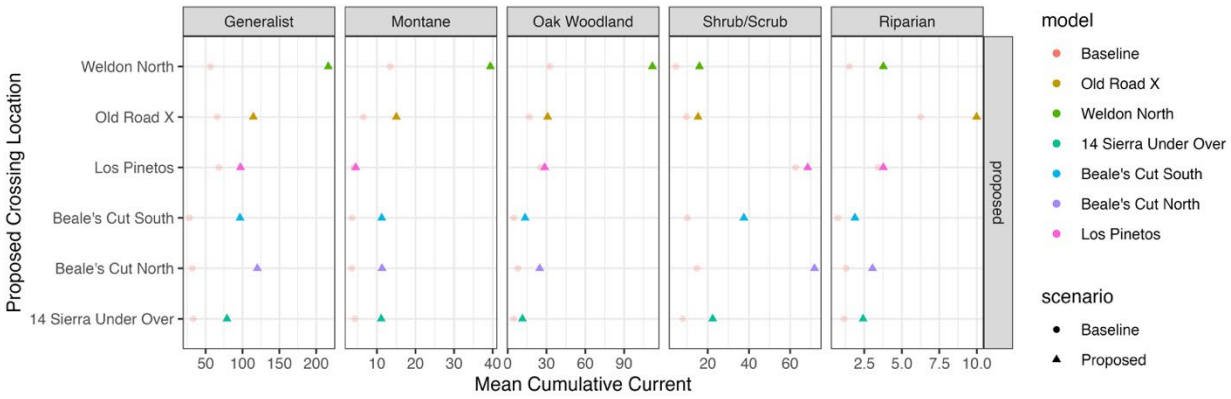
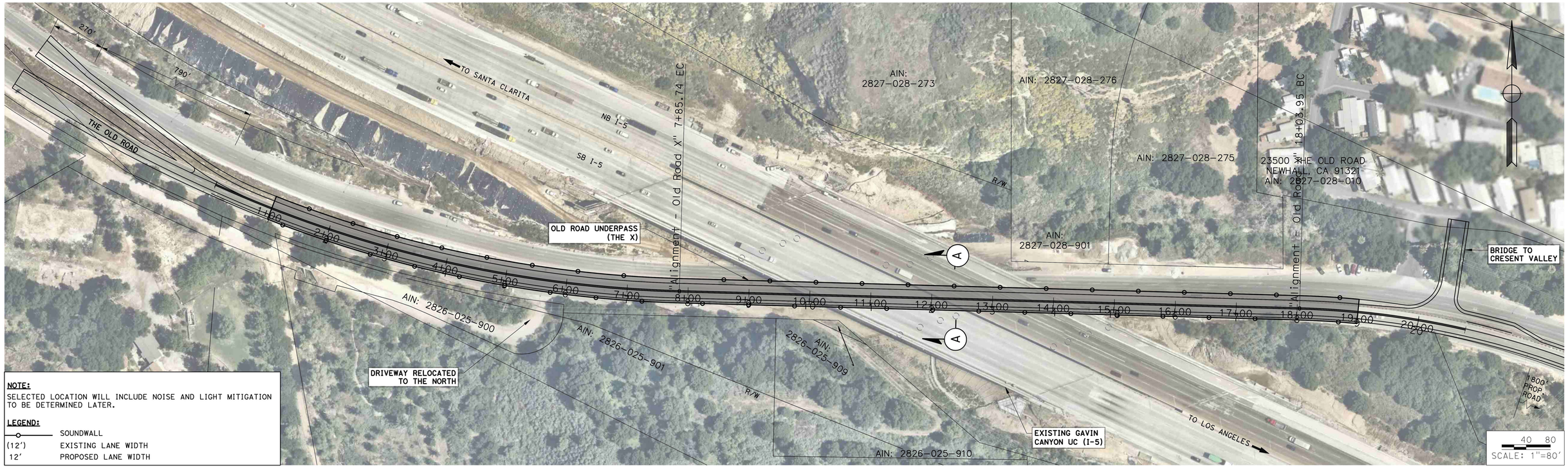


Figure C-1. Changes in Mean Cumulative Current under the baseline connectivity model and 6 alternate crossing location scenarios for each of the 5 focal habitats. Mean cumulative current was calculated at the site of each crossing location.

Appendix D

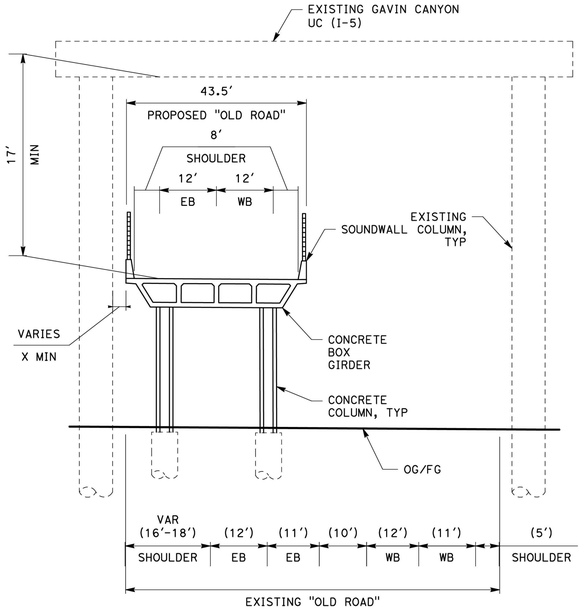
Wildlife Crossing Design Sheets



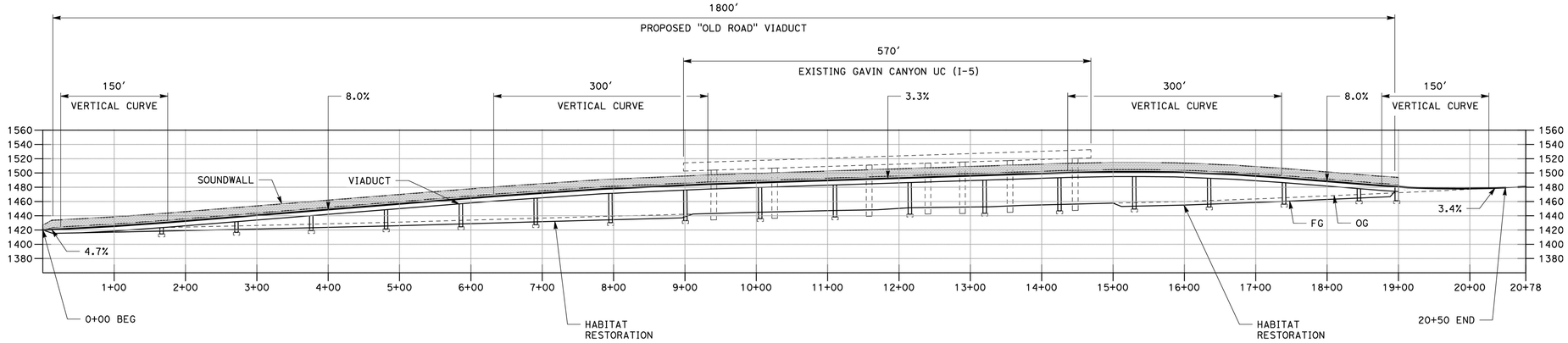
NOTE:
SELECTED LOCATION WILL INCLUDE NOISE AND LIGHT MITIGATION TO BE DETERMINED LATER.

LEGEND:

—o—	SOUNDWALL
(12')	EXISTING LANE WIDTH
12'	PROPOSED LANE WIDTH



SECTION A-A
NOT TO SCALE



PROFILE
NOT TO SCALE

LEGEND:

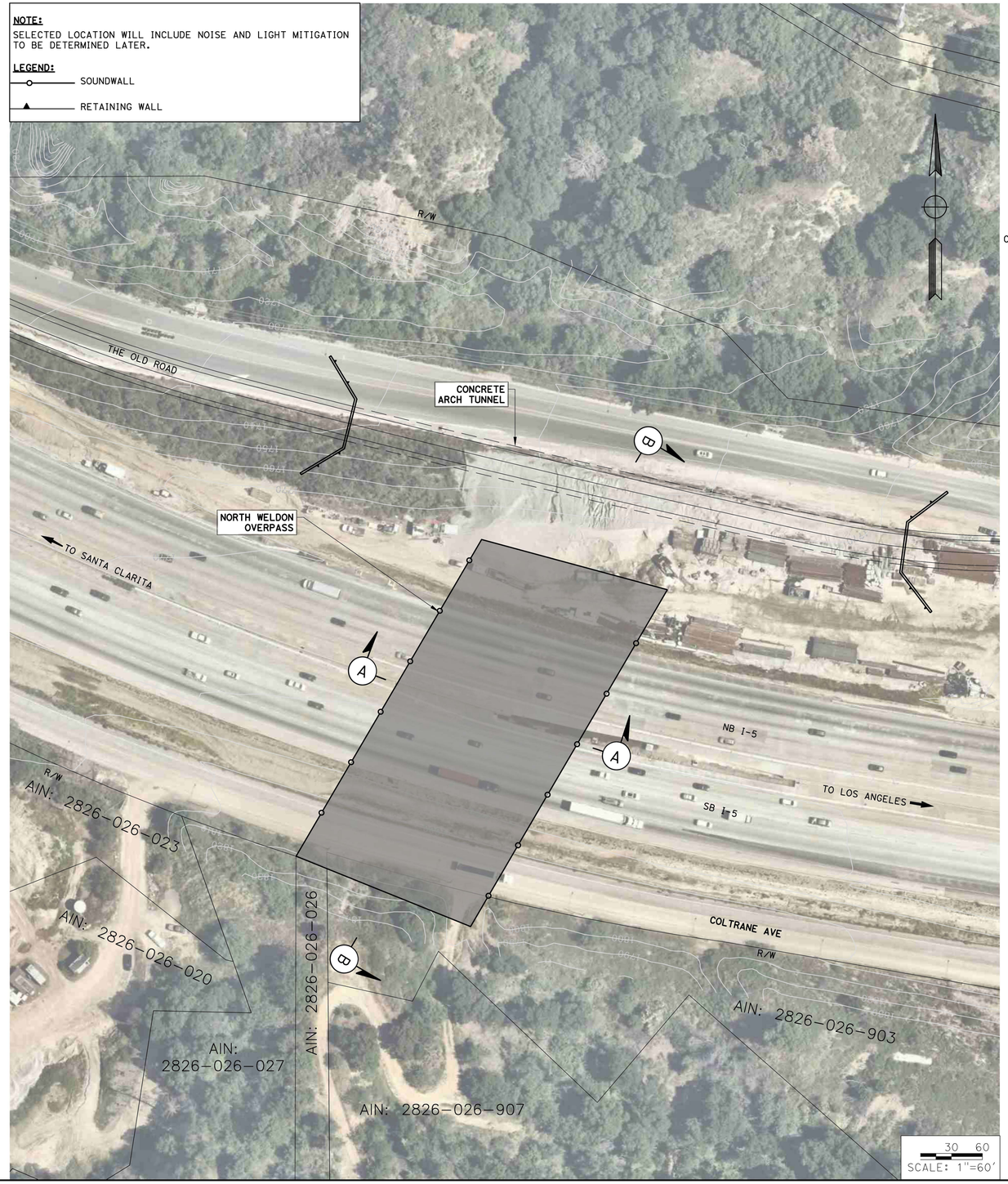
OG	ORIGINAL GRADE
FG	FINISHED GRADE
EB	EASTBOUND
WB	WESTBOUND

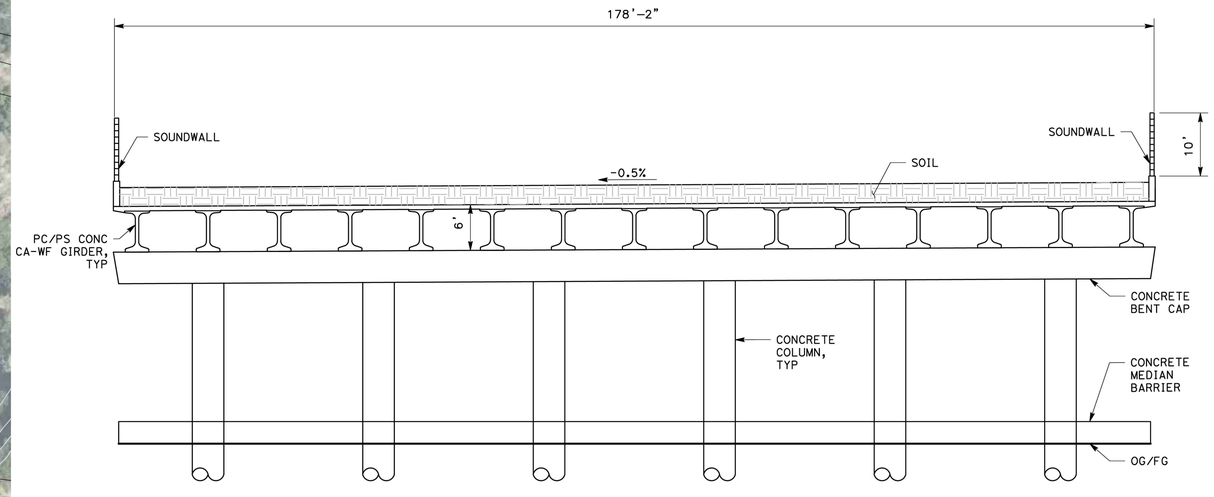
MARK THOMAS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

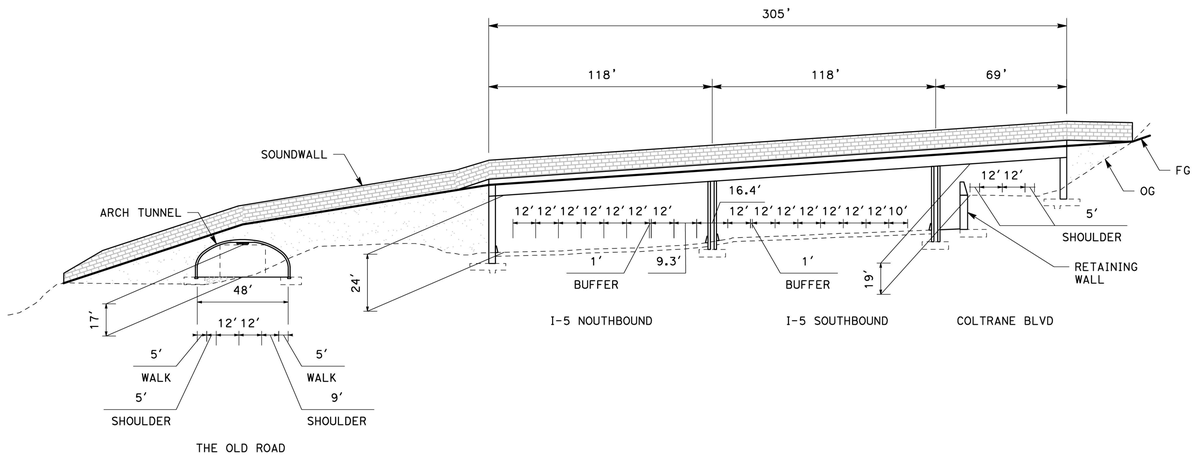
NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: OLD ROAD UNDERPASS (THE X)
I-5 PM R47.83

DATE: 2024-03-19





SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

LEGEND:

OG	ORIGINAL GRADE
FG	FINISHED GRADE

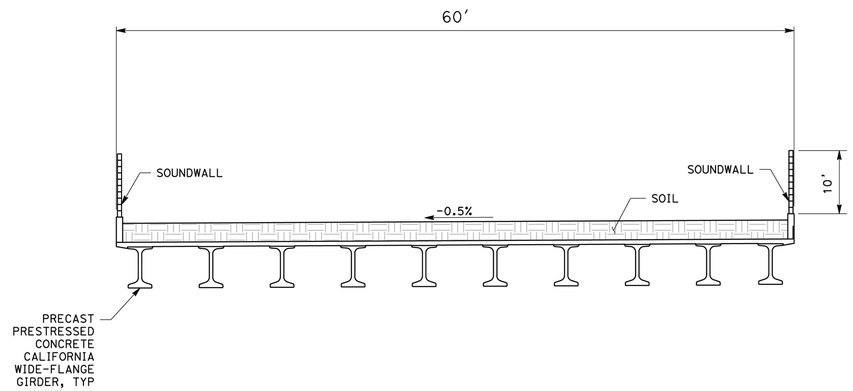
MARK THOMAS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

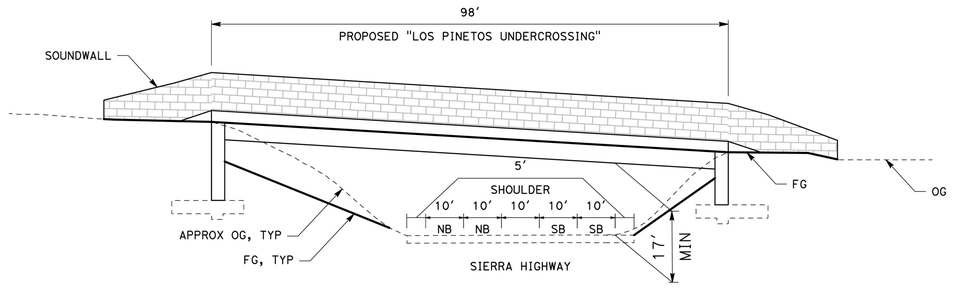
NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: NORTH WELDON OVERPASS
I-5 PM R46.82

DATE: 2024-03-19





SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

LEGEND:

OG	ORIGINAL GRADE
FG	FINISHED GRADE
SB	SOUTHNOUND
NB	NORTHBOUND

MARK THOMAS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: SR-14 LOS PINETOS
SR-14 LA PM R25.98

DATE: 2024-03-19

NOTE:

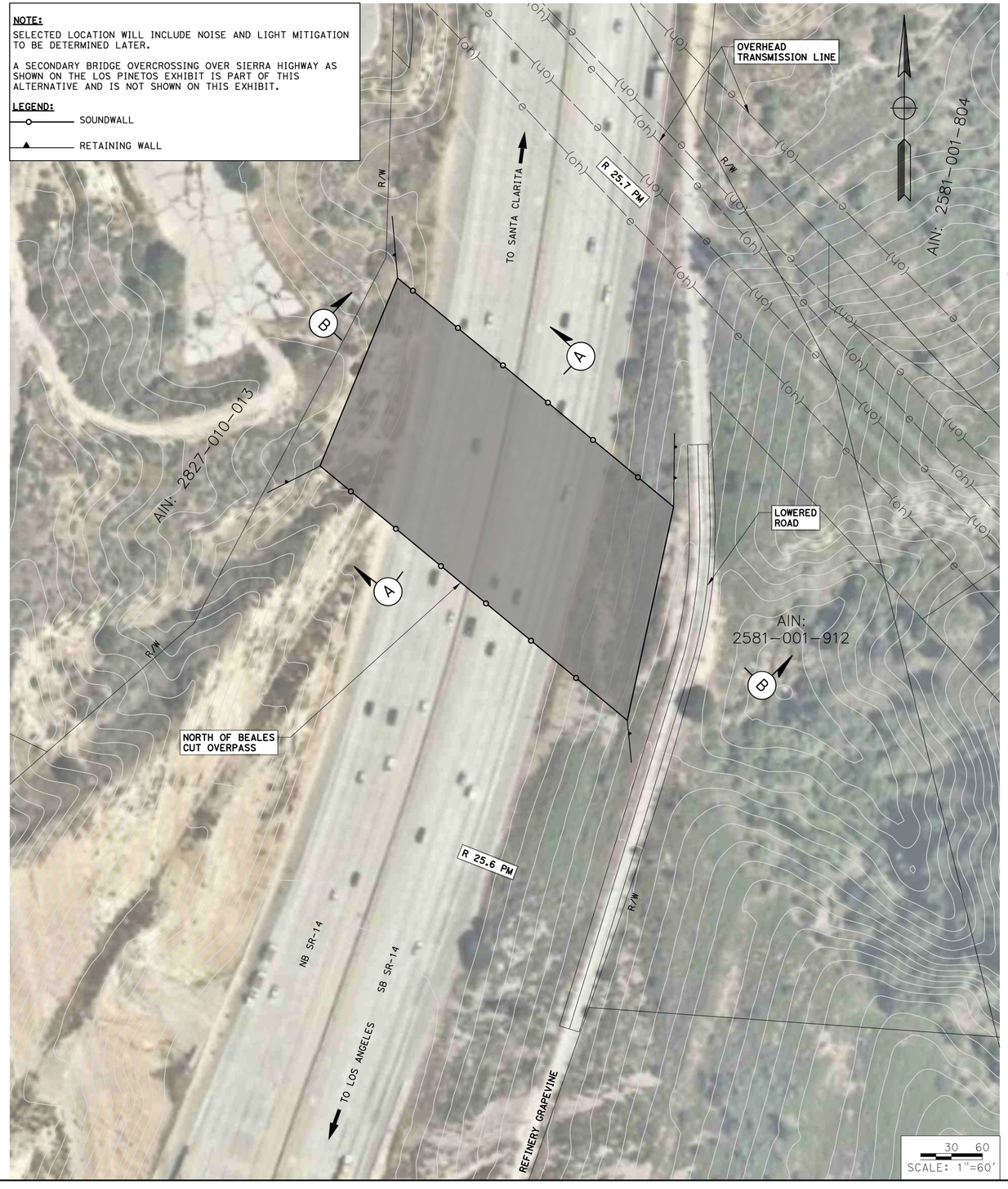
SELECTED LOCATION WILL INCLUDE NOISE AND LIGHT MITIGATION TO BE DETERMINED LATER.

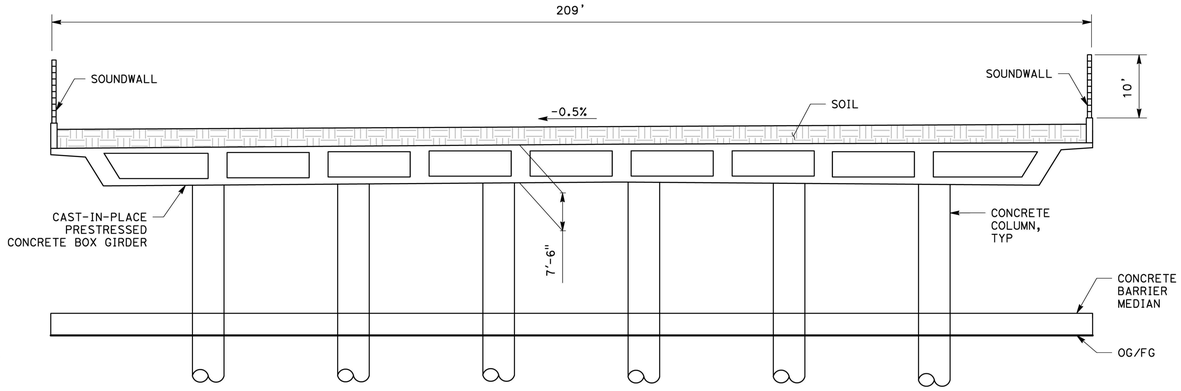
A SECONDARY BRIDGE OVERCROSSING OVER SIERRA HIGHWAY AS SHOWN ON THE LOS PINETOS EXHIBIT IS PART OF THIS ALTERNATIVE AND IS NOT SHOWN ON THIS EXHIBIT.

LEGEND:

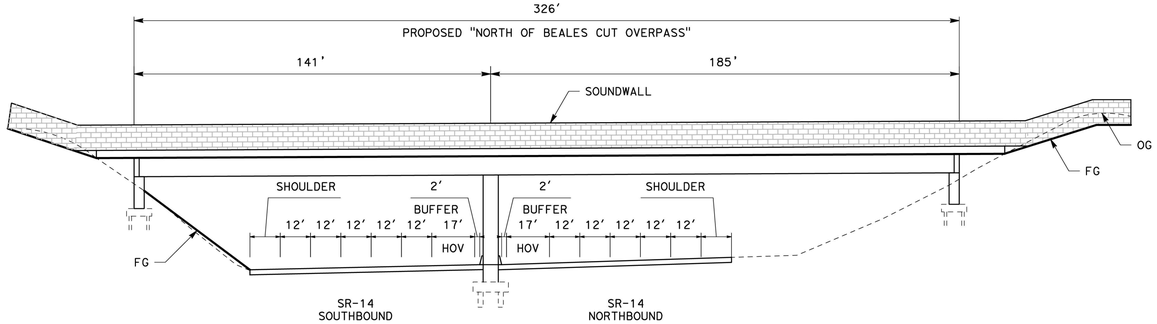
SOUNDWALL

RETAINING WALL





SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

LEGEND:

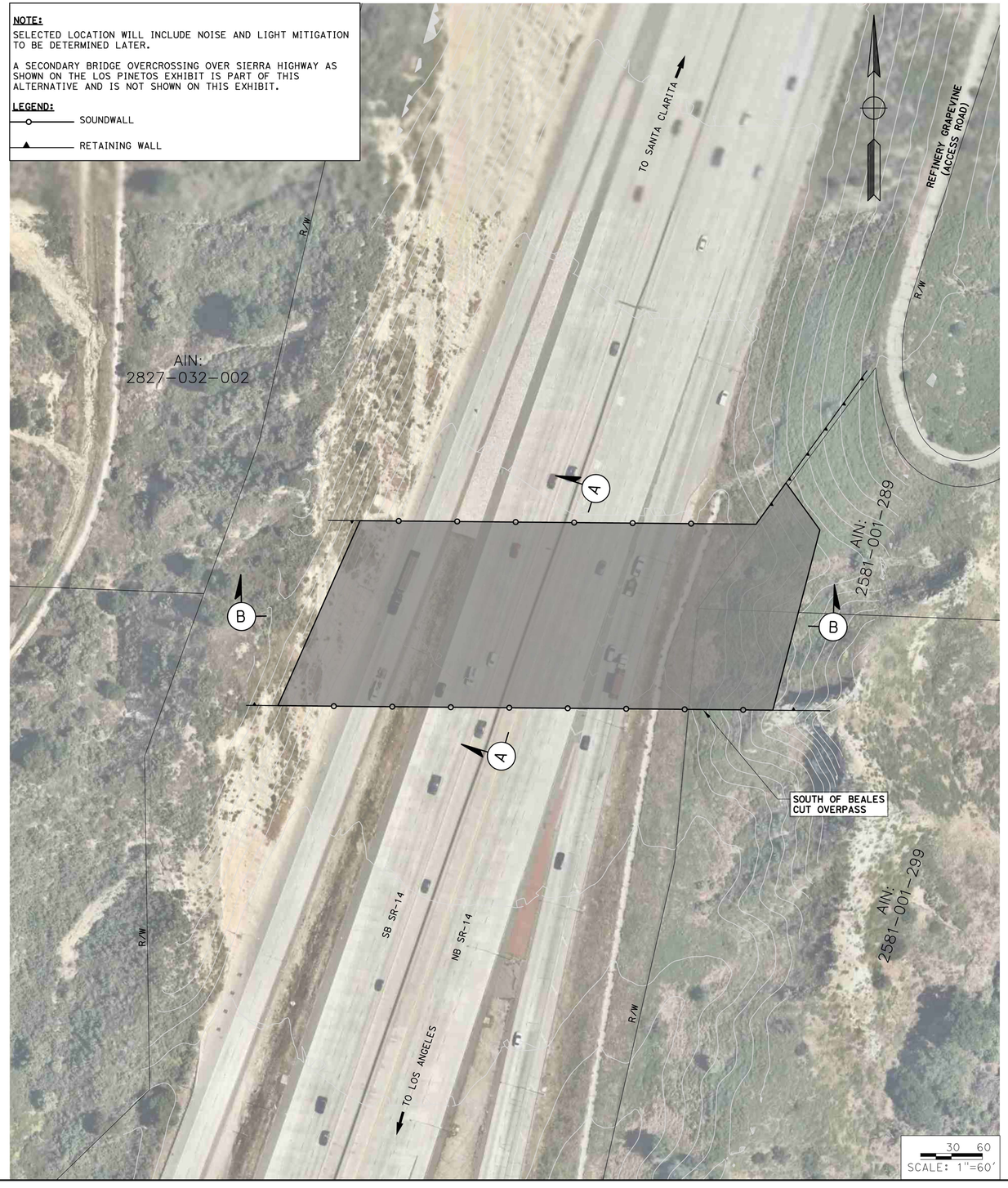
OG ORIGINAL GRADE
FG FINISHED GRADE

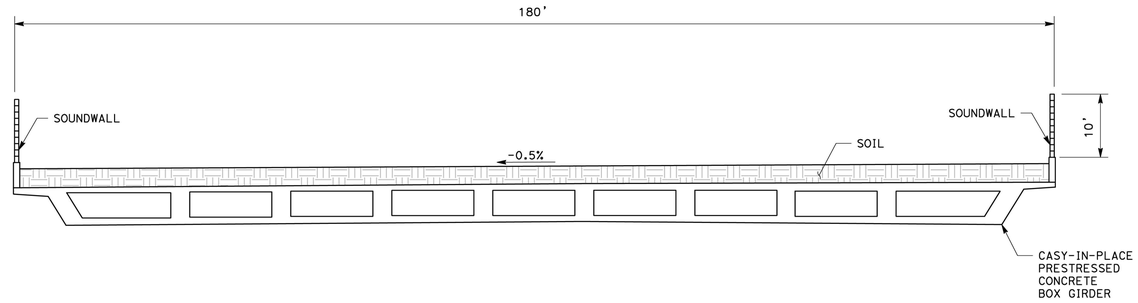
MARK THOMAS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

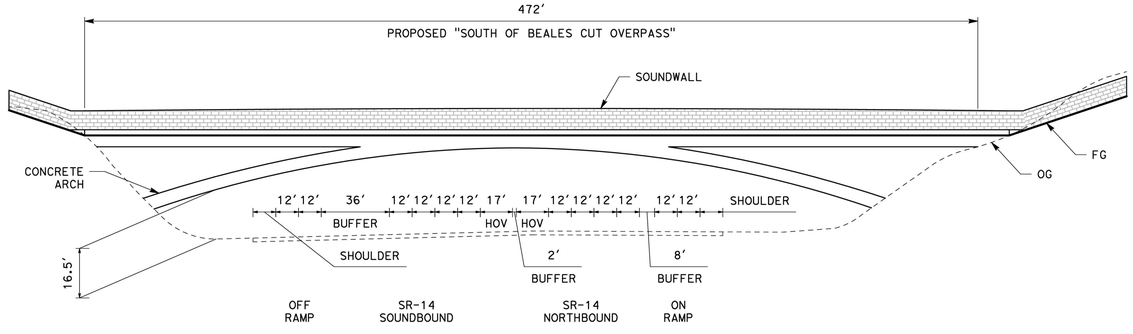
NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: SR-14 NORTH OF BEALES CUT OVERPASS
SR-14 PM R25.67

DATE: 2024-03-19





SECTION A-A
NOT TO SCALE



NOTE:
TEMPORARY VERTICAL CLEARANCE WILL BE DETERMINED DURING DESIGN PHASE

SECTION B-B
NOT TO SCALE

LEGEND:
OG ORIGINAL GRADE
FG FINISHED GRADE

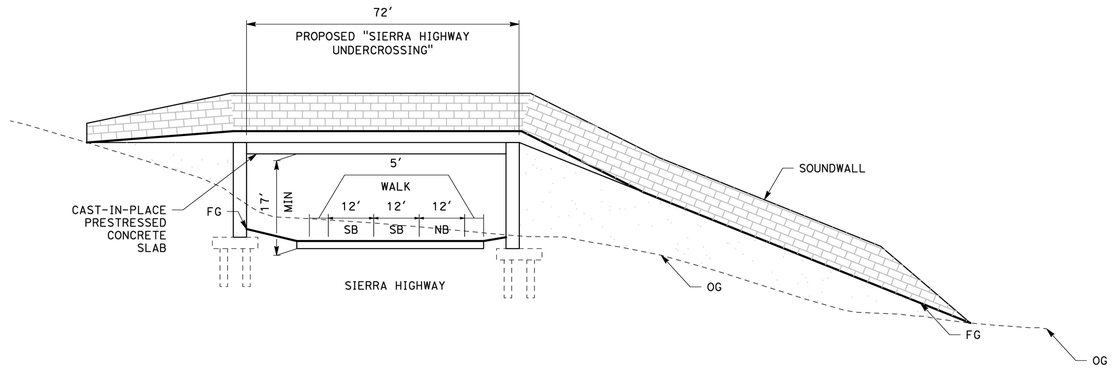
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PRELIMINARY FOR DISCUSSION PURPOSES ONLY

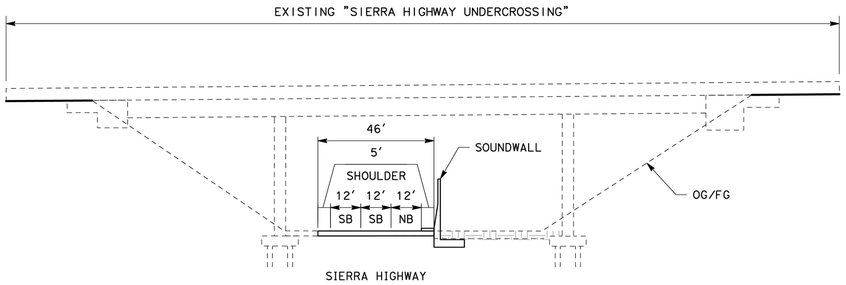
NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: SR-14 SOUTH OF BEALES CUT OVERPASS
SR-14 LA PM R25.38

DATE: 2024-03-19





SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

LEGEND:

OG	ORIGINAL GRADE
FG	FINISHED GRADE
SB	SOUTHOUND
NB	NORTHBOUND

MARK THOMAS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

NEWHALL PASS I-5 WILDLIFE CROSSING
EXHIBIT: SR-14/ SIERRA HIGHWAY UNDERCROSSING
SR-14 PM R25.15

DATE: 2024-03-19

Appendix E

Living With Wildlife: Community Engagement with Crescent Valley Mobile Home Park

Living With Wildlife

The Crescent Valley Mobile Home Park, located between the proposed Old Road X and Weldon North project sites, is described on its website as "surrounded by ancestral oak trees and other wildlife." When we contacted the park's Home Owners Association to start a conversation with about the Project we learned that bears, mountain lions, coyotes, and deer are all seen in the development, and have even been captured on residents' Ring cameras. While we know that mountain lions are seen in the Santa Susana and San Gabriel Mountains, we did not have sighting data of their presence inside the 'Y' (the zone of habitats between the !-5 and SR-14 north of their intersection) prior to this conversation. Residents here are providing information that informs the Project outcomes, and adds to data gathered in the area by National Park Service studies.

On Saturday, January 13, 2024 the RCD's Clark Stevens, Executive Officer and Architect; Dan Cooper, Deputy Officer and Principal Biologist; and Shelly Backlar, Project Manager, gathered at Crescent Valley's clubhouse for the first of what we hope will be many conversations with residents. These are some of the stories we heard:

"I have several cats and feed them outside my home. I keep watch while they are eating and bring any remaining food inside. One night I looked out to see a mountain lion fairly close looking in my direction and it frightened me."

"We had a bear who would frequently wander through the complex, occasionally opening and eating from dumpsters. The word got out about the 'resident bear' and many people began driving into the neighborhood hoping to see one."

"Every day I see coyotes walking through the community headed toward the creek (location). We see them in the morning and again at around 10:00 PM and have started calling the path they take 'the coyote highway.'"

"Several years ago, a young bear was hit near the Church of the Nazarene (location). At first people thought it was a reddish dog that had been hit, however it was a bear cub. (note: collision data places a bear closer to the development, at the Old Road as it crosses under I-5 between East Canyon Park and the Crescent Valley entrance road"

"We had a bear that would bang and push on our metal gate, until one day it broke and knocked the gate down, causing a lot of noise and commotion."

"We've seen deer grazing here, just outside of the clubhouse. One time a noise startled them, and they ran down the hill toward the creek."

While wanting to know more about how to safely navigate around large carnivores, residents were in general enthusiastic and excited about the Project, especially because of the benefit for the wildlife that live in the area and within their community. Making it easier for wildlife to travel from the surrounding area, around the community toward food, water, and shelter via new and better passage routes would also be safer for both residents and mammals.

The community noted also that there is an encampment near the development, in the foothills, where those experiencing homelessness live. This was cited in reference not only to wildlife, but also a concern due to wildfire risk and frequency in the area and the ignition probability which comes with encampment.

Following up on the "coyote highway" comment, we asked about the prospect of adding a new primary entrance to the community at the southeast corner of the property, to extend the

wildlife passage along the old road and N Fork Santa Clara River. The new bridge with better passage underneath would allow conversion of the existing bridge/culvert to a recreational trail and second means of emergency egress under the Old Road Viaduct and to the north at East Canyon Park. The residents reacted positively, both for the new recreational trail connection to East Canyon without requiring a road crossing, and because they have been evacuated on multiple occasions due to wildfire or significant rainfall.

Email Comments:
It's so good to see this concern for our wildlife, as I have seen many of them here, and hiked in the hills adjacent to the park. What a privilege it is for us to be living near them.

I've hiked across that high ridge above, and at the back of the park from Calgrove Blvd. to above the center of the park. It definitely appears to have tracks of migrating wildlife. I have seen deer ascending to that ridge on other ridge crossings. The low slope directly behind my home used to have many creatures crossing it, but now folks have built fences and such, and I'm not sure how they navigate that. Our resident bear *used to go that way as well.*

Meanwhile, I do believe that the drainage tunnel that runs under I5 (Gavin Cyn. Overcrossing) from East Canyon comes up into the creek that runs in front of the park. Our former manager also told us that our resident bear would come in through the creek that crosses from south of the park, and under the bridge entrance to our park. Perhaps from there, a proposed route east to the San Gabriels might be a possibility after crossing SR-14, or other. I am, however, not sure of how the current bridge work will affect that undercrossing from East Canyon. One drainage tunnel also came out in the Gateway Ranch Open Space that is accessed through the gate on the north end of our park. That is where some of us access it to hike. Hopefully, this will add some more possibilities for you.



Figure E-1. Doorbell camera footage of a mountain lion in the "Y" zone between I-5 and SR-14, provided by a Crescent Valley Mobile Home Park resident.

Appendix F

Geotechnical/Geologic Hazard Assessment for Wildlife Crossing Alternatives: *Newhall Pass I-5 Wildlife Crossing Design Project*

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

DATE: January 19, 2024

EMI PROJECT NO: 23-161

TO: Sasha Dansky, PE / Mark Thomas & Company, Inc.

FROM: Michael Hoshiyama, CEG / Earth Mechanics, Inc. (EMI)
Thomas Feistel, PG / EMI
Alaheswaran Thurairajah, G.E. / EMI

SUBJECT: **Geotechnical/Geologic Hazard Assessment for Wildlife Crossing Alternatives**
Newhall Pass I-5 Wildlife Crossing Design Project
Santa Clarita, California

INTRODUCTION

The Newhall Pass Interstate 5 (I-5) Wildlife Crossing Design Project proposes to conduct feasibility studies to determine optimal location(s) for crossings and associated habitat enhancements within the Newhall Pass area that includes the I-5 and adjacent State Route 14 (SR-14). The project is being conducted in a joint partnership between the Resource Conservation District of Santa Monica Mountains (RCD), Stillwater Sciences, Mark Thomas, Occidental College and the Fernandeño Tataviam Band of Mission Indians. EMI has conducted a geotechnical/geologic hazard assessment for selected wildlife crossing alternatives in order to help with the overall feasibility study and subsequent selection for advancement of design for the project.

GEOTECHNICAL/GEOLOGIC HAZARD ASSESSMENT

As part of the feasibility study, EMI was tasked with providing a geotechnical and geologic assessment for five major crossing alternatives to be carried forward for the project. These include:

1. Old Road X (I-5 Underpass Viaduct)
2. Weldon North (I-5 Overpass North of Weldon Bridge)
3. Sierra Over Under (SR-14 Underpass & Overpass)
4. Beale's Cut North/South (SR-14 Overpass)
5. Los Pinetos (Underpass Enhancements)

Each site was assessed for geologic and geotechnical hazards and is discussed in the sections below. We reviewed available as-built reports and logs, regional geologic maps, state hazard reports and maps, and other local and private data and publications. Appendix A has figures that include a Geotechnical Data Map, Regional Geologic Map, Seismic Hazard Map and Landslide Map.

1. Old Road X (I-5 Underpass Viaduct)

Earthquake Shaking. The proposed project site is located proximal to the Northridge blind thrust fault zone (~0.5 miles or less) and moderate to strong ground shaking should be anticipated in the event of a large earthquake along the Northridge blind thrust fault zone. The Northridge fault is anticipated to be capable of producing a M6.8 earthquake. The site is also located just 2 miles north of the Sierra Madre fault zone which is capable of producing moderate to severe ground shaking during an earthquake event. The Sierra Madre fault zone is anticipated to be capable of producing a M6.6 to 6.8 earthquake. Preliminary Peak Ground Acceleration (PGA) at this location is 0.86g.

Other nearby faults:

- San Gabriel Fault zone – A major fault zone located approximately 3.5 miles north of the project site. The San Gabriel fault is expected to be able to produce up to a M7.2 fault.
- Simi-Santa Rosa fault zone- 5.5 miles southwest of the bridge site
- Mission Hills fault zone – The Mission Hills fault is a smaller fault that is approximately 2.5 miles south of the project site and it is capable of producing a M6.0 fault.
- Oak Ridge – The Oak Ridge fault is the north western extension of the Sierra Madre fault. This fault is capable of producing a M7.4 earthquake.
- Holser Alt 1 fault – This fault is a splay or extension of the San Gabreil fault and is capable of producing a magnitude 6.7 earthquake.
- Verdugo-Eagle Rock – This fault is located approximately 8.0 miles south of the site and is capable of generating a M6.8 earthquake.

Liquefaction. The proposed viaduct location traverses along an existing alluvial canyon where groundwater is higher than in the surrounding areas composed of bedrock. According to CGS, the project site is located within a zone of liquefaction potential. Data obtained from the surrounding area shows a good amount of variation in groundwater depths with groundwater depths at the site ranging from 10 to 30 feet below existing grade. Also, there is no historic high groundwater table provided by the CGS Seismic Hazard Report for the area. Available boring data from the Gavin Canyon UC (Widen) project show that soil conditions within the upper 30 feet consist of stiff to hard clayey soils and dense to very dense granular soils. As a result, the risk associated with liquefaction should be considered low.

Landsliding/Slope Stability. The proposed bridge site has natural slopes on either side of the I-5 freeway corridor at the site. These slopes are composed of sedimentary bedrock consisting of claystone and siltstone from the Pico formation. According to CGS (1998), the slope areas both north and south of the Old Road crossing at I-5 are located within zones of seismically induced landslide potential. Also, no known or mapped landslides are documented at the proposed viaduct alternative site (CGS, 1997). Regional geologic mapping in the area indicated a potential for adverse bedding along the southern slopes with favorable bedding along the northern slopes. Additionally, landslides have been documented along the I-5 corridor, particularly in relation to the Northridge earthquake. As a result, the risk of landsliding in the event of an earthquake at the proposed bridge site should be considered moderate to high.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Montmorillonitic clays are most susceptible to expansion due to their layered crystalline structure. The bridge site area is made up of alluvium and sedimentary bedrock that both consist of fine-grained clays and claystone from the Pico Formation. Based on the available boring and laboratory testing, the soils are all generally low plasticity. Potential for expansive soils should be considered low to moderate, though expansive soils will need to be assessed as part of the additional site-specific sampling and testing of site soils during the field investigation.

Subsidence/Settlement. Due to the proximity to the Northridge and Sierra Madre fault zones and the potential for shallow groundwater conditions and existing soil/rock conditions, the risk of seismically induced settlement should be considered low to moderate. It should also be noted that the depth to bedrock may vary significantly along the proposed viaduct structure, thus creating some potential for differential settlement conditions.

Ground subsidence, the gradual settling or sinking of the ground surface with little or no horizontal movement. According to USGS, the site is not located within an area of known land subsidence. Additionally, the area is not known to have a site history of groundwater pumping, peat loss or oil extraction. The risk associated with land subsidence should be considered low.

Fault Rupture. The site is located approximately 0.3 miles from the inferred buried trace of the Northridge blind thrust fault zone and just over 2 miles from the nearest mapped trace of the Sierra Madre fault zone. Due to the fact that the proposed bridge site is located outside the Alquist Priolo fault zone, the risk of fault rupture should be considered low.

Corrosivity. Caltrans defines soils as corrosive when the sulfate concentration if greater than 1,500 parts per million (ppm) and the chloride concentration is greater than 500 ppm, or the pH is less than 5.5. Based on recent data from the Gavin UC Bridge, soil conditions at the proposed alternative site should be considered corrosive due to high sulfate concentrations. The potential for corrosive soils should be considered high.

Rippability. As mentioned previously, the proposed bridge is underlain by both alluvium and bedrock, according existing subsurface data. The rock generally consists of poorly indurated and highly weathered sedimentary units of claystone, siltstone and sandstone. Based on available rock testing data, the unconfined compressive strength of the rock is generally less than 700 psi. The risk associated with rippability should be considered low.

Preliminary Foundation Recommendation. Since available boring data from the Gavin Canyon UC (Widen) project show that soil conditions within the upper 30 feet consist of stiff to hard clayey soils, deep foundations are recommended at this location.

2. Weldon North (I-5 Overpass North of Weldon Bridge)

Earthquake Shaking. The proposed project site is located between the Northridge blind thrust fault zone (~0.6 miles) and the Siera Madre fault zone (~0.8 miles). In the event of a large earthquake on either fault, moderate to strong ground shaking should be anticipated. The Northridge blind thrust fault zone is anticipated to be capable of producing a M6.8 earthquake, while the Sierra Madre fault zone is anticipated to be able to produce a M6.6 to M 6.8 earthquake. Preliminary PGA at this location is 0.88g.

Other nearby faults:

- San Gabriel Fault zone – A major fault zone located approximately 3.5 miles north of the project site. The San Gabriel fault is expected to be able to produce up to a M7.2 fault.
- Simi-Santa Rosa fault zone – 6.1 miles southwest of the bridge site
- Mission Hills fault zone – The Mission Hills fault is a smaller fault that is approximately 2.5 miles south of the project site and it is capable of producing a M6.0 fault.
- Oak Ridge – The Oak Ridge fault is the north western extension of the Sierra Madre fault. This fault is capable of producing a M7.4 earthquake.
- Holser Alt 1 fault – This fault is a splay or extension of the San Gabriel fault and is capable of producing a magnitude 6.7 earthquake.
- Verdugo-Eagle Rock – This fault is located approximately 8.0 miles south of the site and is capable of generating a M6.8 earthquake

Fault Rupture. The proposed bridge site is located outside any Alquist Priolo fault zone with the nearest active fault being the Northridge blind thrust fault zone and the Sierra Madre fault zone. The risk associated with fault rupture should be considered low.

Liquefaction. The proposed bridge location crosses an existing alluvial canyon where groundwater is higher than in the surrounding areas composed of bedrock. According to CGS (1998), the project site is not located within a zone of liquefaction potential. Data obtained from existing reports in the area do not show groundwater within the upper 50 feet and there is no historic high groundwater table provided by the CGS Seismic Hazard Report for the area. Available boring data from the Weldon Canyon Road OC project indicated very shallow bedrock conditions with very dense sands and gravels above the rock. The proposed bridge site is west of the Weldon Canyon Road site where deeper alluvial deposits should be anticipated. Given the lack of groundwater and competent nature of the existing alluvial soils, the risk associated with liquefaction should be considered low.

Landsliding/Slope Stability. The proposed bridge site has natural slopes on either side of the I-5 freeway corridor at the site. These slopes are composed of sedimentary bedrock consisting of claystone and siltstone from the Pico formation. According to CGS (1998), the slope areas both north and south of I-5 are located within zones of seismically induced landslide potential. An existing landslide is mapped along a slope area north of the bridge site based on the CGS (1997) landslide inventory. Regional geologic mapping in the area indicated a potential for adverse bedding along the southern slopes with favorable bedding along the northern slopes. Additionally, landslides have been documented along the I-5 corridor, particularly in relation to the Northridge

earthquake. As a result, the risk of landsliding in the event of an earthquake at the proposed bridge site should be considered moderate to high.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Montmorillonitic clays are most susceptible to expansion due to their layered crystalline structure. The anticipated subsurface conditions at the site includes granular alluvial soils and sandstone and conglomerate bedrock from the Pico formation. The potential for expansive soils should be considered low, though expansive soils will need to be assessed as part of the additional site-specific sampling and testing of site soils during the field investigation.

Subsidence/Settlement. Due to the proximity to the Northridge and Sierra Madre fault zones and the potential for shallow groundwater conditions and anticipated soil/rock conditions, the risk of seismically induced settlement should be considered low to moderate. It should also be noted that the depth to bedrock may vary significantly with shallow rock at the abutments and more alluvium along the middle portion of the I-5 freeway, thus creating some potential for differential settlement conditions.

Ground subsidence, the gradual settling or sinking of the ground surface with little or no horizontal movement. According to USGS, the site is not located within an area of known land subsidence. Additionally, the area is not known to have a site history of groundwater pumping, peat loss or oil extraction. The risk associated with land subsidence should be considered low.

Fault Rupture. The site is located approximately 0.6 miles from the inferred buried trace of the Northridge blind thrust fault zone and just over 0.8 miles from the nearest mapped trace of the Sierra Madre fault zone. Due to the fact that the proposed bridge site is located outside the Alquist Priolo fault zone, the risk of fault rupture should be considered low.

Corrosivity. Caltrans defines soils as corrosive when the sulfate concentration if greater than 1,500 parts per million (ppm) and the chloride concentration is greater than 500 ppm, or the pH is less than 5.5. Data from the Weldon Canyon Road bridge east of the site area found the soils to be non-corrosive. The risk associated with corrosive soils should be considered low to moderate, a site-specific investigation will need to be done to verify whether the onsite soils are corrosive or not.

Rippability. As mentioned previously, the proposed bridge is underlain by both alluvium and bedrock, according existing subsurface data. The rock generally consists of poorly indurated and highly weathered sedimentary units of claystone, siltstone and sandstone. Based on available rock testing data, the unconfined compressive strength of the rock is generally less than 200 psi. The risk associated with rippability should be considered low.

Preliminary Foundation Recommendation. Since shallow bedrock is anticipated at the site, shallow foundation is feasible at this location.

3. Sierra Over Under (SR-14 Underpass & Overpass)

Earthquake Shaking. The proposed Sierra Highway OC/UC alternative site is located proximal to the Northridge blind thrust fault zone (~0.5 miles or less), as well as the Sierra Madre fault zone (~0.5 miles or less). Moderate to strong ground shaking should be anticipated in the event of a large earthquake along the both the Northridge blind thrust and Sierra Madre fault zones. The Northridge fault is anticipated to be capable of producing a M6.8 earthquake. The Sierra Madre fault is anticipated to be capable of producing a M6.6 to M6.8 earthquake. Preliminary PGA at this location is 0.89g.

Other nearby faults:

- San Gabriel Fault zone – A major fault zone located approximately 3.3 miles north of the project site. The San Gabriel fault is expected to be able to produce up to a M7.2 fault.
- Simi-Santa Rosa fault zone – 7.3 miles southwest of the bridge site
- Mission Hills fault zone – The Mission Hills fault is a smaller fault that is approximately 2.7 miles south of the project site and it is capable of producing a M6.0 fault.
- Oak Ridge – The Oak Ridge fault is the north western extension of the Sierra Madre fault. This fault is capable of producing a M7.4 earthquake.
- Holser Alt 1 fault – This fault is a splay or extension of the San Gabriel fault and is capable of producing a magnitude 6.7 earthquake.
- Verdugo-Eagle Rock – This fault is located approximately 8.0 miles south of the site and is capable of generating a M6.8 earthquake.

Liquefaction. The proposed site is located along Sierra Highway which cuts across alluvial channels and slope cut ridges where groundwater is higher than in the surrounding areas composed of bedrock. Data obtained from the as-built reports prepared by Caltrans show groundwater at approximately 20 feet below the ground surface with existing shallow subsurface conditions consisting of medium dense to dense granular alluvial soils. According to CGS (1998), most of the site area along Sierra Highway is mapped within a liquefaction potential zone. The available as-built data indicates liquefaction was expected within medium dense soils at the Sierra Highway Bridge along SR-14. As a result, the risk associated with liquefaction along the Sierra Highway alternative location area is considered moderate to high.

Landsliding/Slope Stability. The proposed potential bridge sites have natural bedrock slopes on either side of Sierra Highway. These slopes are composed of sedimentary bedrock of either the Pico or Saugus Formations. Maps of the area show that the majority of the slopes surrounding the project site along Sierra Highway are steep and are subject to landsliding. According to CGS (1998), most of the slope areas along Sierra Highway are within areas of seismically induced landslide potential. Regional geologic mapping in the area shows adverse bedding in the northeastern slopes on site with favorable bedding on the southwest slopes at the site. Also no known or mapped landslides are documented at the proposed bridge alternative sites. Additionally, landslides have been documented along the I-5 corridor, particularly in relation to the Northridge earthquake. As a result, the risk of landsliding in the event of an earthquake at the proposed bridge site should be considered moderate to high.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Montmorillonitic clays are most susceptible to expansion due to their layered crystalline structure. Based on available data, the anticipated subsurface conditions at the site consist of granular alluvial soils and sandstone, siltstone and claystone bedrock from the Pico and Saugus formations. The bedrock is mostly coarse-grained bedrock of the Pico or Saugus Formations, which is not expected to be very expansive. The alluvium onsite will be derived from the surrounding bedrock, and therefore is not likely to be expansive either. Previous work in the area showed the potential for expansive soils should be considered low. Expansive soils will need to be assessed as part of the additional site-specific sampling and testing of site soils during the field investigation.

Subsidence/Settlement. Due to the proximity to the Northridge and Sierra Madre fault zones and the potential for shallow groundwater conditions and anticipated existing soil/rock conditions, the risk of seismically induced settlement should be considered moderate to high. It should also be noted that the depth to bedrock and existing soil conditions may vary significantly along the Sierra Highway creating for a potential for differential settlement conditions depending on where the exact location of the bridge crossing is located.

Ground subsidence, the gradual settling or sinking of the ground surface with little or no horizontal movement. According to USGS, the site is not located within an area of known land subsidence. Additionally, the area is not known to have a site history of groundwater pumping, peat loss or oil extraction. The risk associated with land subsidence should be considered low.

Fault Rupture. The site is located approximately 0.5 miles from the Northridge Blind Thrust and Sierra Madre fault zone. The proposed bridge site is located adjacent (approximately 0.25 miles west of) an Alquist Priolo fault zone. Depending on where the crossing location is located along Sierra Highway, the potential for fault rupture should be considered moderate to high as portions of Sierra Highway at the site align with the mapped active traces of the Sierra Madre fault zone just west of the site.

Corrosivity. Caltrans defines soils as corrosive when the sulfate concentration if greater than 1,500 parts per million (ppm) and the chloride concentration is greater than 500 ppm, or the pH is less than 5.5. Based on data from nearby as-built report for Sierra Highway UC, soil conditions at the proposed alternative site should be considered corrosive due to high sulfate concentrations. The potential for corrosive soils should be considered high.

Rippability. As mentioned previously, the proposed bridge is underlain by both alluvium and sedimentary bedrock according to regional geologic maps. The rock generally consists of poorly indurated and highly weathered sedimentary units of claystone, siltstone and sandstone. Based on available information at the site, the risk associated with rippability should be considered low.

Preliminary Foundation Recommendation. Since, liquefaction potential is considered moderate to high, deep foundations are recommended at this location.

4. Beale's Cut North/South (SR-14 Overpass)

Earthquake Shaking. The proposed Beale's Cut South OC alternative site is located proximal to the Northridge blind thrust fault zone (~0.4 miles or less), as well as the Sierra Madre fault zone (~300 feet). Moderate to strong ground shaking should be anticipated in the event of a large earthquake along the both the Northridge blind thrust and Sierra Madre fault zones. The Northridge fault is anticipated to be capable of producing a M6.8 earthquake. The Sierra Madre fault is anticipated to be capable of producing a M6.6 to M6.8 earthquake. Preliminary PGA at this location is 0.89g.

Other nearby faults:

- San Gabriel Fault zone – A major fault zone located approximately 3.5 miles north of the project site. The San Gabriel fault is expected to be able to produce up to a M7.2 fault.
- Simi-Santa Rosa fault zone - 7.5 miles southwest of the bridge site
- Mission Hills fault zone – The Mission Hills fault is a smaller fault that is approximately 2.5 miles south of the project site and it is capable of producing a M6.0 fault.
- Oak Ridge – The Oak Ridge fault is the north western extension of the Sierra Madre fault. This fault is capable of producing a M7.4 earthquake.
- Holser Alt 1 fault – This fault is a splay or extension of the San Gabriel fault and is capable of producing a magnitude 6.7 earthquake.
- Verdugo-Eagle Rock – This fault is located approximately 8.0 miles south of the site and is capable of generating a M6.8 earthquake

Liquefaction. The proposed bridge is located along SR-14 which cuts through the low-lying foothills of the San Gabriel Mountains. The area is almost entirely underlain by sedimentary bedrock of the Towsley and Saugus formations. According to CGS (1998), the site is not mapped within a liquefaction potential zone. There is no existing geotechnical data at this site, but based on the available regional maps and data, the risk associated with liquefaction along the at this site should be considered low with the site mainly composed of local sedimentary rock.

Landsliding/Slope Stability. The proposed bridge site has natural bedrock slopes on either side of SR-14. These slopes are composed of sedimentary bedrock of either the Towsley or Saugus formations. According to CGS (1998), most of the slope areas on either side of SR-14 at the bridge site are within areas of seismically induced landslide potential. Regional geologic mapping in the area shows adverse bedding along the eastern slopes with favorable bedding along the west slopes at the site. Also, no known or mapped landslides are documented at the proposed bridge alternative site (CGS, 1997). Additionally, landslides have been documented along the I-5 corridor, particularly in relation to the Northridge earthquake. As a result, the risk of landsliding in the event of an earthquake at the proposed bridge site should be considered moderate to high.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Montmorillonitic clays are most susceptible to expansion due to their layered crystalline structure. The bridge site area is made up of sedimentary bedrock that both consists of sandstone and conglomerate with some interbedded siltstone/claystone. Potential for expansive soils should be considered low, though expansive soils will need to be assessed as part of the additional site-specific sampling and testing of site soils during the field investigation.

Subsidence/Settlement. Since the bridge site is almost entirely on bedrock and the only soil at the site should be engineered fill associated with the SR-14 freeway. The risk associated with seismic settlement should be considered low.

Ground subsidence, the gradual settling or sinking of the ground surface with little or no horizontal movement. According to USGS, the site is not located within an area of known land subsidence. Additionally, the area is not known to have a site history of groundwater pumping, peat loss or oil extraction. The risk associated with land subsidence should be considered low.

Fault Rupture. The site is located approximately 300 feet southwest of a mapped active trace of the Sierra Madre fault zone, it is also 0.5 miles south of the inferred buried trace of the Northridge blind thrust fault zone. The proposed bridge site is located within an existing Alquist Priolo fault zone. Due to this fact the risk of fault rupture should be considered moderate to high. Proceeding with this alternative will require a fault investigation.

Corrosivity. Caltrans defines soils as corrosive when the sulfate concentration if greater than 1,500 parts per million (ppm) and the chloride concentration is greater than 500 ppm, or the pH is less than 5.5. Based on data from nearby as-built report for Sierra Highway UC which is located approximately 0.2 miles south of the undercrossing site, the potential for corrosive soils should be considered moderate to high.

Rippability. As mentioned previously, the proposed bridge is underlain sandstone and conglomerate with interbeds of siltstone/claystone bedrock according to regional geologic maps. The rock is likely highly weathered due to localized folding and faulting. Only the conglomerate units may pose a risk for rippability. As a result, the risk associated with rippability should be considered moderate to low.

Preliminary Foundation Recommendation. Since shallow bedrock is anticipated at the site, shallow foundation is feasible at this location.

5. Los Pinetos UC (Underpass Enhancements)

Earthquake Shaking. The proposed project site is located proximal to the Northridge Blind Thrust fault zone (~0.25 miles or less) and moderate to strong ground shaking should be anticipated in the event of a large earthquake along the Northridge blind hrust fault zone. The Northridge fault is anticipated to be capable of producing a M6.8earthquake. The site is also located just 1.3 miles north of the Sierra Madre fault zone which is capable of producing moderate to severe ground shaking during an earthquake event. The Sierra Madre fault zone is anticipated to be capable of producing a M6.6 to 6.8 earthquake. Preliminary PGA at this location is 0.87g.

Other nearby faults:

- San Gabriel Fault zone – A major fault zone located approximately 3.5 miles north of the project site. The San Gabriel fault is expected to be able to produce up to a M7.2 fault.
- Simi-Santa Rosa fault zone- 7.5 miles southwest of the bridge site
- Mission Hills fault zone – The Mission Hills fault is a smaller fault that is approximately 2.5 miles south of the project site and it is capable of producing a M6.0 fault.
- Oak Ridge – The Oak Ridge fault is the north western extension of the Sierra Madre fault. This fault is capable of producing a M7.4 earthquake.
- Holser Alt 1 fault – This fault is a splay or extension of the San Gabriel fault and is capable of producing a magnitude 6.7 earthquake.
- Verdugo-Eagle Rock – This fault is located approximately 8.0 miles south of the site and is capable of generating a M6.8 earthquake

Liquefaction. The proposed undercrossing site is located in an alluvial channel where groundwater is likely higher than in the surrounding areas composed of bedrock. According to CGS (1998), portions of the site are mapped within a liquefaction potential zone. As-built data indicates approximately 30 feet of granular alluvial soils overlying sandstone and conglomerate sedimentary bedrock from the Saugus formation. The risk of liquefaction at the site should be considered moderate to low.

Landsliding/Slope Stability. The proposed bridge site has a few natural slopes on the edges of the site. These slopes are composed of sedimentary bedrock of the Saugus Formation. The slope on the eastern edge of the site appears to be an engineered cut slope. Regional geologic mapping in the area shows slightly adverse bedding conditions along the south side of the undercrossing with favorable bedding conditions along the north side of the undercrossing. According to CGS (1998), portions of the crossing site are within areas of seismically induced landslide potential. Additionally, landslides have been documented along the I-5 corridor, particularly in relation to the Northridge earthquake. The risk of landsliding in the event of an earthquake at the proposed site should be considered low to moderate.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Montmorillonitic clays are most susceptible to expansion due to their layered crystalline structure. The project area is made up of alluvium and bedrock. The bedrock is mostly coarse-grained bedrock of the Saugus Formation, which is not expected to be very expansive. The alluvium onsite will be derived from the surrounding bedrock, which is mostly Saugus formation, and therefore is not likely to be expansive. The potential for expansive soils should be considered low. Expansive soils will need to be assessed as part of the additional site-specific sampling and testing of site soils during the field investigation.

Subsidence/Settlement. Based on available information, the alluvial soils at the site are considered to be dense granular soils. Due to the proximity to the Northridge and Sierra Madre fault zones and the potential for shallow groundwater conditions and anticipated existing soil/rock conditions, the risk of seismically induced settlement should be considered low. It should also be noted that the depth to bedrock and existing soil conditions may vary at the undercrossing site creating for a potential for differential settlement conditions.

Ground subsidence, the gradual settling or sinking of the ground surface with little or no horizontal movement. According to USGS, the site is not located within an area of known land subsidence. Additionally, the area is not known to have a site history of groundwater pumping, peat loss or oil extraction. The risk associated with land subsidence should be considered low.

Fault Rupture. The site is located approximately 0.25 miles from the Northridge blind thrust fault zone and 1.3 miles from the nearest mapped trace of the Sierra Madre fault zone. Due to the fact that the proposed bridge site is located outside the Alquist Priolo fault zone, the risk of fault rupture should be considered low.

Corrosivity: Caltrans defines soils as corrosive when the sulfate concentration if greater than 1,500 parts per million (ppm) and the chloride concentration is greater than 500 ppm, or the pH is less than 5.5. No data is available for corrosivity, additional testing will be needed to determine site specific corrosivity conditions.

Rippability. As mentioned previously, the proposed bridge is underlain sandstone and conglomerate bedrock according to regional geologic maps. The rock is likely highly weathered due to localized folding and faulting. Only the conglomerate units may pose a risk for rippability. As a result, the risk associated with rippability should be considered moderate to low.

Preliminary Wall Type. Ground Anchor Wall is feasible at the site if existing underpass will need to be widened.

REFERENCES

California Geological Survey, 1976, Official Map of Alquist-Priolo Earthquake Fault Zones, Oat Mountain Quadrangle, California Division of Mines and Geology.

California Geological Survey, 1979, Official Map of Alquist-Priolo Earthquake Fault Zones, San Fernando Quadrangle, California Division of Mines and Geology.

California Geological Survey, 1997, Seismic hazard zone report for the Oat Mountain 7.5-Minute quadrangle, Los Angeles County, California: Division of Mines and Geology, Seismic Hazard Zone Report 005.

California Geological Survey, 1998, Seismic hazard zone report for the San Fernando 7.5-Minute quadrangle, Los Angeles County, California: Division of Mines and Geology, Seismic Hazard Zone Report 015.

California Geological Survey, 1998, Seismic hazard zones, Oat Mountain quadrangle: California Division of Mines and Geology, Official Map, February 1.

California Geological Survey, 1999, Seismic hazard zones, San Fernando quadrangle: California Division of Mines and Geology, Official Map, March 25.

Dibblee, T.W., Jr., 1991, Geologic map of the San Fernando and Van Nuys (north ½) Quadrangles: Dibblee Geological Foundation Map DF 33.

Dibblee, T.W., Jr., 1992, Geologic map of the Oat Mountain and Canoga park (north ½) Quadrangles: Dibblee Geological Foundation Map DF 36.

APPENDIX A – FIGURES

Northridge Blind Thrust Fault

Sierra Madre Fault
(San Fernando Section)

Sierra Madre Fault
(San Fernando Section)

OLD ROAD X

WELDON NORTH

LOS PINETOS

SIERRA OVER UNDER

BEALE'S CUT NORTH/SOUTH

Leaming Canyon

Rice Canyon

East Canyon

San Fernando Pass

Fremont Pass

Pacific Tunnel

San Gabriel Mountains

Weldon Canyon

Los Angeles Aqueduct

Elsmere Canyon

E CANYON MTWY

GRAPEVINE FIRE RD

THE OLD RD

RC-09-001(2009)

RC-17-133 (2017)

RC-17-134 (2017)

RC-09-002(2009)

RC-17-135 (2017)

A-17-155 (2017)

A-17-156 (2017)

A-17-157 (2017)

A-17-158 (2017)

R-17-136 (2017)

Earthquake Damage (1971)

Earthquake Damage (1994)

RC-10-104 (2010)

RC-17-111(2017)

RC-17-110(2017)

A-17-109(2017)

2K3-4(2003)

B-1(2005)

B-2 (2005)

2K3-5 (2003)

2K3-4 Existing As-Built Geotechnical Boring (Year)

Alquist-Priolo Earthquake Fault Zone (CGS, 2018)

USGS Quaternary Faults

Fault (inferred location) Historic (<150 years)

Fault (moderately constrained location) Historic (<150 years)

Fault (well constrained location) Historic (<150 years)

Proposed Major Crossing Alternative

N

0 1,000 2,000 FEET

SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Newhall Pass I-5 Wildlife Crossing
Geotechnical Data Map

OLD ROAD X

LOS PINETOS

WELDON NORTH

BEALE'S CUT NORTH/SIERRA OVER UNDER

Proposed Major Crossing Alternative

1,000 2,000 FEET

SCALE

N

Earth Mechanics, Inc.

Geotechnical and Earthquake Engineering

Newhall Pass I-5 Wildlife Crossing

Regional Geologic Map

LEGEND

SURFICIAL SEDIMENTS
unconsolidated alluvial deposits; generally undissected
af artificial cut and fill
Qg gravel and sand of major stream channels
Qa alluvial gravel, sand and clay of valley and floodplain areas

LANDSLIDE DEBRIS

OLDER SURFICIAL SEDIMENTS
dissected, weakly consolidated alluvial deposits
Qos older sandy alluvium, including slope wash, derived from Chatsworth Formation (Kcs)
Qos older alluvium composed largely of angular pebble-size fragments of Miocene shale and some of sandstone (Tm, Tsq, and Ttos); in light gray to tan silty matrix in part indurated by calcareous caliche; crudely bedded to massive; about 200 ft (60m) thick; blends northward upslope in Browns Canyon drainage area into old debris-flow landslides (Qls); slightly deformed and much dissected where elevated; but at Horse Flats the surface of deposition preserved; late Pleistocene age; mapped as slope wash, older alluvium, and Saugus Formation (upper member) by Barrows 1975; Evans and Miller 1978; and Saul 1979; probably in places equivalent to Pacoima Formation of Oakeshott 1958; Barrows et al. 1975; and Dibblee 1991

—UNCONFORMITY—

SAUGUS FORMATION
mostly terrestrial, weakly consolidated; Pleistocene and Pliocene age
QTs light gray to brown pebble-cobble conglomerate, sandstone and lesser amounts of grayish to reddish brown, soft siltstone/claystone; conglomerate composed of granitic, gneissic, metavolcanic, quartzitic, gabbroic and anorthositic detritus in sandy matrix; deposited by westward-flowing streams; Pleistocene age; south of Santa Susana fault mapped as middle member of Saugus Formation by Barrows et al. 1974, Evans and Miller 1978, and Saul 1979 [in adjacent San Fernando quadrangle (Dibblee 1991) QTs west of Elsmere Canyon should be shown as Ts]
Ts (in Newhall area) similar to QTs, but correlative in age with units Tsr and Tps in part; probably Pliocene age
Tsr Sunshine Ranch Member (of Hazzard 1940, in Treiman 1987; Barrows et al. 1974; Evans and Miller 1978; and Saul 1979; type area extends eastward from lower Aliso Canyon to Van Norman Reservoir, Hazzard 1940); terrestrial deposits similar to QTs, but south of Santa Susana fault composed largely of more indurated greenish gray claystone, siltstone, and fine grained sandstone, and contains in lower part brackish marine layers of oyster shells; in exposures northwestward from San Fernando Pass, consists mostly of interbedded conglomerate and fine grained sediments that locally contain few thin layers of peat; unit intertongues westward into Tps, mostly Pliocene age

PICO FORMATION
marine clastic; mostly Pliocene age
Tps south of Santa Susana fault: Pico sandstone (included in Saugus Formation by Kew 1924; Pico Formation by Butler 1977, Lant 1977, Yeats 1987; Pico and Saugus Formations by Evans and Miller 1978) mostly light gray to nearly white, soft friable sandstone, locally pebbly, contains abundant whole and fragmented bivalve shells west of Browns Canyon; deposited under marine to lagoonal conditions; grades upward into terrestrial Saugus Formation; unconformable on Miocene formations
Tpg conglomerate in lower Limekiln Canyon: gray massive conglomerate of cobbles of granitic and metavolcanic rocks in sandstone matrix; nonmarine (?), unconformable on Monterey Shale (Tml), overlain by Saugus Formation
Tp and Tps north of Santa Susana fault: Pico Formation of Kew 1924, Winterer and Durham 1958, 1962; Tps mostly light gray semi-friable sandstone, locally pebbly; upper beds contain bivalve shell fragments; intertongues into Saugus Formation (Ts); Tp mostly gray micaceous siltstone-claystone, bedded to massive, includes few thin sandstone layers

TOWSLEY FORMATION
marine clastic; early Pliocene age (Repettian Stage) and possibly latest Miocene ("Delmontian Stage")
Ttos light gray to tan coherent to semi-friable sandstone, medium grained to locally gritty and pebbly, bedded; includes minor micaceous siltstone; grades laterally northward into Saugus Formation (Ts) in San Fernando Pass area
Ttoc gray micaceous silty claystone and siltstone; minor sandstone

SYMBOLS
(not all symbols present on every map)

FORMATION CONTACT — MEMBER CONTACT — CONTACT BETWEEN SURFICIAL SEDIMENTS
dashed where inferred or indefinite — between units of a formation — located only approximately in places

FAULT: Dashed where indefinite or inferred, dotted where concealed, queried where existence is doubtful. Parallel arrows indicate inferred relative lateral movement. Relative vertical movement is shown by U/D (U-upthrown side, D-downthrown side). Short arrow indicates dip of fault plane. Sawteeth on upper plate of low angle thrust fault.

FOLDS: ANTICLINE — SYNCLINE
arrow on axial trace of fold indicates direction of plunge; dotted where concealed by surficial sediments

STRIKE AND DIP OF STRATIFIED ROCKS: inclined — horizontal — inclined (approximate) — overturned — vertical — inclined — approximate — vertical

FOSSIL LOCALITY — DIRECTION OF LANDSLIDE MOVEMENT — SANDSTONE MARKER BED — CONGLOMERATE MARKER BED — ABANDONED EXPLORATORY OIL (OR GAS) WELL — OIL WELLS (ON TOPOGRAPHIC BASE MAP)

Northridge Blind Thrust Fault

OLD ROAD X

WELDON NORTH

Sierra Madre Fault
(San Fernando Section)

LOS PINETOS

SIERRA OVER UNDER

BEALE'S CUT NORTH/SOUTH

Sierra Madre Fault
(San Fernando Section)

MAP EXPLANATION

EARTHQUAKE FAULT ZONES

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments; the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required.

USGS Quaternary Faults

- Fault (inferred location) Historic (<150 years)
- Fault (moderately constrained location) Historic (<150 years)
- Fault (well constrained location) Historic (<150 years)

SEISMIC HAZARD ZONES

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslide Zones
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Overlapping Liquefaction and Earthquake-Induced Landslide Zones
Areas that lie within zones of required investigation for both liquefaction and earthquake-induced landslides.

Proposed Major Crossing Alternative

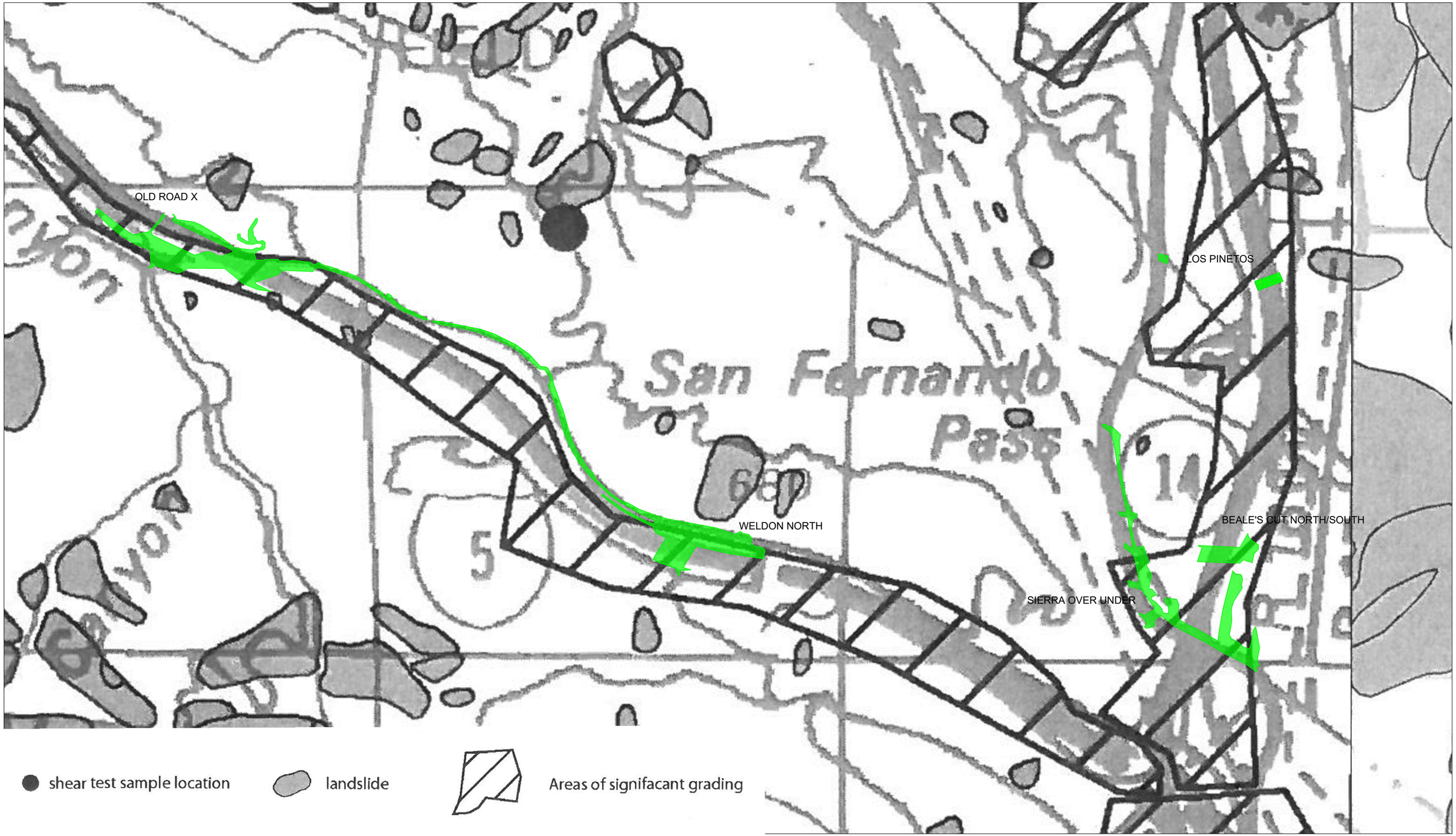
N

0 1,000 2,000 FEET

SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Newhall Pass I-5 Wildlife Crossing
Seismic Hazard Map



Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Newhall Pass I-5 Wildlife Crossing
Landslide Map