





FEASIBILITY REPORT
Newhall Pass Wildlife Connectivity Design Project

PREPARED FOR

Wildlife Conservation Board
Grant Agreement No. WC-2295DC

Resource Conservation District of the Santa Monica Mountains

PREPARED BY

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connect

southwest to
SANTA MONICA MOUNTAINS

focal habitat:
MONTANE WOODLANDS

connect

north to
LOS PADRES NATIONAL FOREST

SANTA SUSANA MOUNTAINS

focal habitat:
EAST CANYON RIPARIAN

connect

crossing alternative:
OLD ROAD X

Oaktree Gun Club

crossing alternative:
WELDON NORTH

5 I-5

The Old Road

focal habitat:
NORTH FORK SANTA CLARA RIVER RIPARIAN

east to
SAN GABRIEL MOUNTAINS

Ecological connectivity is one of the most important components of **climate resilience** for wildlife populations and landscapes.

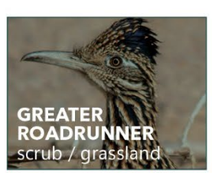
REPRESENTATIVE SPECIES OF FOCAL HABITATS



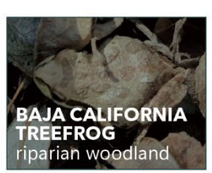
MOUNTAIN LION
chaparral / generalist



WESTERN GRAY SQUIRREL
oak woodland



GREATER ROADRUNNER
scrub / grassland



BAJA CALIFORNIA TREEFROG
riparian woodland



BIGCONE DOUGLAS-FIR
montane woodland

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EXECUTIVE SUMMARY

Located at the intersection of several regional ecological zones, the Newhall Pass area (the Pass)—a hotspot of biodiversity and ecological diversity—will likely be an integral climate change refuge of connectivity and resilience for numerous species of flora and fauna. The location is also a hotspot for wildlife-vehicle collisions, especially for mountain lions (*Puma concolor*).

Project Purpose and Need

The Resource Conservation District of the Santa Monica Mountains, in partnership with Caltrans, recommends constructing a major wildlife crossing feature in the Newhall Pass area to improve connectivity and resilience of wildlife populations and ecosystems in the Southern California Coast Ecoregion, and particularly in the San Gabriel, Santa Susana, and Santa Monica mountains. This Feasibility Report serves as the first step toward locating and designing this feature, and potentially others, to restore ecological connectivity and support long-term ecological resilience of the Newhall Pass area and surrounding ecosystems.

The general need for wildlife connectivity enhancements associated with the Newhall Pass at I-5 has been identified in CDFW's *Priority Wildlife Movement Barrier Locations by Region as Barrier W047* (CDFW 2020), with the mountain lion and associated species designated as key focal species for future crossing strategies. Mountain lions in Southern California face an increasing risk of local extinction due to small population size and lack of connectivity (Ernest et al. 2014, Gustafson et al. 2019). The local Southern California population has recently been designated as a candidate species evolutionarily significant unit (ESU) for listing under the California Endangered Species Act, temporarily granting it the same protections granted to listed species. Additionally, the Pass is known to have frequent wildlife-vehicle collisions, many involving mountain lions.

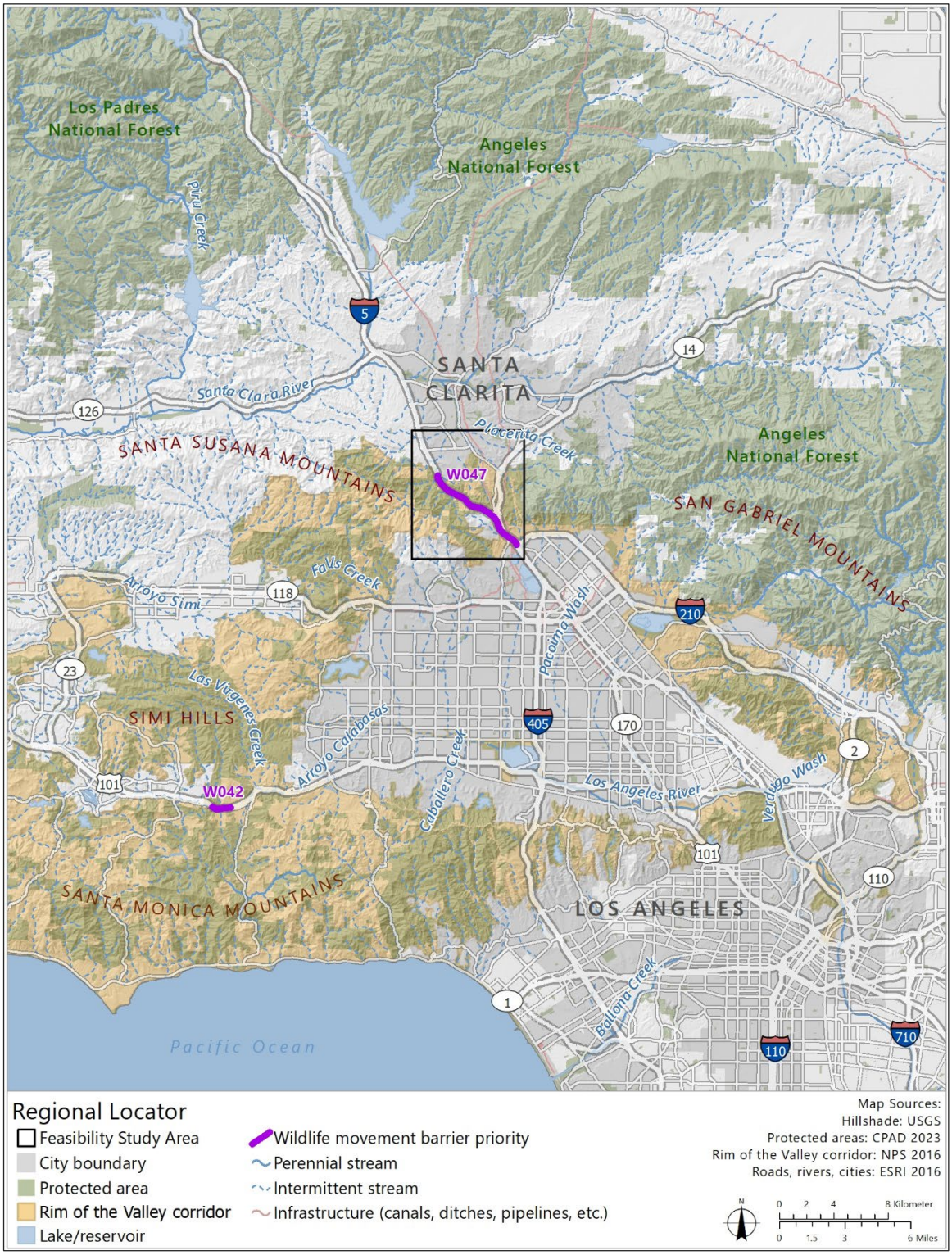
Approach and Science Basis

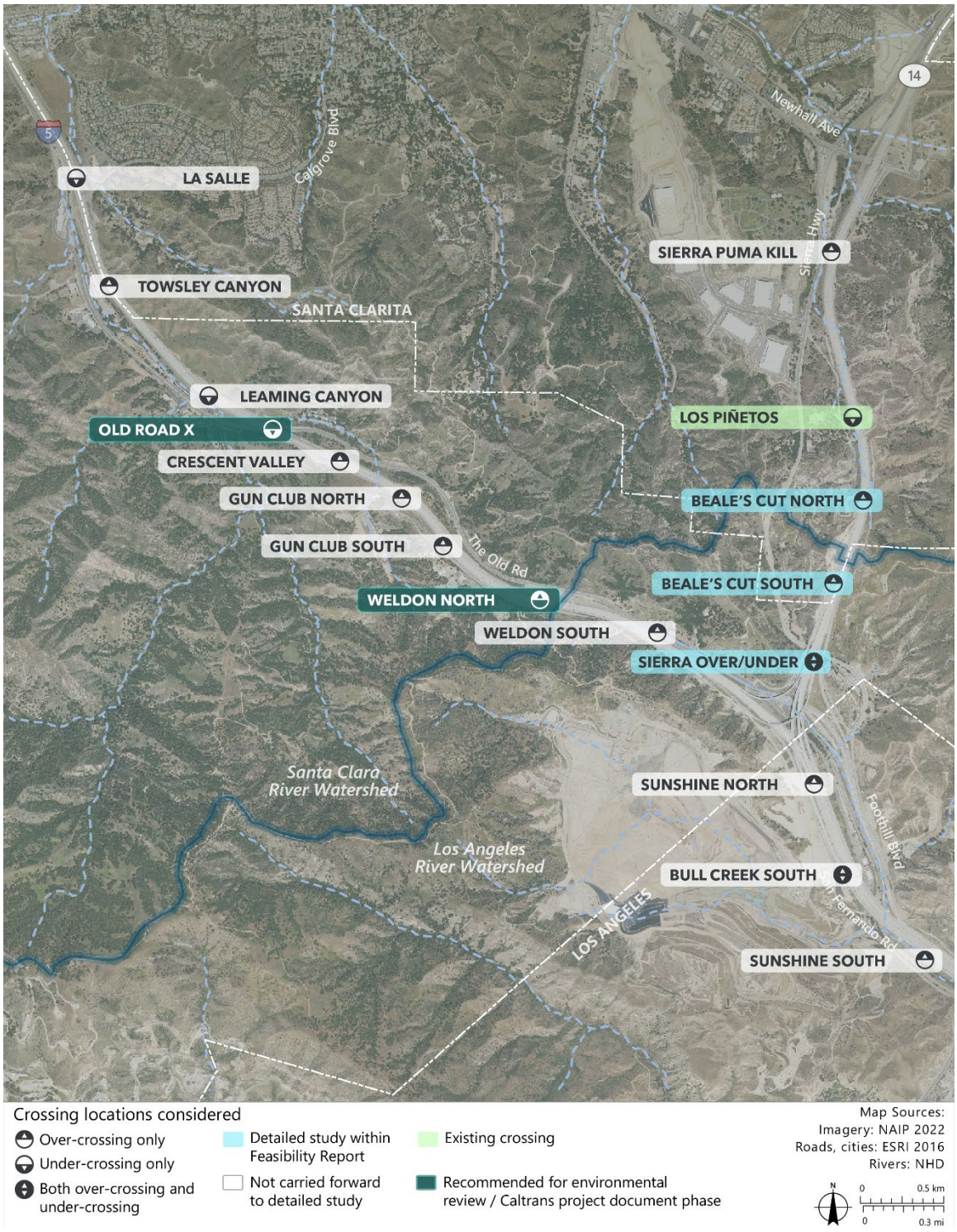
High habitat connectivity improves key ecological processes such as gene flow, biotic migration, predator-prey relationships, nutrient flow, geophysical processes, and pollination (CDFW 2022). Increasing gene flow, in particular, is essential for the recovery of local mountain lion populations, currently in danger of local extinction due to inbreeding depression (Benson et al. 2016, Riley et al. 2014a). Local National Park Service scientists Dr. Seth Riley and Jeff Sikich, who have pioneered this research, both serve as Technical Advisors on this Project. Additionally, landscape connectivity is one of the most important tools for ensuring climate-resilient conservation networks that can accommodate long-term landscape change (Heller & Zaveleta 2009, McRae et al. 2016).

To address these connectivity needs, high-quality wildlife crossings, either overpasses or underpasses and associated supporting connectivity enhancement measures, are needed at I-5 and SR-14 within the Pass. This study and resulting recommendations focused on the following key questions:

1. What are appropriate habitats or ecological features to connect?
2. What are the best locations for crossing structures and other connectivity enhancement measures?
3. What general design and construction approaches are feasible for major crossing structures at selected locations?

4. Which crossing locations and design concepts should be considered for further study during the Environmental Document phase, the 65% Design phase, and beyond?




LA SALLE
TOWSLEY CANYON
SANTA CLARITA
LEAMING CANYON
OLD ROAD X
CRESCENT VALLEY
GUN CLUB NORTH
GUN CLUB SOUTH
WELDON NORTH
WELDON SOUTH
SIERRA PUMA KILL
LOS PIÑETOS
BEALE'S CUT NORTH
BEALE'S CUT SOUTH
SIERRA OVER/UNDER
SUNSHINE NORTH
BULL CREEK SOUTH
SUNSHINE SOUTH
Calgrove Blvd
Newhall Ave
Sierra Hwy
The Old Rd
Foothill Blvd
San Fernando Rd
LOS ANGELES
Santa Clara River Watershed
Los Angeles River Watershed
5
14
Crossing locations considered
Over-crossing only
Under-crossing only
Both over-crossing and under-crossing
Detailed study within Feasibility Report
Not carried forward to detailed study
Existing crossing
Recommended for environmental review / Caltrans project document phase
Map Sources:
Imagery: NAIP 2022
Roads, cities: ESRI 2016
Rivers: NHD
N
0
0.5 km
0
0.3 mi

Determining Suitability of Crossing Sites and Design Alternatives

Crossing location alternatives, design features, and other connectivity considerations were identified and evaluated for three categories of suitability criteria:

Ecological Criteria provide an estimate of potential ecological value of connectivity measures for wildlife, habitats, and natural processes.

Permanence Criteria provide an estimate of potential permanence, or resilience, of connectivity measures, due to both human and environmental factors.

Constructability Criteria provide an estimate of design and construction feasibility, complexity, and cost of connectivity measures.

We applied omnidirectional connectivity modeling, implemented with Omniscape (Landau et al. 2021), to provide a systematic and data-driven approach to landscape analysis for ecological criteria including a set of focal habitats and associated species within the Pass. Permanence criteria included factors such as land conservation status, wildfire frequency, and climate refuge value. Criteria were considered iteratively throughout the site analysis and alternatives evaluation process, with review and guidance from the Technical Advisory Committee. During the first iteration of crossing site identification, ecological criteria and supporting models were used to identify crossing locations with the greatest potential to provide connectivity between focal habitat areas. Next, other key criteria, such as land conservation status or physical constraints like steep slopes, served as initial "filters" to identify six of the best locations for more detailed study.

These six locations, located along both I-5 and SR-14, are Old Road X, Weldon North, Los Piñetos, Beale's Cut North, Beale's Cut South, and Sierra Over/Under. Detailed design studies and constructability analyses were then conducted for each site. A final resulting qualitative assessment of the full set of suitability criteria for the six sites supported recommendations for preferred alternatives to be carried forward.

Site-Specific and Pass-Wide Design and Connectivity Program Recommendations

Once the six locations were identified, detailed design studies were conducted for each site in service of a more detailed suitability analysis. The six sites were thoroughly compared using the ecological, permanence, and constructability criteria. The resulting qualitative assessment provided an understanding of the suitability of each location for a wildlife crossing, informing recommendations for design decisions and potential implementation.

An I-5 crossing was deemed a higher priority than an SR-14 crossing in the near term because the Los Piñetos underpass of SR-14 currently provides connectivity between the "Y" and the San Gabriel Mountains, while connectivity across I-5 is currently limited to small culverts, the unvegetated and constrained Old Road underpass, and the future unvegetated new Weldon Bridge.

Two of the I-5 sites were identified to be carried forward as alternatives for crossing structures and supporting habitat restoration: Old Road X and Weldon North. Following this Feasibility Report, the two preferred crossing alternatives will be evaluated through the Caltrans environmental review process, and one will be selected to design to 65% completion in the final phase of this Project.

While an I-5 crossing was deemed a higher priority than an SR-14 crossing in the near term, the long-term viability of the SR-14 crossing at Los Piñetos is questionable due to adjacent private land zoned for commercial development and the relatively low results for ecological criteria. The other SR-14 crossing site alternatives are considered as grossly feasible for future phases of connectivity enhancement work for the Newhall Pass region and should be evaluated further, including performing additional baseline wildlife studies and land conservation planning along SR-14 and I-5 south of the Y.

Fully achieving ecological connectivity and climate resilience across an ecologically complex subregion like the Newhall Pass will require broader conservation planning and additional projects beyond the initial I-5 crossing. Therefore, this Report also includes recommendations for medium- and long-term actions that will support, and in some cases are necessary for, the success of the initial I-5 crossing feature. These include additional crossings of both I-5 and SR-14 to provide both riparian and upland connectivity, as is included in precedent crossing projects at the Wallis Annenberg Wildlife Crossing over US-101 at Liberty Canyon and the Interstate 15 Wildlife Crossing of the Santa Ana-Palomar Mountains Linkage. Finally, to address accelerating climate-driven landscape change predicted to occur during the 75-year designed lifespan of the initial I-5 crossing feature, we propose additional measures informed by emerging best practices in connectivity planning.

Reading this Report

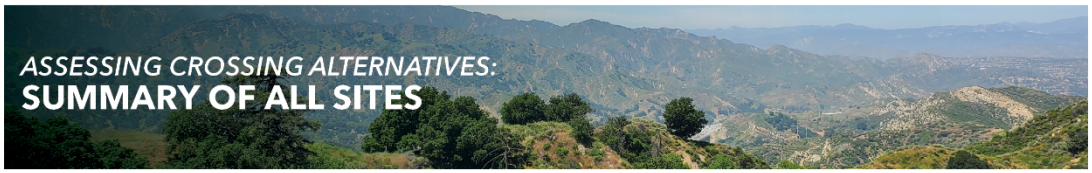
Sections 2 and 3 provide the locational context and science basis that informed the Project approach.

Section 4 explains in detail the suitability criteria and other suitability considerations used to guide decision-making on alternatives selection.

Section 5 contains an in-depth qualitative assessment of the six alternative sites.

Section 6 contains site-specific and Pass-wide connectivity program, design, implementation, and adaptive management recommendations.

> **"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."**
>
> Crescent Valley Mobile Home Park resident



CARRIED FORWARD

	Type	Ecological	Permanence	Constructability	Next steps
OLD ROAD X					Selected for Environmental Review and Caltrans Project Documentation in next phase of project
WELDON NORTH					Selected for Environmental Review and Caltrans Project Documentation in next phase of project
SIERRA OVER/UNDER					Carried forward for full feasibility analysis in current phase of project
BEALE'S CUT NORTH					Carried forward for full feasibility analysis in current phase of project
BEALE'S CUT SOUTH					Carried forward for full feasibility analysis in current phase of project
EXISTING CROSSING **LOS PINETOS**					Carried forward for full feasibility analysis in current phase of project

NOT CARRIED FORWARD

	Type	Limiting criteria	Reason for disqualification
GUN CLUB NORTH		Permanence and Constructability	Current land ownership and land use unideal; potential widening of I-5 would make construction impossible
GUN CLUB SOUTH			
CRESCENT VALLEY		Permanence	Private land ownership
LEAMING CANYON		Constructability	High cost of constructing a sufficiently large tunnel
TOWSLEY CANYON		Permanence	Multiple permanence issues east of I-5
LA SALLE		Ecological and Constructability	Challenging topography and difficult access for wildlife
SIERRA PUMA KILL		Ecological	Close proximity to urban habitat resistances
"Y" INTERCHANGE		Permanence and Constructability	High construction complexity across I-5/SR-14 interchange; land ownership and regulatory challenges; challenges with addressing the high vehicular collision risk to wildlife
SUNSHINE NORTH			
BULL CREEK SOUTH			
SUNSHINE SOUTH			

CROSSING TYPES Over-crossing only; Under-crossing only; Both over-crossing and under-crossing

OVERALL ASSESSMENT Insufficient; Marginal; Average; Good; Excellent

SELECTED ALTERNATIVES COMPARED

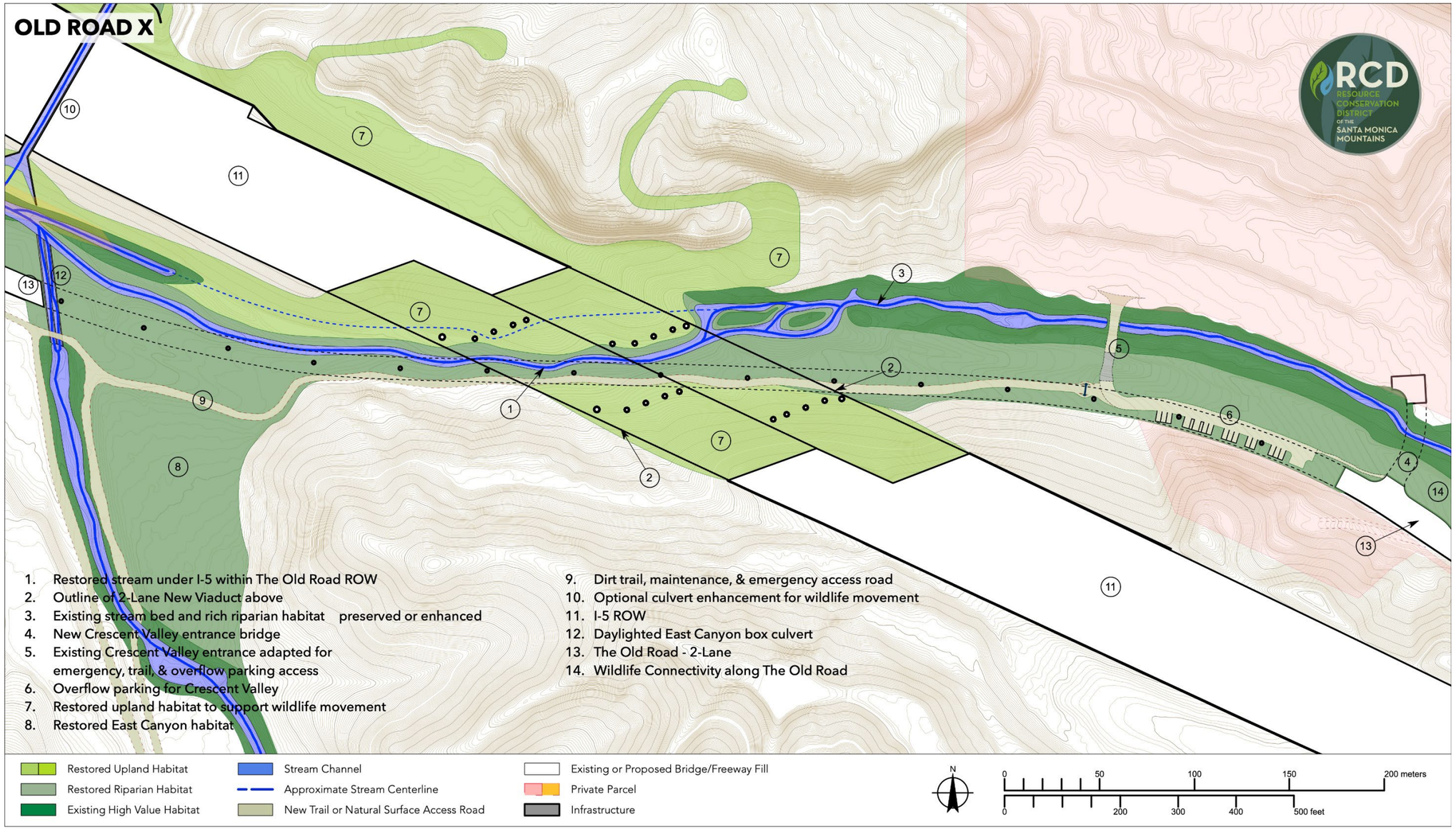
The two crossing alternatives here are recommended to be carried forward through environmental review and Caltrans documentation in the next phase of the project.

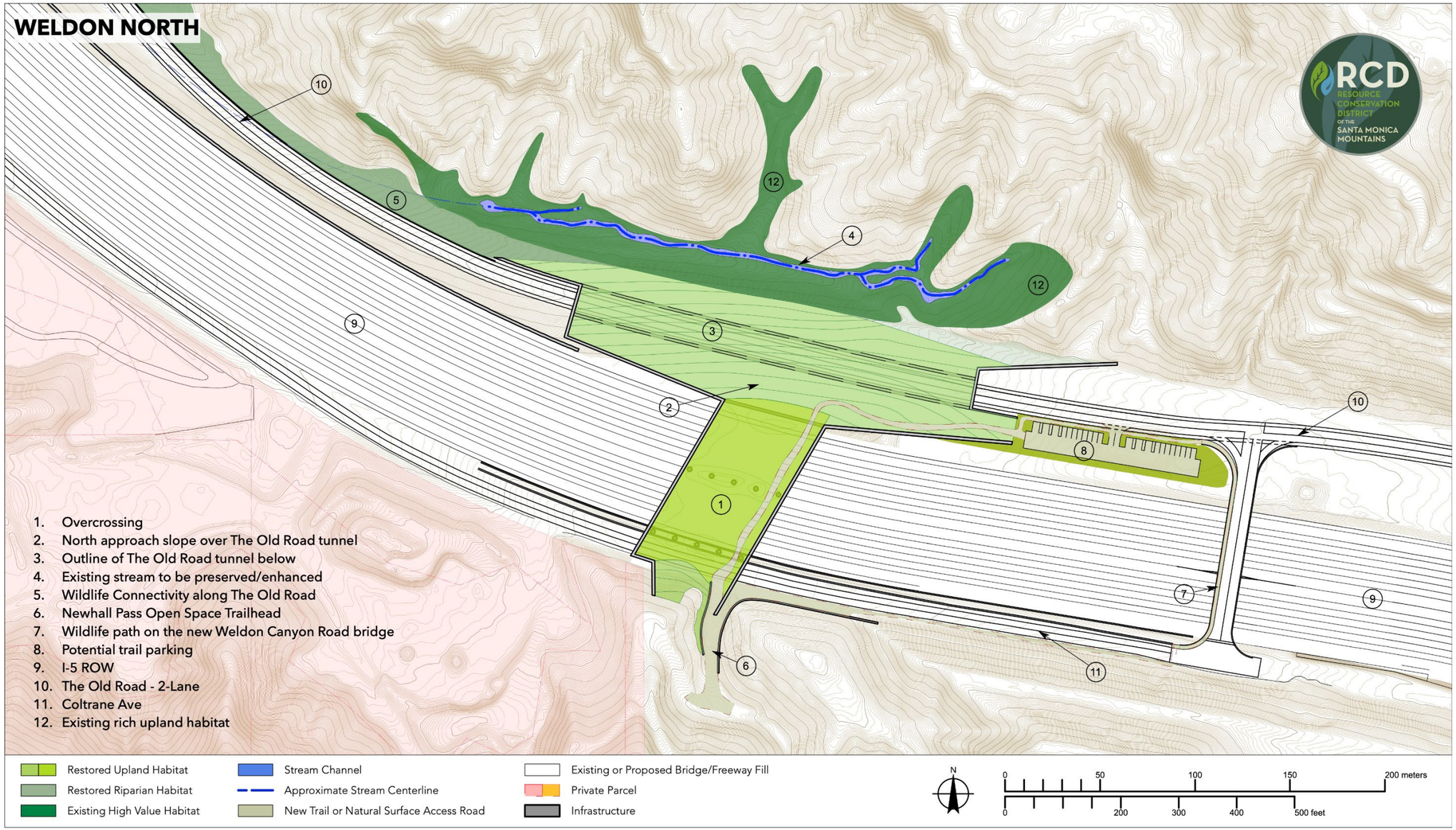
The **Old Road X** alternative, which includes an underpass of the I-5 and an Old Road viaduct, runs above the North Fork of the Santa Clara River and would provide extensive riparian habitat restoration and connectivity enhancement, and trail opportunities associated with the East Canyon Trailhead.

The **Weldon North** I-5 and Old Road overpass alternative provides strong connectivity adjacent to high quality, and relatively rare, upland montane conifer habitat. This alternative connects with the Newhall Pass Open Space trailhead.

Both alternatives would also provide high quality connectivity for mountain lions and other habitat generalist species. Note that the I-5 and Old Road viaduct surfaces have been removed from the Old Road X illustrative to better communicate the connectivity benefits (columns are shown).




OLD ROAD X
RCD
RESOURCE CONSERVATION DISTRICT OF THE SANTA MONICA MOUNTAINS
1. Restored stream under I-5 within The Old Road ROW
2. Outline of 2-Lane New Viaduct above
3. Existing stream bed and rich riparian habitat preserved or enhanced
4. New Crescent Valley entrance bridge
5. Existing Crescent Valley entrance adapted for emergency, trail, & overflow parking access
6. Overflow parking for Crescent Valley
7. Restored upland habitat to support wildlife movement
8. Restored East Canyon habitat
9. Dirt trail, maintenance, & emergency access road
10. Optional culvert enhancement for wildlife movement
11. I-5 ROW
12. Daylighted East Canyon box culvert
13. The Old Road - 2-Lane
14. Wildlife Connectivity along The Old Road
Restored Upland Habitat
Restored Riparian Habitat
Existing High Value Habitat
Stream Channel
Approximate Stream Centerline
New Trail or Natural Surface Access Road
Existing or Proposed Bridge/Freeway Fill
Private Parcel
Infrastructure
N
0 50 100 150 200 meters
0 200 300 400 500 feet


WELDON NORTH
RCD
RESOURCE CONSERVATION DISTRICT OF THE SANTA MONICA MOUNTAINS
1. Overcrossing
2. North approach slope over The Old Road tunnel
3. Outline of The Old Road tunnel below
4. Existing stream to be preserved/enhanced
5. Wildlife Connectivity along The Old Road
6. Newhall Pass Open Space Trailhead
7. Wildlife path on the new Weldon Canyon Road bridge
8. Potential trail parking
9. I-5 ROW
10. The Old Road - 2-Lane
11. Coltrane Ave
12. Existing rich upland habitat
Restored Upland Habitat
Restored Riparian Habitat
Existing High Value Habitat
Stream Channel
Approximate Stream Centerline
New Trail or Natural Surface Access Road
Existing or Proposed Bridge/Freeway Fill
Private Parcel
Infrastructure
N
0 50 100 150 200 meters
0 200 300 400 500 feet

1 INTRODUCTION

The Resource Conservation District of the Santa Monica Mountains, in partnership with Caltrans, recommends constructing a major wildlife crossing feature of I-5 freeway (I-5) in the Newhall Pass area to improve connectivity of wildlife populations between the San Gabriel, Santa Susana, and Santa Monica mountains (See Figure 1: Regional Locator). This Feasibility Report serves as the first step toward locating and designing this crossing feature, and potentially others, to restore ecological connectivity and support long-term ecological resilience of the Newhall Pass area and the broader Southern California Coast Ecoregion.

In its *2020 Priority Wildlife Movement Barrier Locations by Region*, the California Department of Fish and Wildlife (CDFW) identified I-5 north of Sylmar and south of Santa Clarita, also known as the Newhall Pass (the Pass), as Barrier W047 (CDFW 2020) (Figure 1). With funding from the Wildlife Conservation Board (Grant Agreement No. WC-2295DC), the Resource Conservation District of the Santa Monica Mountains (RCDSMM) has partnered with Stillwater Sciences, Mark Thomas, Occidental College, and the Fernandeño Tataviam Band of Mission Indians to conduct this feasibility study that includes recommendations for a wildlife crossing and associated habitat connectivity improvements of I-5. This Feasibility Report also recommends potential associated actions on adjacent lands to maximize effectiveness of crossings and broader connectivity, potentially including land purchases and other future restoration activities within Pass. Therefore, this feasibility study considered a broad area of the Pass encompassing I-5 and SR-14 freeways between the City of Santa Clarita and City of Los Angeles (Project Study Area - Figure 2).

Following this Feasibility Report, two preferred crossing alternatives will be evaluated through the Caltrans environmental review process, and one will be designed to 65% in the final phase of this project. Because fully achieving ecological connectivity and resilience across an ecologically complex subregion like the Newhall Pass will require additional projects and broader conservation planning, this Report also includes recommendations for long-term conservation and restoration for the broader Pass area that will support, and in some cases are necessary for, success of the recommended I-5 crossing feature.



Figure 1. Regional location.

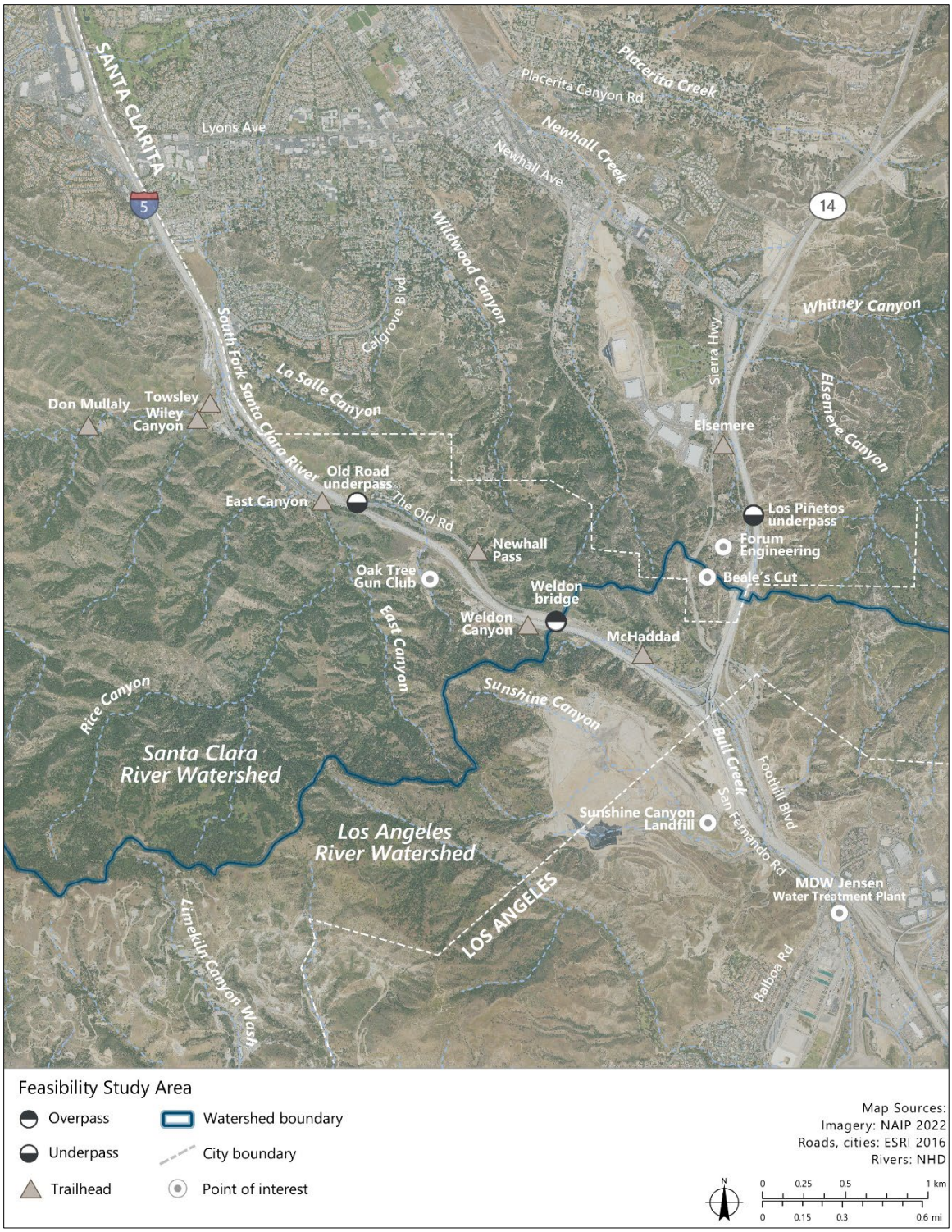


Figure 2. Project study area.

1.1 Project Purpose and Need

Purpose

- Reduce vehicle collisions and increase connectivity and gene flow of mountain lion and other wildlife populations on either side of Newhall Pass.
- Improve broader ecological connectivity of habitats, ecosystems, watersheds, and natural processes to support local and regional ecological resilience as we enter an era of rapid climate change.

Need

The general need for wildlife connectivity enhancements associated with the Newhall Pass, Barrier W047, has been identified in CDFW's *2020 Priority Wildlife Movement Barrier Locations by Region* (CDFW 2020). CDFW identified the mountain lion and associated species as key focal species for future crossing strategies. Mountain lions in Southern California face an increasing risk of local extinction due to small population size and lack of connectivity (Ernest et al. 2014, Gustafson et al. 2019). The local Southern California population has recently been designated as a candidate species evolutionarily significant unit (ESU) for listing under the California Endangered Species Act, temporarily granting them the same protections granted to listed species. The Pass is also a known hotspot for wildlife vehicle collisions, many involving mountain lions (Appendix A, Figure A-11).

High habitat connectivity improves ecological processes such as gene flow, migration, predator-prey relationships, nutrient flow, and pollination (CDFW 2022). Increasing gene flow is essential for recovery of local mountain lion populations, which are in danger of local extinction due to inbreeding depression (Benson et al. 2016, Riley et al. 2014a). Local National Park Service scientists Dr. Seth Riley and Jeff Sikich, who pioneered this research, serve as Technical Advisors on the Project. To address connectivity constraints, a high-quality wildlife over- or -under-crossing and associated supporting connectivity enhancement measures are needed at I-5.

We assume that complex landscape changes will occur during the 75-year designed lifespan of the planned crossing feature and that these future changes must be considered when making design recommendations (AASHTO 2017). Located at a hotspot of biodiversity and ecological diversity, at the intersection of several regional ecological zones, the Pass will likely become even more integral for connectivity and resilience of numerous other species of flora and fauna (Figure 3 – Ecological Subsections) with climate change. Landscape connectivity is proposed as one of the most important components of climate-resilient conservation networks that can accommodate long-term landscape change (Heller & Zaveleta 2009, McRae et al. 2016). Accordingly, a key assumption about the role of connectivity projects within conservation planning is that when connectivity is restored between natural areas, the resulting network of reserves creates greater resilience benefit than the sum of individual preserves alone. Therefore, along with restoring connectivity for wildlife movement of focal species such as mountain lions, crossing location and design recommendations must also consider the potential for restoration of the natural pattern and processes of many types of ecosystems and habitats in anticipation of long-term and complex ecological change, a connectivity design concept that has been referred to as "conserving nature's stage" (Beier, Hunter, & Anderson 2015, Gordon, Bailey & Larwood 2022).

This Feasibility Report provides recommendations for the location and design of a crossing structure alternatives (over or under) I-5. As discussed in subsequent sections, improving connectivity across the SR-14 Freeway, Old Road, and Sierra Highway were also revealed to be an urgent need if the I-5 crossing is to be successful. Therefore, this Report also gives

significant consideration to these and other supporting connectivity enhancement needs in the Pass.

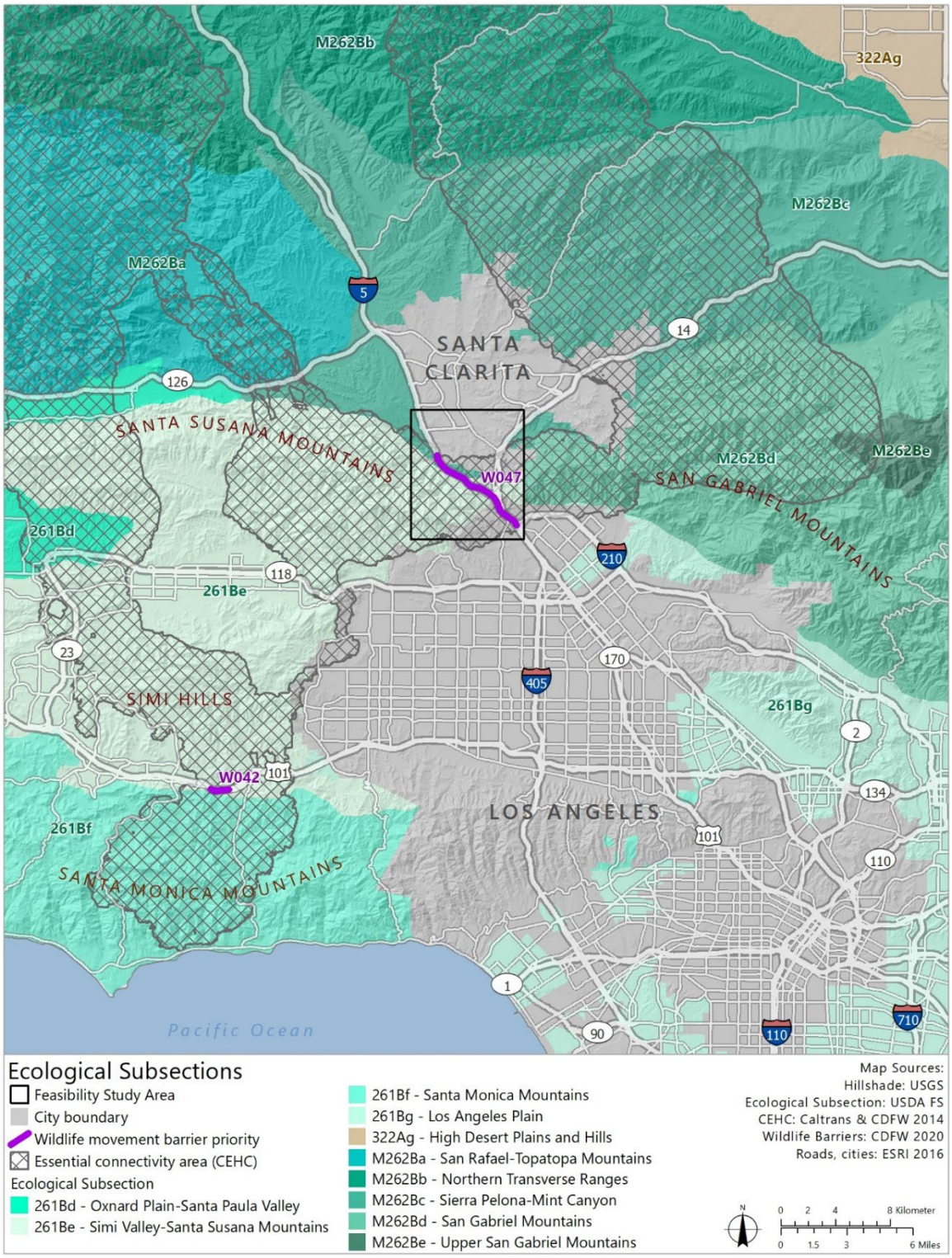


Figure 3. Regional ecological subsections and essential connectivity areas.

1.2 Project Approach and Summary

This feasibility study falls within a broader project process leading to 65% design of a major crossing structure. The overall project process includes the following 4 tasks aligned with the Caltrans project delivery process:

- Task 1: Project Management
- Task 2: Feasibility Study **(Current Task)**
- Task 3: Environmental Review and Caltrans Project Documentation (including Project Initiation and Project Approval Documents, PSR-PDS and Project Report)
- Task 4: 65% Design

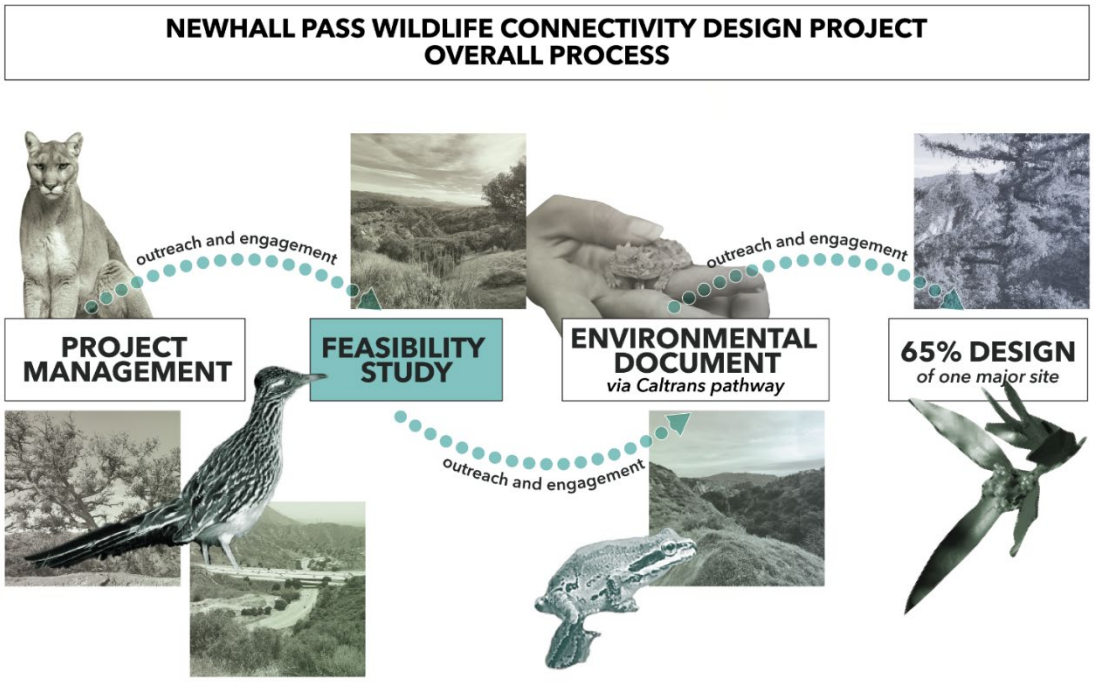


Figure 4. Overall project process.

The above steps are being completed over a 4-year timeline, with the Feasibility Study being completed in year one. To ensure effective integration of science, engineering, and regulatory requirements, a technical advisory committee of experts in wildlife connectivity and related topics was convened to support and guide the Project. Additionally, local landowners and governing agencies are providing feedback on project information and products as they are developed. While the following process diagrams presents a linear process, as with all complex land planning projects, the process has been iterative where each step has resulted in refinements and adjustments to all other steps as new information is revealed, leading to integrated and defensible recommendations.

The current feasibility study component of the overall project applied the general process presented in Figure 5 to produce recommendations for the I-5 crossing structure and supporting connectivity measures.

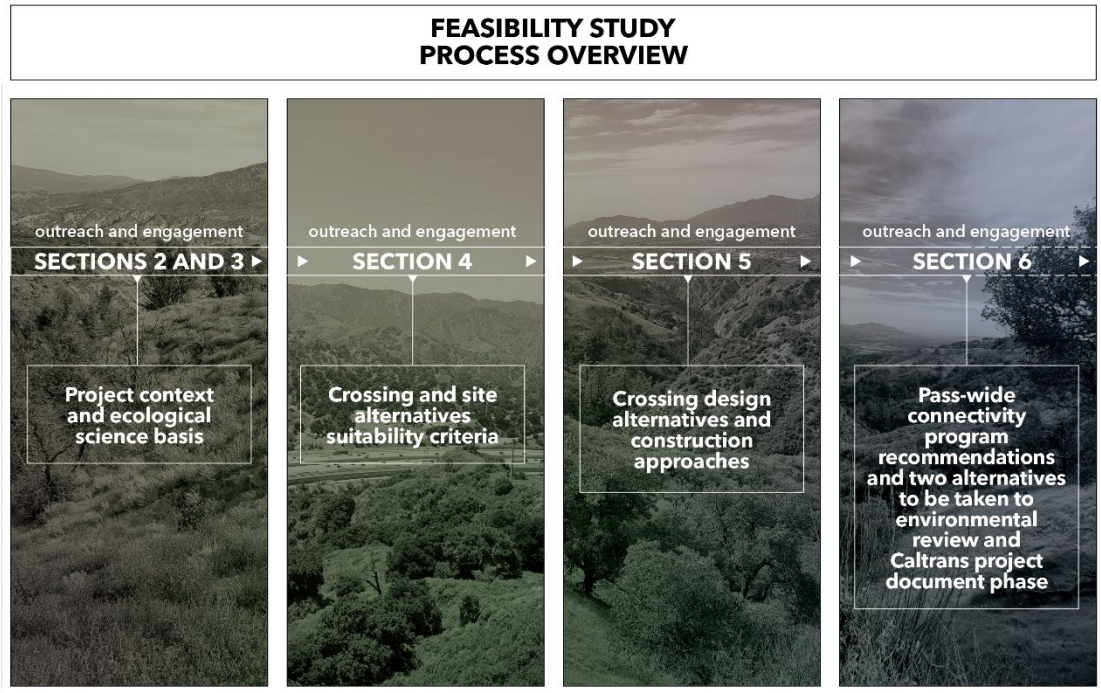


Figure 5. Feasibility Study process and report structure.

The feasibility study process began with a characterization of the project context and a science basis that are discussed in detail in Sections 2 and 3 of this report. These steps provide the starting point for addressing the following four key questions:

1. What are appropriate habitats or ecological features to connect?
2. What are the most suitable locations for crossing structures and other connectivity enhancement measures?
3. What design and construction approaches are feasible for major crossing structures at alternative locations?
4. Which crossing locations and design concepts should be considered for further study during the Environmental Review and Caltrans Document phase, the 65% Design phase, and beyond?

The context and science basis led to the development of three sets of suitability criteria to guide crossing site selection and design discussed Section 4. The sets of criteria used to evaluate 17 initial crossing site locations along I-5 and SR-14 are:

Ecological Criteria – estimate of potential ecological value of crossing measures for wildlife, habitats, and natural processes

Permanence Criteria – estimate of potential permanence, or resilience, of crossing measures

Constructability Criteria – estimate of design and construction feasibility, complexity, and cost of crossing measures

Six alternative crossing site locations and design concepts were then selected for in-depth feasibility analysis in Section 5 and two locations were recommended to be carried forward in the subsequent Environmental Review and Caltrans Document phase. Finally, in Section 6, we present recommendations for advancing the I-5 crossing in the context of additional beneficial, and in some cases necessary, connectivity measures for SR-14 and the broader Pass area, including:

Near-term Recommendations – focused on quickly re-establishing connectivity of mountain lion populations through design of a single crossing structure over/under I-5, and associated connectivity design measures in adjacent areas including at the existing, but constrained, Los Piñetos underpass of SR-14.

Medium-term Recommendations – implementation of a permanent crossing strategy for SR-14 and other Pass-wide connectivity measures.

Long-term Recommendations – implementation of additional connectivity measures throughout the Newhall Pass to support climate-resilient regional wildlife populations and ecosystems.

2 PROJECT CONTEXT

2.1 Regional Connectivity Context

The Newhall Pass Wildlife Connectivity Project (the Project) will enhance regional wildlife connectivity between the San Gabriel Mountains (east of I-5) and the Santa Susana Mountains (west of I-5), and by extension the Santa Monica Mountains and Simi Hills, located to the south of the Santa Susanas, and the Los Padres National Forest to the north of the Santa Susanas (Figure 1). The Project represents CDFW Barrier W047, one of only three other high priority areas for wildlife crossing enhancements in Los Angeles County, identified by the CDFW *2020 Priority Wildlife Movement Barrier Locations by Region* report and is included in the California Essential Linkages Plan (CDFW 2020). Construction on another barrier, Barrier W042, the Wallis Annenberg Wildlife Crossing of SR-101 is now (2024) underway nearby. While crossing barriers at State Route 118 in the Simi Hills between the Santa Susanas and Santa Monicas were not prioritized in CDFW (2020), this location should also be considered in the future. Together, crossing features at these locations are expected to fulfill CDFW high-priority goals and objectives identified in the *California Essential Linkages Plan* and support other state and local plan goals including the California's 30 x 30 Habitat Connectivity Program, LA City and County Biodiversity Indices, the City of LA Green New Deal, LA County Planning's Significant Ecological Areas Program, and the LA County Sustainability Plan (LASAN 2020, CNRA 2022).

The Project will also benefit other urban connectivity planning efforts currently underway, including a region-wide "Wildlife Habitat Connectivity Masterplan" for southern LA County expected to commence this year. As a key wildland connection bordering the plan area, the future Newhall Pass Wildlife Crossing stands to benefit this broader regional initiative which focuses on connecting natural and constructed habitats within and surrounding urban areas of Los Angeles including the Rim of the Valley Corridor Special Resources Study Area, the Los Angeles River and Arroyo Seco, Ballona Wetlands and Palos Verdes, Whittier Narrows and the San Gabriel River, and the many other natural areas in urban Los Angeles County via urban wildlife corridors and stepping-stones. It also addresses highly urban areas through the lens of access to nature, creek daylighting and green infrastructure, and guidance on "backyard biodiversity" initiatives such as school nature gardens and certified wildlife friendly landscapes. This effort also builds upon the City of Los Angeles Wildlife Ordinance which provides new land use policies that balances wildlife habitat and connectivity with private property development in the hillsides and habitats of the Eastern Santa Monica Mountains Los Angeles.

More locally, the Project area is also included in the *Upper LA River and Tributaries Revitalization Plan* (ULART) which includes the nearby Pacoima Wash watershed, an area of exceptionally high biodiversity located just east of the Pass, which flows southwest from the western San Gabriel Mountains through the communities of Sylmar and Pacoima in the City of Los Angeles. The ULART emphasizes the need to protect and enhance the region's ecological habitat and acknowledges the role of terrestrial areas, such as the proposed project site, in supporting watershed sustainability. Bull Creek, is adjacent to Pacoima Wash to the west, drains the Pass to the south and passes through the center of the urbanized San Fernando Valley.

Numerous other efforts are underway regionally and nationally to stave off the biodiversity crisis, and would be supported by greater regional connectivity provided by the project, including: the aforementioned President Biden and Governor Newsom's 30% by 2030 ("30 x 30") conservation plan; LA County's Significant Ecological Areas; Ventura County's Wildlife Connectivity Ordinance; the LA River Master Plan; the San Gabriel Mountains National Monument Expansion, LA River Southern California Steelhead fish passage projects (several with leadership by RCDSMM); and regional and subregional habitat conservation plans and

natural communities conservation plans in Riverside, Orange, and San Bernardino counties, and in Palos Verdes; and the Southern California Council of Governments *Connect SoCal Regional Wildlife Connectivity Plan*.

2.2 Regional Socio-Cultural Context

The Project will also benefit neighboring disadvantaged communities as an educational opportunity, and potentially as a recreational resource if a trail component is deemed to be compatible with wildlife crossing designs. The California Environmental Protection Agency (CalEPA) and the California Office of Environmental Health and Hazard Assessment (OEHHA) administer CalEnviroScreen, a mapping tool that helps identify California communities that are most affected by multiple sources of pollution. Sylmar, San Fernando, and Pacoima, communities south of the project area along the I-5 corridor, are defined as disadvantaged communities according to CalEnviroScreen 4.0. Disadvantaged communities are defined by CalEPA as the top 25 percent overall scoring areas from CalEnviroScreen, as well as the top 5 percent pollution-burdened census tracts that do not have an overall CalEnviroScreen score (Figure 6).

The Project has implications for recreational linkages identified in the *Rim of the Valley Plan* and the vision for the Crest to Coast Trail, eventually connecting the Pacific Crest Trail in Agua Dulce to the Ventura County line, reaching the ocean, (if trails are deemed to be compatible with planned crossing structures). By connecting the Rim of the Valley, the project also may integrate a key trail connection for the region, advancing the vision for a connected network of open space and recreation between the San Gabriel Mountains, the Santa Monica Mountains, the Santa Susana Mountains, and the LA River. The related Crest to Coast Trail aims to connect the San Gabriel Mountains National Monument and Pacific Crest Trail to the coast in Ventura County and planning is currently in progress for the Newhall Pass. Consideration, and potential integration, of trail components into crossing structures should be balanced with any potential conflicts with wildlife movement based on science and expert guidance.

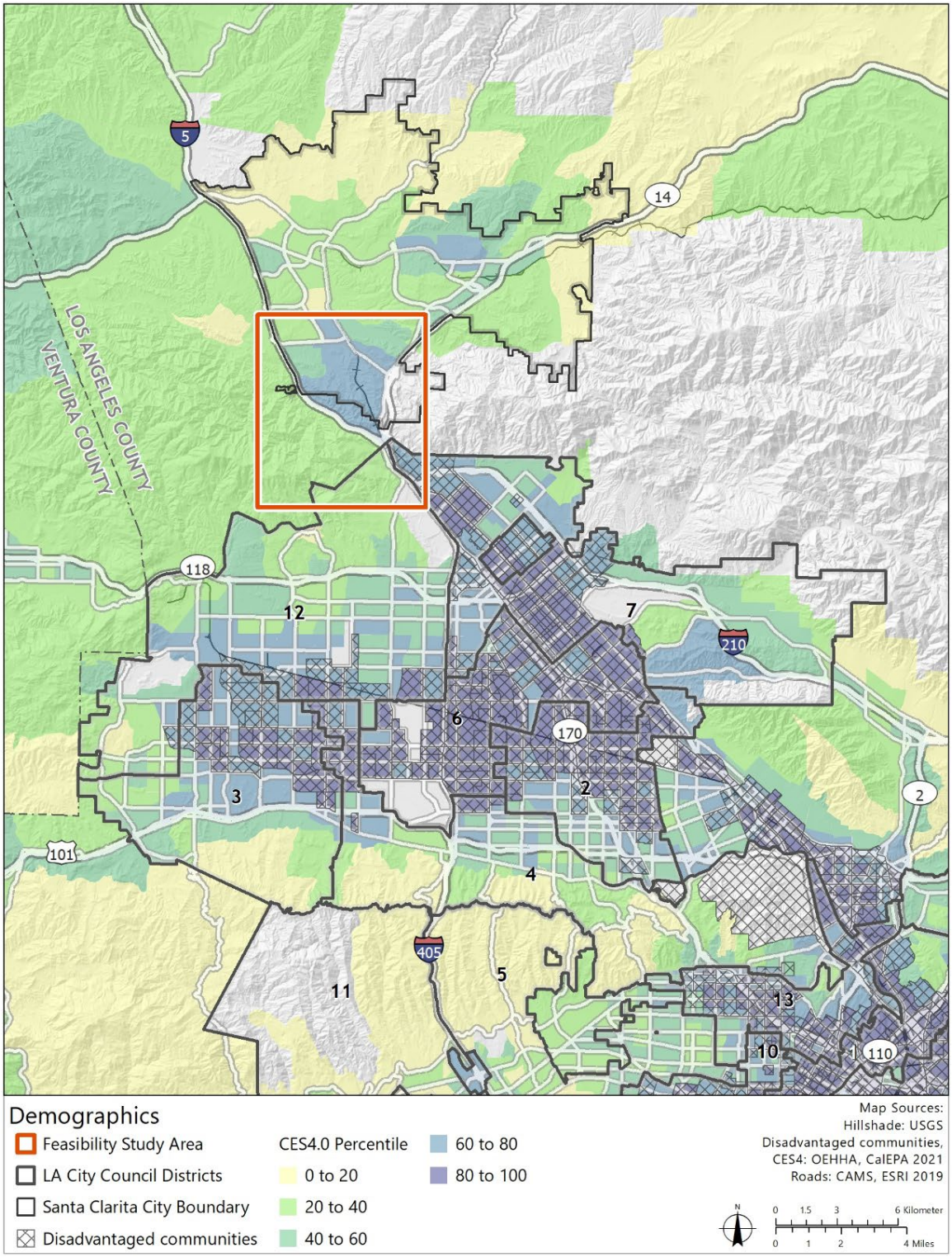


Figure 6. Disadvantaged communities within the project vicinity.

The Project acknowledges that the Newhall Pass area was historically occupied by the Fernandeño Tataviam Band of Mission Indians, and its descendants continue to live in the area. An important stakeholder and outreach partner for the Project, the Tribe's ancestral lands include the Pass and lands throughout the San Fernando, Santa Clarita, eastern Simi, and Antelope valleys (Figure 7). The Tribe originates in the lineages, villages, and cultures of the period that came before the establishment of Mission San Fernando in 1797, from which their ancestors received the name Fernandeño during enslavement by the Spanish. Before Spanish colonization, the ancestors lived in villages with their own sovereign governments, with territory, laws, dispute resolution, control over the legitimate use of force, and hereditary leadership vested in individuals (Fernandeño Tataviam Band of Mission Indians 2024). The Tribe has formed a land conservancy and is exploring an environmental strategy for restoration and native plant horticulture. Access to land, rights to water, and the ability to gather acorns and burn tobacco are also priorities. These priorities present multiple opportunities for the Project to be integrated with the Tribe's continuing stewardship of the Pass area and other cultural activities.

Sensitivity to the Tribe's environmental and cultural resources that exist within the Pass is also an important consideration. For the last four decades, the Tribe must actively consult with local governments on environmental protection under the California Environmental Quality Act (1970). Through Assembly Bill 52 (Gatto 2014), the Tribe consults on a government level with the County of Los Angeles and cities throughout the region to mitigate impacts on cultural resources by projects breaking ground within their ancestral lands. The Tribe's Elders Council provides important decisions on highly sensitive projects involving cultural resource preservation through expertise in cultural heritage and ancestral traditions. The Pass has always been a significant location for human movement and settlement patterns, and the culturally sensitive sites are known to be common in the area.



Figure 7. Context map of (selected) tribal villages from which Fernandeño Tataviam Band of Mission Indians descended and significant lands that are culturally shared with neighboring tribal governments (Fernandeño Tataviam Band of Mission Indians 2024).

2.3 Local Connectivity Context

Locally, within the Pass, several plans and policies are important drivers of the existing conservation context and future opportunities for connectivity. This section discusses some key local plans and specific physical contextual factors relevant to the identification and selection of crossing alternatives.

Physical Infrastructure
The study area is defined—and fragmented—by various roads and freeways. We therefore refer to areas of habitat relative to these infrastructural elements throughout this Report. The shape of a Y in aerial view is created by I-5 (10 lanes) and SR-14 (12 lanes) transecting the Santa Susana and San Gabriel mountain ranges from the northeast and northwest, merging at the south (see Figure 2, Project Study Area). Numerous flyover ramps and two tunnels weave together at the Newhall Pass Interchange, which sits at the base of the 'Y'. "Within the Y" refers to the isolated patch of habitat between the two northerly segments of the freeways. The interior wildlife habitat between I-5 and SR-14 in the passage/connectivity study area is also referred to as the interior of the "Y".

Well before the completion of I-5 in 1967, the Old Road (formerly Highway 99) created the first real barrier to wildlife passage. The addition of I-5 increased the barrier to wildlife movement by 11 lanes of freeway—275% wider than the existing Old Road. As this study report is being drafted, an additional widening adding truck lanes is underway at I-5.

Apart from the freeways and roads being barriers to passage in themselves, the grading and widening of the Old Road to a divided four lanes with broad east side shoulder areas significantly constrained and channelized the South Fork of the Santa Clara River and its tributaries. In some sections of the widened roadway, steep and impassable cut face slopes were made leaving largely unvegetated areas and further hampering species flow and habitat connectivity.

The SR-14 runs adjacent to the original eastern passage through Newhall Pass: Sierra Highway, formerly El Camino Sierra via Beale's Cut. SR-14 opened in sections starting in 1963 and ending in 1975 and meant wildlife moving from the Santa Susanas to the San Gabriel range would need to cross up to 14 lanes of roadway (including on- and off-ramps). The 250% increase in traffic lanes significantly diminished the likelihood of successful wildlife passage, and so diminished patch and home-range size for most species.



Figure 8. 1930 aerial photo of part of the Project area, including Beale's Cut and Sierra Highway. Photo source: UC Santa Barbara Digital Library

As the primary route for human connectivity from the north into the LA Basin, the Pass area also includes other extensive infrastructure systems. Water delivery infrastructure is prevalent with Metropolitan Water District and Los Angeles Department of Water and Power owning extensive infrastructure and land in the Pass (see Figure 2, Section 1: Project Study Area and Figure 10 below). Major power lines and corridors are present, especially east of SR-14. A major rail corridor is also present, but the future California High Speed Rail is not currently planned to travel through this area.

Another piece of key infrastructure is the existing wildlife and recreational undercrossing of SR-14 at Los Piñetos (see Figure 2, Project Study Area). This undercrossing plays a significant role in conservation based on its use by native animals and it is necessary for connectivity between a future crossing of I-5 and the San Gabriel Mountains to the east. Wildlife use studies have been performed at this underpass and have documented use by diverse wildlife; however, no mountain lions have been documented using the crossing. Multiple mountain lion-vehicle collisions both north and south of Los Piñetos also suggest that the undercrossing may be ineffective as a mountain lion crossing (see additional discussion in Section 3.4.1).

Land east of Los Piñetos is protected, but land to the west is privately held and is zoned for commercial and industrial development (see Appendix A). Compatibility of any future development proposals within these parcels with the SEA designation, the Area Plan and the General Plan (see below), and wildlife connectivity needs will be essential for maintaining regional connectivity value of Los Piñetos and the associated future I-5 crossing. Conservation of these private parcels, or a corridor through them, will be necessary unless another crossing location of SR-14 can be secured (such as the Sierra over/under, Beale's Cut North, or Beale's Cut South Alternatives discussed in Section 5).



Figure 9. Photo of existing Los Piñetos underpass. Photo credit: Max Yasuda.

Local Plans and Policies

The ***Santa Clarita Valley Area Plan*** **(Area Plan)** was adopted by the Los Angeles County Board of Supervisors on November 27, 2012 and took effect on December 27, 2012. The Area Plan is a component of the County General Plan which provides goals, objectives, policies, and implementation actions that apply only to the unincorporated portions of the Santa Clarita Valley. The Area Plan is a component of "One Valley One Vision", a joint planning effort with the City of Santa Clarita. The other component is the *City of Santa Clarita General Plan*, which was adopted by the Santa Clarita City Council on June 14, 2011. Together, the County's Area Plan and the City's General Plan provide a unified vision for development and conservation for the entire Santa Clarita Valley, including areas of the Pass within the City of Santa Clarita.

Los Angeles County Significant Ecological Areas (SEAs) are officially designated areas within LA County with irreplaceable biological resources. Most of the Pass is covered by this designation. The SEA Program, through the goals and policies of the General Plan and the SEA ordinance (Title 22 zoning regulations), helps guide development within SEAs. The General Plan goals and policies are intended to ensure that privately held lands within an SEA retain the right of reasonable use, while avoiding activities and developments that are incompatible with the ability of SEAs to thrive in the long term. While this designation does not preclude development of private parcels within the Pass, private parcels adjacent to crossing location alternatives are subject to a higher level of environmental review and decision making before development is permitted. While natural lands adjacent to the I-5/SR-14 interchange south of the Y do not fall within the SEA, these areas are shows as important in the California Essential Habitat Connectivity Area (Figure 3: Regional Ecological Subsections) and the Rim of the Valley Corridor Area (Figure 1: Regional Locator) demonstrating their potential importance and need for elevated conservation consideration, potentially including wildlife crossing measures.

Finally, the National Park Service draft ***LA Metro and Caltrans Recommendations for Improved Wildlife Permeability*** (National Park Service 2023) summarizes wildlife connectivity opportunities along I-5 between S-14 and Castaic. The study focuses on connectivity needs and conditions along I-5 north of the Newhall Pass, discusses enhancements to culverts and other features, and recommends a wildlife crossing near the Weldon North alternative discussed in Section 5. The study provides a strong set of recommendations for key projects that should advance to support connectivity along I-5 north of the existing Weldon Bridge.

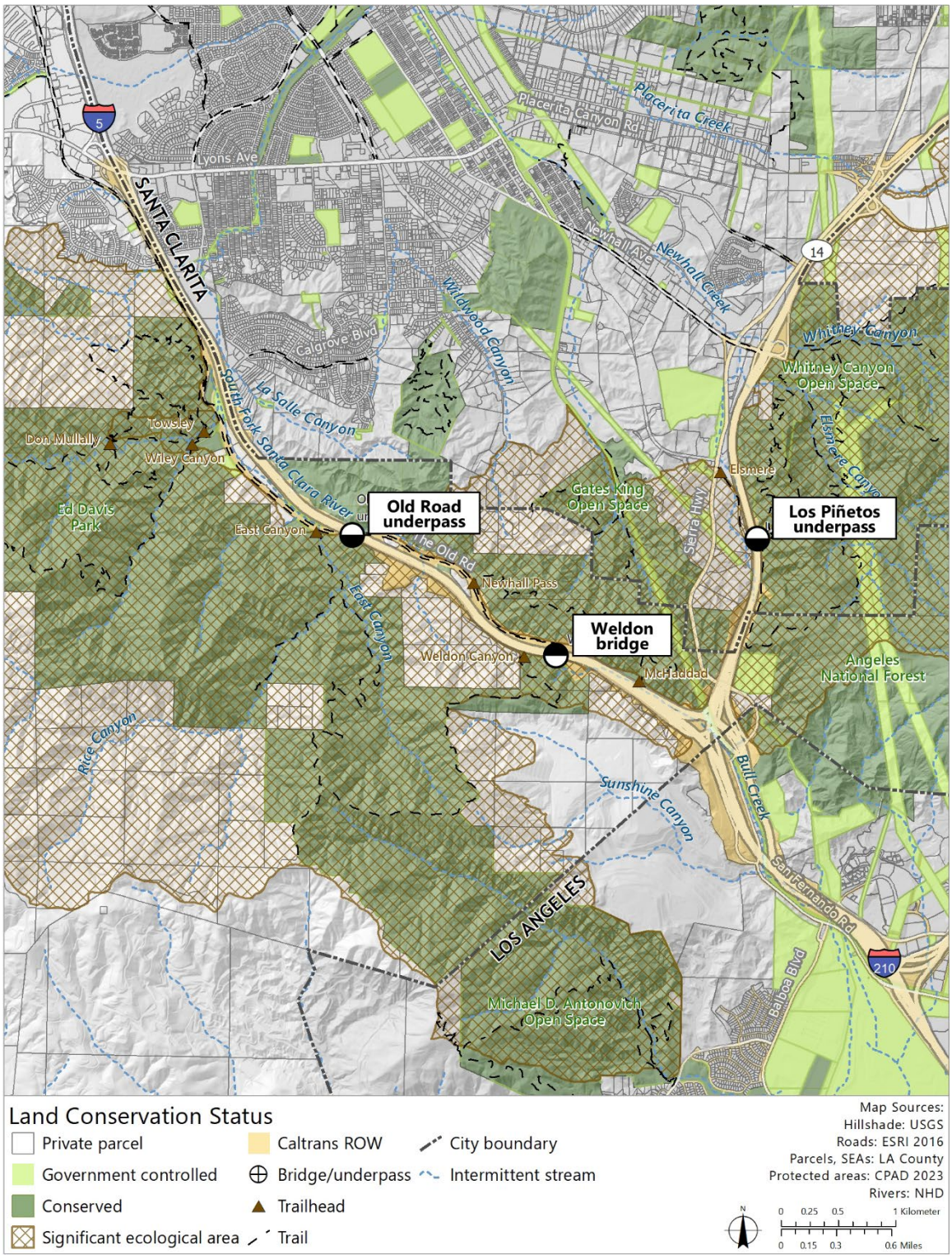


Figure 10. Land conservation and ownership context. See Section 4.3 for information on land conservation status designations and planning implications.

Local Community Input

As part of the ongoing community engagement process, Project Team members met with the Homeowners Association (HOA) of the Crescent Valley Mobile Home Park within the Project Area, located between the proposed Old Road X and Weldon North project sites. This engagement was formative for the Project in several ways. Conversations with the HOA resulted in information that adds to existing data gathered in the area by prior National Park Service studies, and ultimately will inform Project outcomes. For example, the Project Team had no sighting data confirmation of mountain lions inside the "Y" zone of habitats between I-5 and SR-14. One resident provided doorbell camera footage of a mountain lion present on their property (Figure 11).



Figure 11. 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.

Additionally, the HOA members' input provided several meaningful examples of how human life and wellbeing might be positively impacted by the Project. For more details regarding this engagement, including first-hand accounts from residents and comments in support of the Project, see Appendix E.

2.4 Regulatory Context

The regulatory context and process is also an important contextual factor that will guide decision making around the project. The exact location and features of the preferred wildlife crossing alternative will determine the appropriate Lead Agency under CEQA for the Project. Potential CEQA Lead Agencies include Caltrans, the City of Los Angeles, the City of Santa Clarita, or Los Angeles County. The appropriate level of environmental documentation under CEQA required for the project alternatives is not known at this time and will be determined during the Project Initiation Document (PID) phase of the Caltrans project development process. The project may be cleared using the Statutory Exemption for Restoration Projects (SERP), an Initial Study/ Mitigated Negative Declaration, or potentially and

Environmental Impact Report if un-mitigatable significant impacts under CEQA are later determined.

Regardless of the selected location, the preferred crossing will occur within Caltrans right-of-way (I-5 and/or SR-14 freeways). Caltrans will have jurisdiction over either location, having direct jurisdiction over SR-14 and under NEPA delegation from the U.S. Department of Transportation Federal Highway Administration (FHWA) on I-5. Since the project will come under the jurisdiction of Caltrans, the project will be developed, approved, and designed according to Caltrans project development process. The selected refined alternatives would need to be documented under the PID phase by preparing a Project Study Report - Project Development Support (PSR-PDS) and a Preliminary Environmental Analysis Report (PEAR). Under all scenarios, Caltrans would serve as the lead agency for the project under NEPA through FHWA delegation. It is anticipated that either a Categorical Exclusion or Environmental Assessment would need to be completed as part of the NEPA approval process.

Federally and state-listed species have the potential to be impacted by construction of wildlife crossings. Coordination with the US Fish and Wildlife Service (USFWS) regarding compliance with the Federal Endangered Species Act (ESA) though Section 7 consultation and coordination with California Department of Fish and Wildlife under the California Endangered Species Act (CESA) is expected. In addition, preparation of a Biological Assessment (BA) may be required as part of ESA Section 7 consultation. Permits would be secured after completion of the environmental phase and final design. Construction and encroachment permits would be required from jurisdictional agencies depending on the location of the preferred crossing, in addition to Regional Water Quality Control Board (RWQCB) Section 401 Water Quality Certification. If the wildlife crossing impacts jurisdictional waters, a CDFW Section 1602 Streambed Alteration Agreement and U.S. Army Corps of Engineers (USACE) Section 404 Nationwide Permit Authorization (NWP) would be required.

3 ECOLOGICAL SCIENCE BASIS

The Newhall Pass presents a unique and challenging opportunity for connectivity planning due to its complex ecology located at the intersection of multiple ecological subregions (see Figure 3 – Regional Ecological Subsections). On one hand, connectivity projects at such a location may prove especially beneficial over time due to the broad biodiversity that they support. Local mapping and inventories of existing priority wildlife species such as mountain lion and their habitats provide a solid foundation for conservation planning and decision making. On the other hand, the ecological complexity of such a location makes an effective characterization, prediction of benefits, and optimal design challenging, especially over the more than 75-year anticipated usable life of such a major crossing structure (AASHTO 2017). Limited available data on specific local climate-driven ecosystem change and future habitat suitability adds challenge to providing climate-resilience recommendations. Finally, the location at the urban-wildland interface also requires careful consideration of human factors that may influence connectivity measures, site suitability and performance over time. Realities such as land ownership and land conservation status, expected future land use and growth, existing and future edge effects, and other human influences on wildlife behavior and ecological processes necessitate trade-offs in location and design of any wildlife crossing in the study area.

Three ecological goals were identified early in the process based on the general connectivity context described above and the purpose and need as supported by earlier studies (e.g., CDFW 2020). These goals include:

Goal 1: Enhance connectivity for mountain lions, a key species of conservation concern.

Goal 2: Maximize connectivity within and between habitat types present within the Pass to improve connectivity for diverse native species and natural processes (e.g., montane habitat, oak woodland habitat, riparian habitat, coastal sage scrub habitat, etc.).

Goal 3: Maximize potential resilience of connectivity measures by anticipating climate and other landscape change (e.g., urban growth, watershed and ecosystem patterns and processes, climate refugia, wildfire exposure, etc.).

Stemming from the goals, the following key questions were the focus of the following ecological and connectivity characterization, and subsequent selection criteria for crossing locations and design strategies discussed in Sections 5 and 6. These questions include:

1. What are appropriate habitats or ecological features to connect?
2. What are the best locations for crossing structures and other connectivity enhancement measures?
3. What general design and construction approaches are feasible for major crossing structures at selected locations?
4. Which crossing locations and design concepts should be considered for further study during the Environmental Document phase, the 65% Design phase, and beyond?

The following subsections explain the connectivity analysis approach and ecological characterization of the Pass that guided the development of crossing site selection criteria, design alternatives, and recommendations.

3.1 Ecological Connectivity Analysis Approach

We chose to use omnidirectional connectivity modeling, implemented with Omniscape (Landau et al. 2021), to provide a systematic and data-driven approach to landscape analysis

and connectivity planning. Conventional methods of site selection for wildlife crossings often rely on expert opinion, historical data, or the presence of obvious landscape features such as available land or key river corridors. Such approaches may overlook complex wildlife movement and ecological patterns (the Pass area is especially complex as described below), leading to suboptimal crossing locations. However, wildlife crossings need to facilitate not only cross-road movement, but should also increase connectivity overall (Soanes et al 2024). This is important because roads not only have an impact on connectivity directly at the roadway itself, but also (more diffusely) in the adjacent habitat (de Rivera et al. 2022).

Moreover, because our study area consists of multiple roadways in a Y-shaped pattern, there are numerous alternative pathways by which connectivity could be restored between the San Gabriels and the Santa Susanas. As such, it was essential to use an approach like omnidirectional connectivity modeling to investigate the impact of alternative scenarios for crossing locations on regional connectivity across the freeways. Omniscape, which is based on circuit theory, accounts for the possibility of multiple movement pathways across the landscape (McRae et al. 2016). Omniscape has been used in identifying movement corridors (Aylward et al. 2020) and can aid in developing adaptive connectivity models, particularly in dynamic landscapes (Jennings et al. 2020; Cameron et al 2022) or in assessing the potential resilience of landscapes to climate or other environmental changes (McRae et al. 2016).

To conduct a comprehensive assessment of ecological connectivity throughout the study area, and to provide inputs for the Omniscape model, we began by identifying key habitats to connect and species representative of those habitats. We first compiled data on vegetation and landcover to quantify significant habitats that had been divided by I-5 and SR-14. Habitats were denoted as significant if they were substantially represented across the study area or of conservation concern. We then compiled a list of all species observed within the study area using biodiversity databases, including iNaturalist, Global Biodiversity Information Facility (GBIF), and the California Natural Diversity Database (CNDDB). We noted species of conservation concern or cultural significance with current and or historic distributions both east and west of I-5/SR-14. The five identified focal habitats and associated species are detailed below. Our goal in modeling landscape connectivity for each of these five focal habitats/species was to help evaluate the existing connectivity of these habitats as well as the potential improvements to landscape connectivity for alternative proposed crossing locations. Crossing locations that show the best potential for contributing to connectivity for multiple focal species/habitats would be preferable.

To model connectivity, we began by creating a comprehensive landcover map that identified existing habitat types and infrastructure relevant to wildlife movement based on a combination of the Meter-scale Urban Landcover Classification dataset (MULC), CALVEG California Wildlife Habitat Relationships System Regional Dominance Types, and infrastructure extracted from Open Street Maps (OSM) (see Appendix A). Maps were refined for accuracy through field validation, including addressing landscape change as a result of recent wildfires (see Appendix A). With this map, we then created "source" and "resistance" layers, indicating areas where species/habitats are *currently* concentrated, and barriers to their movement (such as roads, unsuitable habitats, and steep topography). These layers were then used to model omni-directional landscape connectivity for each of the focal habitats/species (baseline scenario). For each species/habitat we modeled connectivity with varying parameters (see Figures in Section 3.3 below) and compared model outputs with known observations of species within the study area to validate our models. Once we identified the parameters for our baseline model, we then modeled connectivity for each alternate crossing scenarios. These results serve as the performance assessment criteria of crossing alternatives presented in Section 4.

These alternate connectivity models were then compared with the connectivity model for the existing baseline scenario to quantify predicted changes in landscape connectivity. For each focal habitat/species, crossing sites with greater increases in predicted connectivity relative to the baseline scenario were ranked higher for prioritization. See Appendix C for detailed connectivity modeling methods and results.

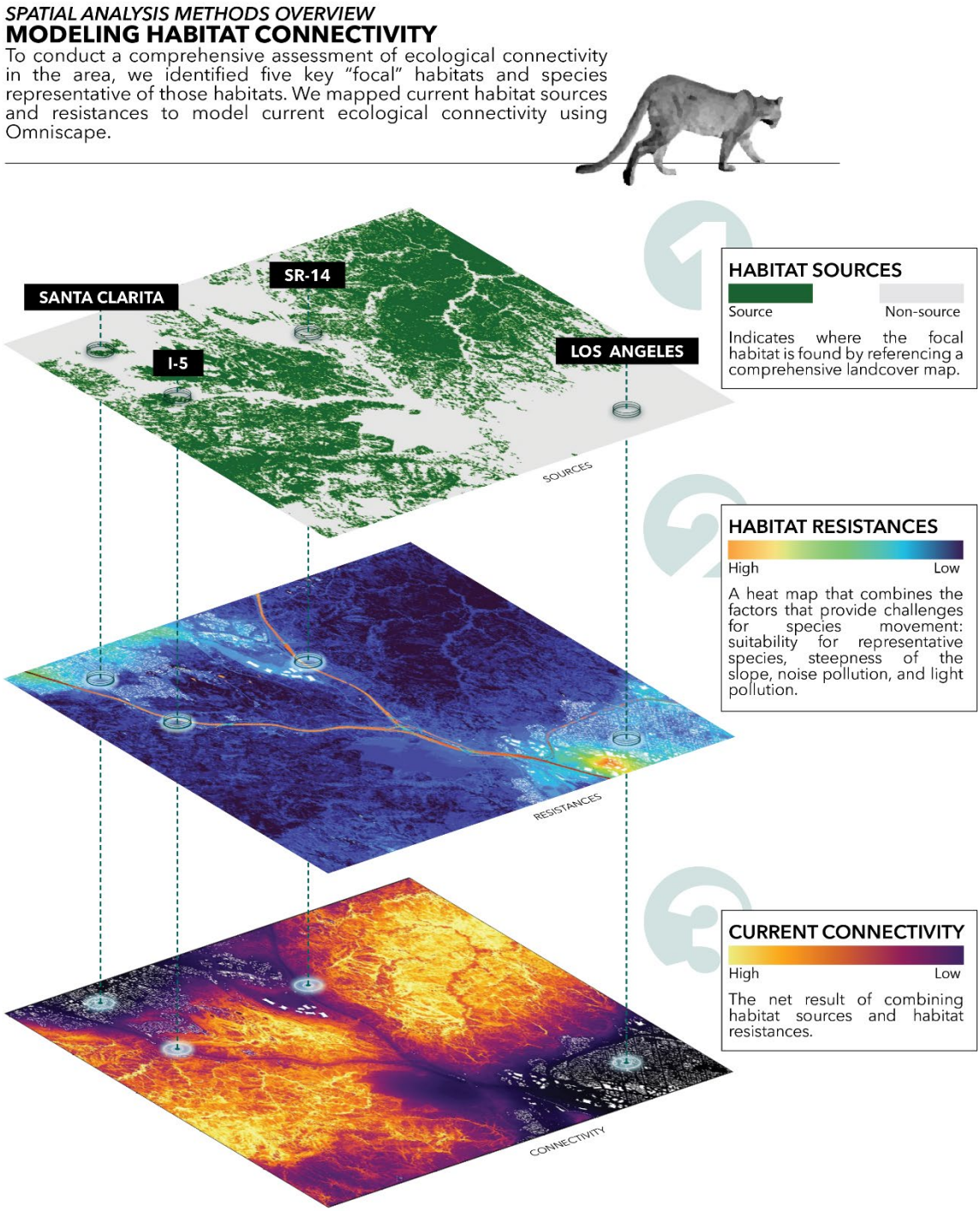


Figure 12. Diagram showing high-level inputs used within the Omniscape connectivity model. See Appendix C for detailed methods.

3.2 Ecological Landscape Characterization

Biogeographically, Newhall Pass represents both a natural ecological barrier and linkage point, depending on the processes and species involved. As a barrier, the Pass marks the division of two major southern California watersheds, the Santa Clara River to the north, and the Los Angeles River to the south (Figure 13 – Subregional watershed map). These watersheds were linked in relatively recent geological history and share most species. However, the Pass also separates the more coastal-lowland habitats of the San Fernando Valley from the more interior Santa Clarita Valley, which has weak Mojave Desert influences that become even more pronounced farther east (toward Acton/Palmdale). The high ridge of the Pass captures orographically enhanced precipitation from winter storms that frequently dump rain (and occasionally snow) from south to north, maintaining the cool and moist mesic environment on these peaks. As the north-facing slopes are shaded from solar radiation and take much longer to dry out, this wetter microclimate extends lower on north-facing (and, to an extent, northeast-facing) slopes in the vicinity of the Pass. This is most evident in places like the Weldon Rd. bridge/Antonovich Trailhead on the west side of the Pass (northeast-facing slope), in the upper Romo Trail east of the Pass (northeast-facing), and the north-draining canyons on the north side of the Pass (East Canyon, Rice Canyon). Lower montane plant species such as bigcone Douglas-fir (*Pseudotsuga menziesii*), California bay (*Umbellularia californica*), canyon live oak (*Quercus chrysolepis*) and mountain phacelia (*Phacelia imbricata*) are reliable indicators of these microclimates, while foothill wildlife indicator species include mountain quail (*Oreortyx pictus*), hairy woodpecker (*Picoides villosus*), Steller's jay (*Cyanocitta stelleri*), Merriam's chipmunk (*Tamias merriami*), black bear (*Ursus americanus*) and California mountain kingsnake (*Lampropeltis californiae*), all associated with this higher-elevation habitat in the area.

By contrast, more warm/arid microclimate-favoring plant species typical of warm, south-facing slopes along the coast, such as southern California black walnut (*Juglans californica*) and purple sage (*Salvia leucophylla*), extend north from the San Fernando Valley to the lower (usually south-facing, or west-facing) slopes of the Pass, into the Santa Clarita Valley area. These two valleys also bring a warm/arid microclimate influence to the Pass, with desert-slope species (and those that tolerate either very hot summer days *or* cold winter nights) coming south from the northeast, including rubber rabbitbrush (*Ericameria nauseosus*). Sensitive wildlife species expected in these more arid environments would include greater roadrunner (*Geococcyx californianus*), Southern California rufous-crowned sparrow (*Aimophila ruficeps canescens*), coast horned lizard (*Phrynosoma blainvillii*), western whiptail (*Aspidoscelis tigris stejnegeri*), side-blotched lizard (*Uta stansburiana*), and coast patchnose snake (*Salvadora hexalepis virgultea*).

Still other species reach their ecological limits near the Pass for more obscure reasons not apparent in climatic or slope/aspect differences, but because of soil type and edaphic variation. For example, valley oak (*Quercus lobata*) is a large tree that in our area is typical of fine soils (clay or shale) of warm interior valleys; it approaches the Pass from the west (Santa Susana Mountains), barely reaching the study area along high, exposed flatter ridges. It is largely absent in the granitic slopes in the San Gabriel Mountains east of the Pass, though it would have been a dominant tree in the north San Fernando Valley prior to widespread clearing for agriculture (mid-1800s) and later, urban development (mid-1900s).

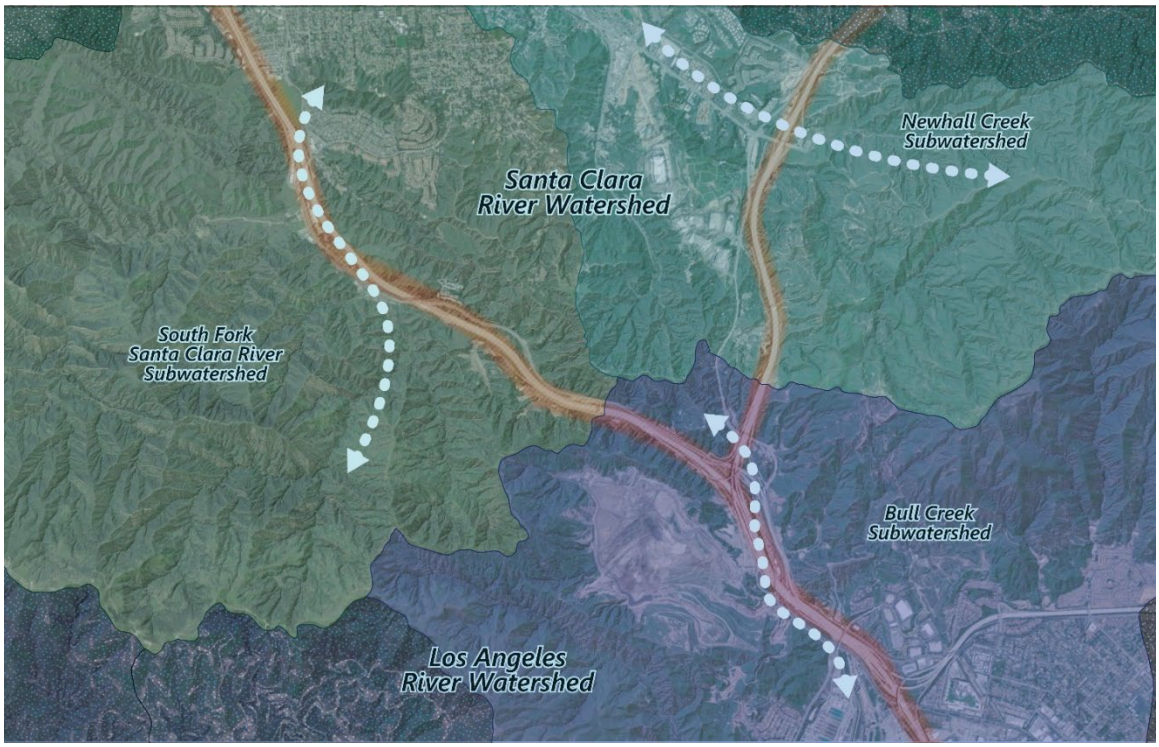


Figure 13. Subregional watershed map.

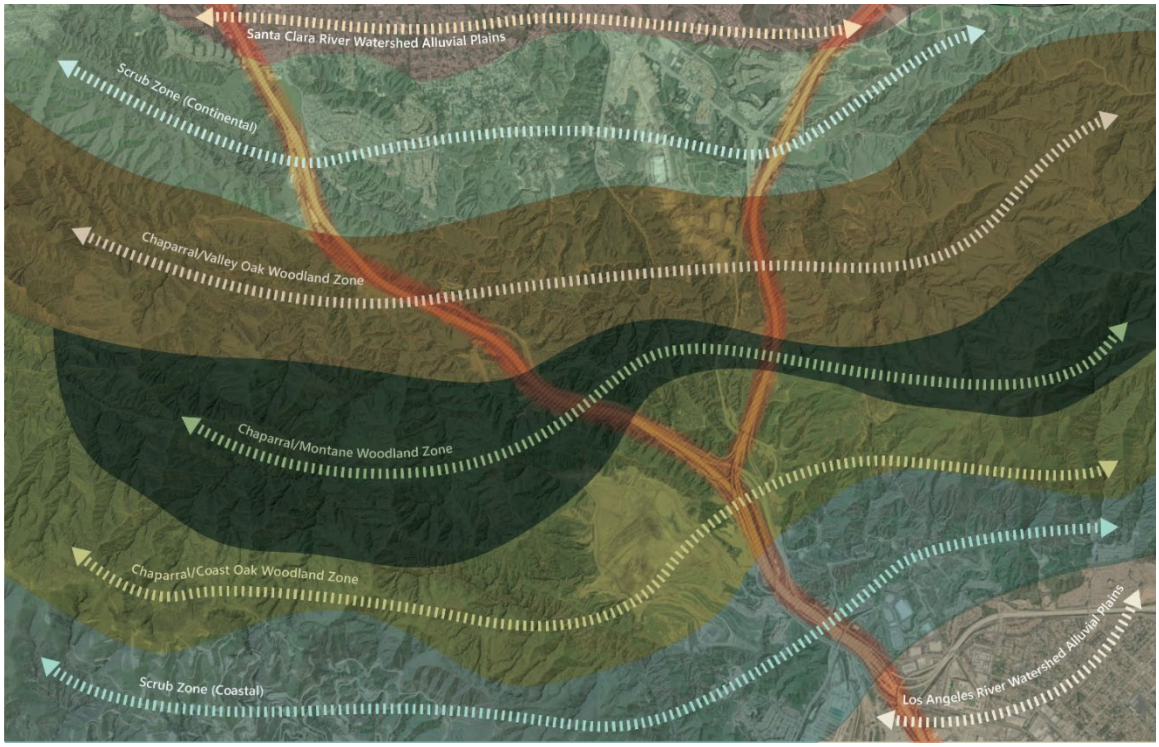


Figure 14. Subregional ecological zone map.

As a habitat linkage area, the Pass effectively connects the higher ridges of the San Gabriel and Santa Susana mountain ranges (the Santa Susanas being essentially a link between the Transverse Ranges of southern California to the Coast Range of Central California), which we refer to as the "east-west" movement pattern. The Pass also connects "north-south" movement patterns and natural processes within the study area that certain species would use to move between high elevations and lowland areas, either along roads, via creeks and riparian habitats, or along ridges.

The Pass area also would have connected the upper reaches of the South Fork Santa Clara River and Newhall Creek with the Santa Clara River mainstem to the north, allowing for movement of plants and animals up and down the elevational gradient here. Development and channelization of these creeks within Santa Clarita has limited this connection. To the south, upper tributaries of the Los Angeles River have been comparatively more completely altered, but upper Bull Creek still drains the slopes south of the Pass, with one branch directed into the Van Norman Reservoir complex, and another emerging near the present-day Knollwood Country Club, where a small stretch still flows un-channelized. Bull Creek eventually drains into Sepulveda Basin several miles to the south and meets the Los Angeles River at Lake Balboa. This emphasizes the strong—and still extant—hydrological connectivity through the region, which is reflected in wildlife use and movement.

Finally, we recognize that countless preexisting ecological patterns are present in the vicinity of Newhall Pass, which will influence the success of any crossing improvements. For example, based on radio collar and genetic data, it is thought that mountain lions move along two main axes in the Newhall Pass region (S. Riley, pers. comm.) one west of I-5, and another to the east of SR-14. Thus, "western" animals largely move northwest and southeast, connecting populations in the Santa Susana Mountains with those to the northwest (Los Padres National Forest/Sierra Madre) and west (Simi Hills, Santa Monica Mountains), while animals east of the Pass are largely confined to the San Gabriel Mountains. This split population pattern appears to be borne out in roadkill data, with multiple animals killed along SR-14, presumably involving individuals attempting to move west out of the San Gabriel Mountains (see Appendix A, Figure A-11). While the dataset is very small, comparatively fewer lion roadkills have been noted along I-5 through the Pass, suggesting that to disperse, mountain lions living west of I-5 are more likely to move north and west (i.e., up into the Sierra Madre). However, recent evidence (from Ring cameras) indicates that at least one mountain lion is present (as of 2023) just east of I-5 within the Y north of the Weldon bridge.

Any improved crossing at Newhall Pass would best serve the overall regional mountain lion population by connecting the eastern/San Gabriel Mountains population with that of the Santa Susanas to the west, and increasing the genetic variability of the latter area. We note that other ongoing or proposed crossing projects in the region, such as that across SR-101 (e.g., at Liberty Canyon), were designed to augment the genetic diversity across Ventura County into the Santa Monica Mountains. For animals in the San Gabriels to make contact with these individuals, however, at least one crossing that spans (over or under) SR-14 would be essential. Otherwise, with only a crossing at I-5, animals would simply be moving from one area where they have a lot of room to roam (the Santa Susana Mountains) into a relatively small, "landlocked" wedge of open space ("the Y") between I-5 and SR-14, where they would likely become trapped. Thus, as discussed in Section 2.3, securing permanent connectivity of the Los Piñetos underpass through adjacent private land in the Y is essential, or a new crossing of SR-14 is needed, in addition to a new crossing of I-5.

3.3 Focal Habitat and Species Characterization

We identified five "focal habitats" for connectivity modeling to guide recommendations for connectivity improvements, including locations of crossing features. Focal habitats are the major habitat types in the Pass as mapped in the Calveg California Wildlife Habitat Relationships (CWHR) database. Habitat connectivity models relied on movement parameters for "representative species"[1] for each habitat type selected from a broader list of "focal species" included in Appendix B. Movement parameters consider several factors, including habitat suitability, species' mobility, detectability, conservation status, and likelihood of using (or benefiting) from a crossing feature. Selected representative species were ones that had the most information for factors and represented the needs of multiple other focal species (i.e., a small number of representative species were used for modeling, while the focal species list was much larger).

3.3.1 Chaparral/Generalist Habitat (Representative Species: Mountain Lion)

Our first focal habitat includes all undeveloped habitat, including woodland, chaparral, scrub, and riparian habitat such that we could model connectivity for habitat generalists. The study area consists of two large swaths of contiguous undeveloped habitat to the east and west of I-5 and SR-14 with a moderately sized patch of undeveloped habitat in between I-5 and SR-14 within the Y. Species that are habitat generalists with large home ranges, such as mountain lions, are present in the study area and would benefit from connectivity of these habitat patches.

Mountain lion is a highly mobile, high-interest species that has been a focus of numerous wildlife crossing planning projects in the region. Several mountain lion populations in southern California, including the Santa Monica Mountains population just south of the study area, are believed to be in decline through inbreeding. A crossing at Newhall Pass would increase genetic exchange between two major biomes in southern California that have been identified as important reserves of mountain lion genetic variability, the Los Padres National Forest/Sierra Madre (west of the pass) and the San Gabriel Mountains (east of the pass). Mountain lions generally require large, undeveloped blocks of open space, and are vulnerable to edge effects and inbreeding. The local population was added as an evolutionarily significant unit (ESU) candidate species for listing under California Endangered Species Act, temporarily affording the same protection as listed species during the review period. They are known to be habitat generalists, favoring brushy areas, but utilizing a variety of habitats throughout the year, and using secondary roads for movement.

Extensive mountain lion activity within the Santa Susana Mountains adjacent to I-5 has been documented by the National Park Service (2023), and NPS has identified a crossing of I-5 as a high priority, with the Weldon North crossing identified as their preferred overcrossing location. Only one mountain lion collision has been documented on I-5 near the Sunset Canyon Landfill and SR-14/I-5 interchange. Black bear and mule deer collusions have been documented on I-5 (see Section 4, Figures 25, 27, and 29 and Appendix A, Figure 11).

Importantly, three mountain lions collisions have been documented along SR-14, suggesting that individuals are struggling to safely cross the pass from the east. Notably, these collisions

[1] We considered using the term "Umbrella Species" to describe these, since they can stand in for a larger number of species of interest. For example, improving and protecting habitat and conditions for coast horned lizard would also benefit western whiptail, side-blotched lizard, harvester ants (*Pogonomyrmex*), and a variety of native scrub-dwelling invertebrates.

occurred even with the existing Los Piñetos underpass of SR-14 as an available option, suggesting that this crossing may not be effective for mountain lions. Modeling data below suggests that access to the Los Piñetos undercrossing from the east may be limited by steep slopes and poor habitat quality. Additionally, the small subwatershed that contains Los Piñetos appears topographically isolated from primary ridgeline of the San Gabriel Mountains to the south, which we believe is a natural movement location for mountain lions and where three of the four mountain lion collisions in the Pass are documented. This may suggest that Los Piñetos is either not an ideal crossing location for mountain lions or that habitat quality adjacent to it must be improved (further study of mountain lion activity east of SR-14 is a key research need). Therefore, improving connectivity across both SR-14 and I-5 is a is a high priority.

The mountain lions may be considered an umbrella species for other large and mid-sized mammals, including mule deer, bobcat, black bear, gray fox, and American badger, all of which would presumably benefit by improved wildlife crossing conditions for mountain lion.

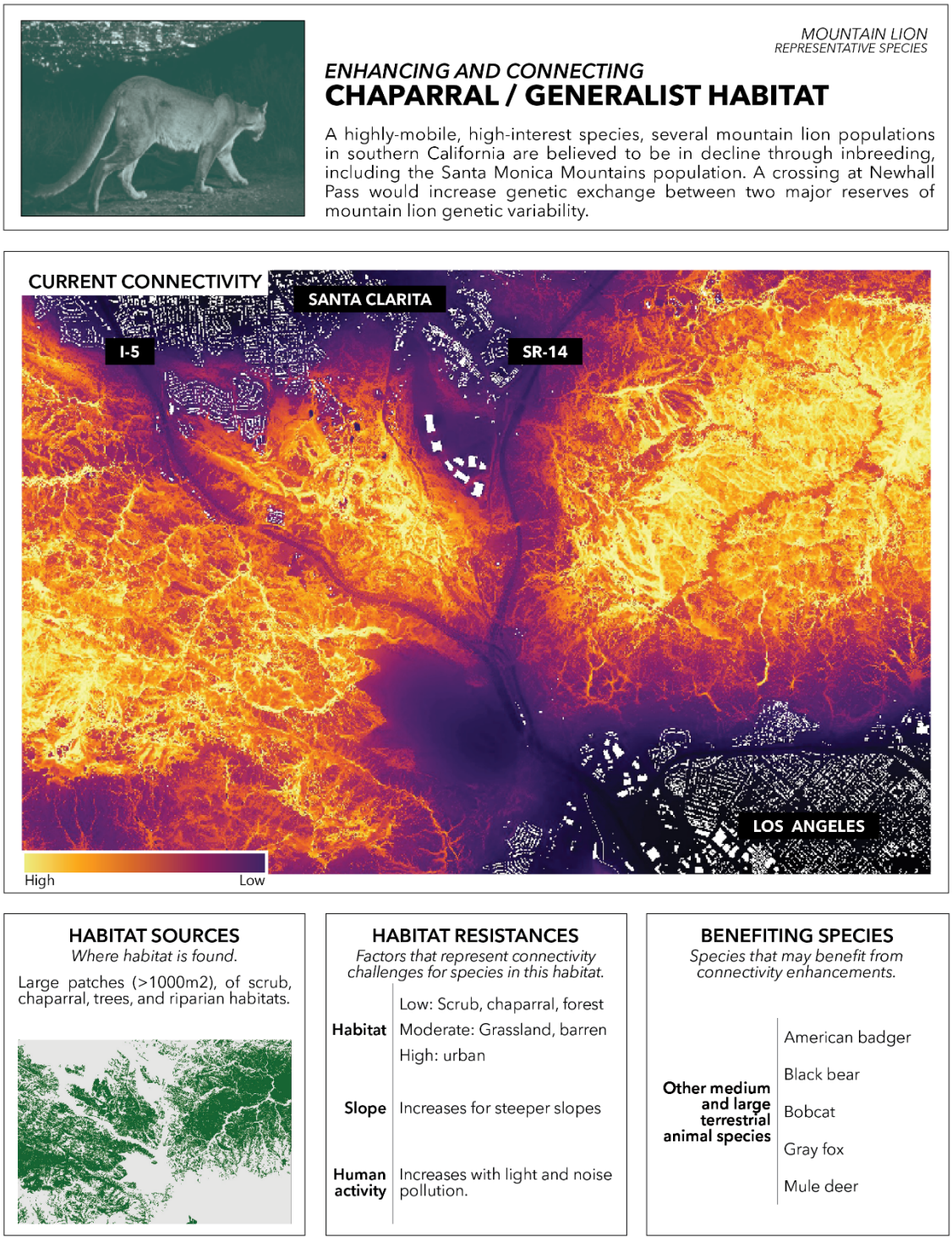


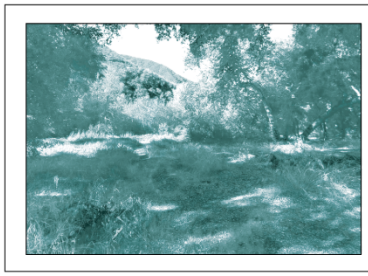
Figure 15. Fact sheet showing connectivity model inputs and outputs for chaparral/generalist focal habitat.

3.3.2 Oak Woodland (Representative Species: Western Gray Squirrel)

Various types of oak-dominated habitats occur in the vicinity of Newhall Pass, dominated by coastal oak woodland at lower elevations, and montane hardwood/Sierran mixed conifer forest (of which canyon live oaks are a strong component). Locally, valley oak woodland, dominated by *Quercus lobata*, occurs mainly at the lowest elevations of the Pass to the north, though scattered valley oaks occur in various other habitats (as do other oak species). Oak woodlands are iconic habitats in California, with numerous indicator species associated with oaks and oak woodland, many of which are endemic/entirely restricted in range to California (or even more specifically to southwestern California). While many organisms were considered as examples of representative species, we arrived on the western gray squirrel as the best example to use for our models, given their strong preference for oak woodland (above any other habitat type), their likelihood of using wildlife crossings, and the ease of detection (e.g., via iNaturalist and other observation).

The western gray squirrel (*Sciurus griseus)* is a strong indicator of (and maintainer of) intact oak woodland throughout southern California, and lowland and urban-edge populations have been widely extirpated in the region (Cooper and Muchlinski 2015). Currently, the Newhall Pass area still supports a small population of this species, and importantly, appears to be relatively free of invasive (eastern) fox squirrels (*Sciurus niger*), which have displaced gray squirrels throughout the Los Angeles area. Young gray squirrels may disperse long distances, and are frequently found as roadkill, even on lightly traveled roads. This, combined with the relatively low density at which pairs occur (e.g., each pair requires c. 5 acres of contiguous oak woodland), makes it of particular conservation concern at urban-adjacent sites. Oak woodland, including coast live oak, valley oak, and canyon live oak/mixed evergreen stands, is still a major habitat type in the study area, albeit now fragmented by freeways and major roads. Thus, connecting these stands of woodland across Newhall Pass (via western gray squirrel activity) is a high priority for the crossing.

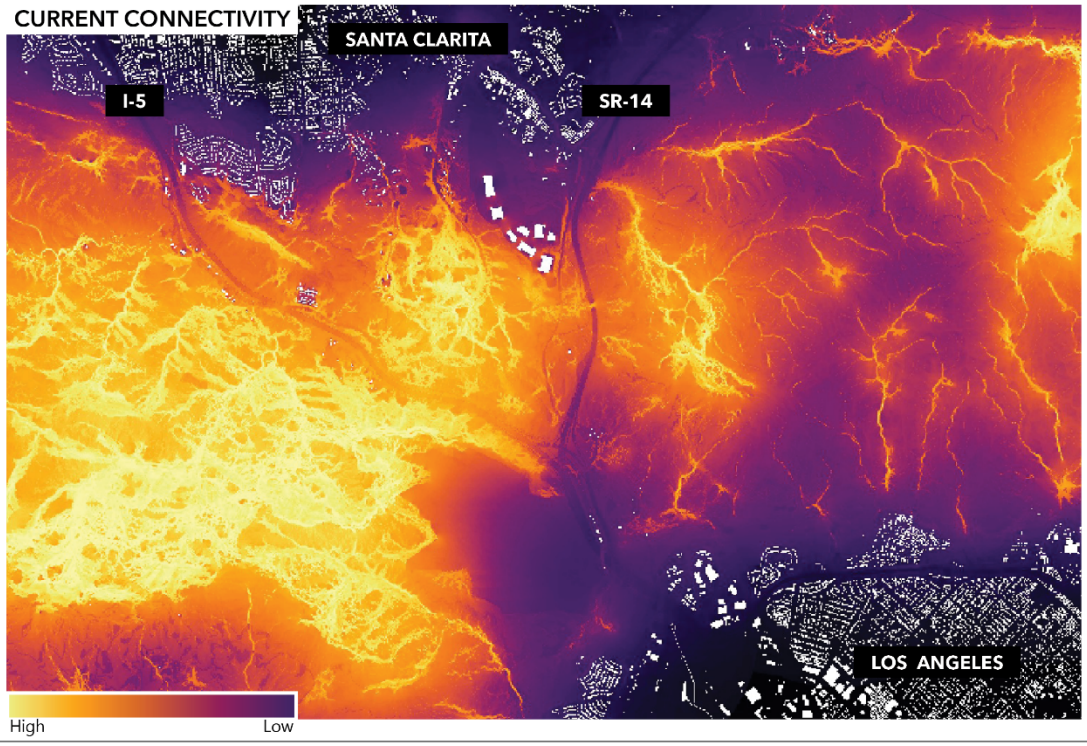
The western gray squirrel may be considered an umbrella species for a variety of oak woodland obligate and associated taxa, including California sister, western screech-owl, arboreal salamander, and many others. Without a crossing, its populations would be expected to become further isolated, and eventually would be highly vulnerable to extirpation due to fire, prolonged drought, and other increasing threats.



WESTERN GRAY SQUIRREL
REPRESENTATIVE SPECIES

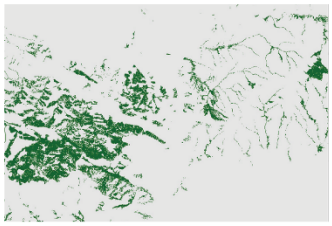
ENHANCING AND CONNECTING
OAK WOODLAND HABITAT

The Newhall Pass area supports a small population of Western Gray Squirrel, and importantly, appears to be relatively free of invasive fox squirrels. Young gray squirrels may disperse long distances, and are frequently found as roadkill, even on lightly-traveled roads. Each pair of squirrels requires roughly 5 acres of contiguous oak woodland.



HABITAT SOURCES
Where habitat is found.

All coastal oak woodland, montane hardwood/Sierran mixed conifer forest containing canyon live oak >100m from developed areas.



HABITAT RESISTANCES
Factors that represent connectivity challenges for species in this habitat.

Habitat	Low: All oak habitat Moderate: none High: All non-oak habitat
Slope	Increases for steeper slopes
Human activity	Increases with light and noise pollution.

BENEFITING SPECIES
Species that may benefit from connectivity enhancements.

Direct benefits: *oak woodland obligate species impacted by freeways and major roads*	Arboreal salamander California sister Western screech-owl
Indirect benefits: *oak species*	California black walnut Valley oak

Figure 16. Fact sheet showing connectivity model inputs and outputs for oak woodland focal habitat.

3.3.3 Scrub and Grassland (Representative Species: Greater Roadrunner)

Native scrub and grassland dominate areas of Newhall Pass not covered by dense chaparral or woodland. While some riparian habitats may qualify as "scrub" (e.g., alluvial fan sage scrub), this habitat type specifically refers to the more arid coastal sage scrub typically found below the "chaparral belt". This community differs strongly from north to south across the Pass (i.e., from interior-influenced to coastal-influenced areas), and also varies based on the landform on which it is found. For example, sandy washes such as the tributaries of the Santa Clara and Los Angeles rivers support an alluvial scrub habitat with distinct vegetation not found on steeper slopes (e.g., scalebroom, *Lepidospartum californicum*). Pure grassland vegetation is relatively rare, mainly found in gaps between various other habitat types. However, small areas of native-rich grassland are found on clay soil locally. Importantly, large areas of the study area have type-converted to non-native-dominated grassland due to shortened (human-caused) fire frequency. While these areas support some floral/faunal elements of the native grassland community (as well as scrubland elements), they are best considered "disturbed" when compared to native-dominated grasslands. For this habitat type, we selected Greater Roadrunner as the representative species, as it seems particularly tied to arid scrub and grassland habitat in the area (and throughout its range), it is considered to be of high conservation interest in the region (Allen et al. 2009), it could physically use a freeway crossing, and is readily observable.

Few local species are as strongly terrestrial as the greater roadrunner, and over time, roadrunners have been essentially extirpated from the floor of the Los Angeles Basin/San Fernando Valley. For this reason, it was identified as a Los Angeles County Bird Species of Special Concern (Allen et al. 2009), despite being still reasonably common in the desert. Despite decades of development, individuals still frequent the Santa Clarita area, including the low hills surrounding the valley, and the Santa Clara wash itself. They are still present in the Newhall Pass area, found in a variety of habitats, but most commonly in low, arid scrub with sandy soil and ample areas of bare ground for foraging. Roadrunners, therefore, would be most likely to occur toward the far northern edge of the study area (closest to the Santa Clara River), and in the sparse scrub vegetation along the southern edge; they would be far less likely in the high ridges and peaks with montane and woodland habitats. Thus, roadrunner would also serve as an umbrella species for taxa that are characteristic of the more inland/continental ecosystems in the area, including coast horned lizard, a California Species of Special Concern.

Greater roadrunners (in Texas) were found to use 28-50 hectares of land, but home range was variable depending on resource availability (Montalvo et al. 2014). Their habitat preferences include grasslands, mesa-ridges, chaparral, and open, grassy areas adjacent to scrub (Montalvo et al. 2014, Soule et al. 1988). Barriers to their dispersal include bare ground, habitat loss, degradation, and urbanization (Montalvo et al. 2014). Positive habitat associations include grasslands, ridge habitat, and chaparral (Montalvo et al. 2014, Garrett 2011, Soule et al. 1988). Negative habitat associations are bare ground, and flat land. (Montalvo et al. 2014). Greater Roadrunners respond negatively to fires and burned areas (Soule et al. 1988, Hargrove & Unitt 2018), which implies that they have likely declined in the study area, at least on slopes toward the San Fernando Valley, which are burning at unnaturally frequent rates (see Appendix A, Figure A-3).

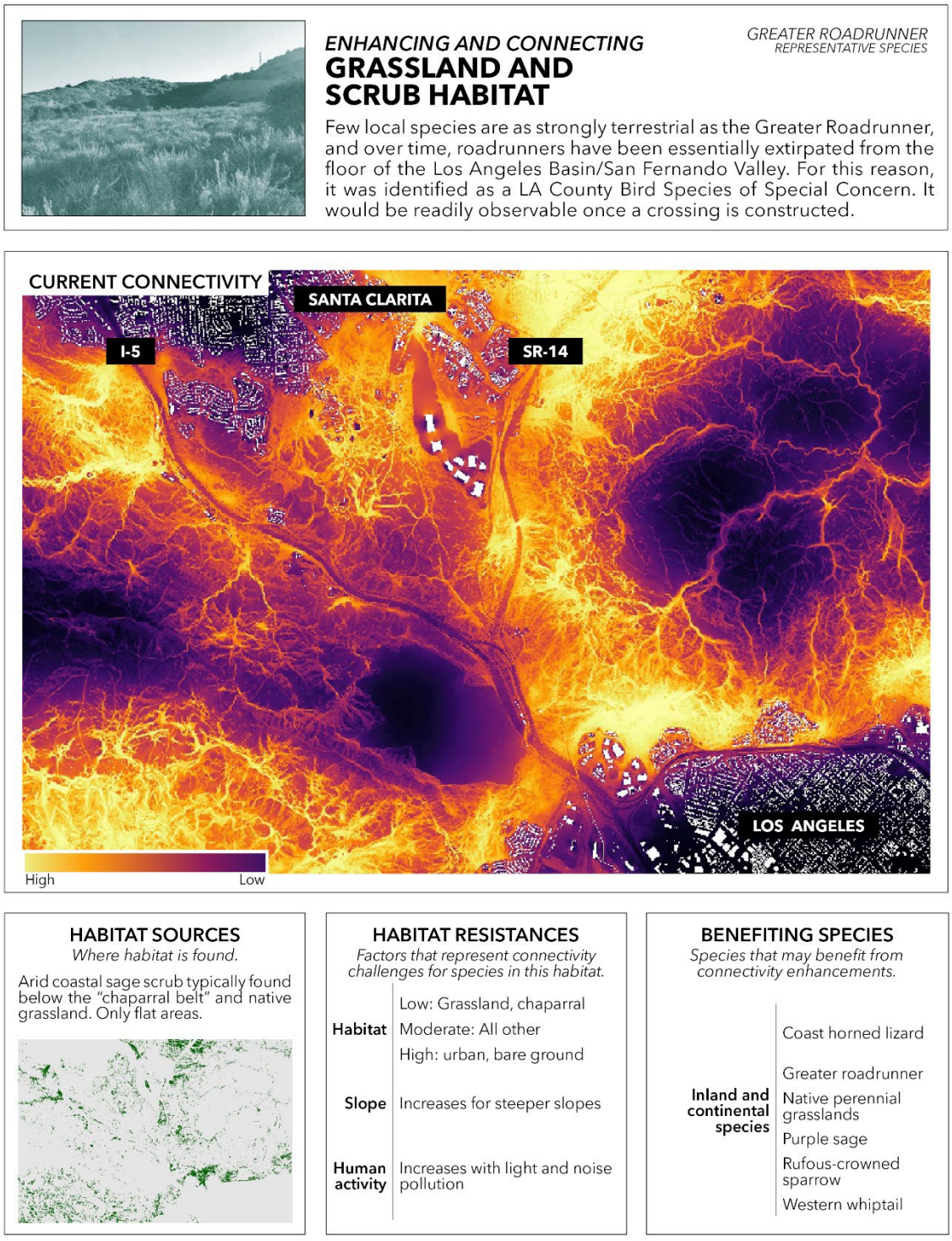


Figure 17. Fact sheet showing connectivity model inputs and outputs for scrub and grassland focal habitat.

3.3.4 Riparian Woodland (Representative Species: Baja California Treefrog)

Riparian habitats are relatively limited in the study area compared with the lower reaches of the two watersheds to the north (Santa Clara River) and south (Los Angeles River). Two main types recognized by CWHR include "valley foothill riparian" and "montane riparian". In the immediate vicinity of the Pass, valley foothill riparian is present along seasonal drainages (including East Canyon, Rice Canyon, South Fork Santa Clara River, among others). Dominant trees of this habitat type include several species of willows (*Salix* spp.), black cottonwood (*Populus trichocarpus*), western sycamore (*Platanus racemosa*) and the two common oak species, coast live oak and valley oak. Understory in these areas is typically dense along the drainages, but few plant species occur here that are not also found on the surrounding hillsides (vs. lowland riparian areas and alluvial wash scrub, which have a distinctive and much more diverse understory flora). A handful of the most abundant representatives of the alluvial wash plant community occur locally here, such as scalebroom (*Lepidospartum californicum*). These drainages become even more restricted at higher elevations (as surface water also diminishes), and more foothill/montane plants occur along them, such as canyon live oak and California bay. At the lowest elevations in the study area, willows become more dominant, and the lowland Fremont cottonwood (*P. fremontii*) appears. Several of these areas have seen their banks modified by past flood-control measures, though anthropogenic water – a feature of many lowland riparian areas in the region – is relatively scarce, given the lack of residential development and associated landscaping here.

We selected the Baja California treefrog *(Pseudacris hypochondriaca)* as our representative species to help define and describe riparian habitats in the study area. These frogs are abundant in nearly any (seasonally) moist area in and around the Pass, and are generally absent in arid habitats, oak woodland, and other non-riparian local vegetation types. For this reason, they are a good indicator of riparian and wetland habitat in the study area. We have also included them as a representative species because of their ability to utilize restored wetland habitats, including riparian restoration areas. Particularly if riparian/culvert restoration is considered a component of a planned crossing in the study area, this easily detected (by sight and sound) amphibian makes an ideal representative species.

Other amphibians, notably western toads, are also found in these same habitats (including breeding we documented in 2023 a small ditch adjacent to the Old Road). However, toads (and salamanders) range into a far wider array of habitats than treefrogs; several are regularly found in chaparral, for example. We also note that many riparian-obligate species found elsewhere in the region, such as two-striped garter snake, Coast Range newt, and least Bell's vireo, do not appear to occur in the more limited habitats in the study area. This limited the pool of species considered as riparian representative species to model.

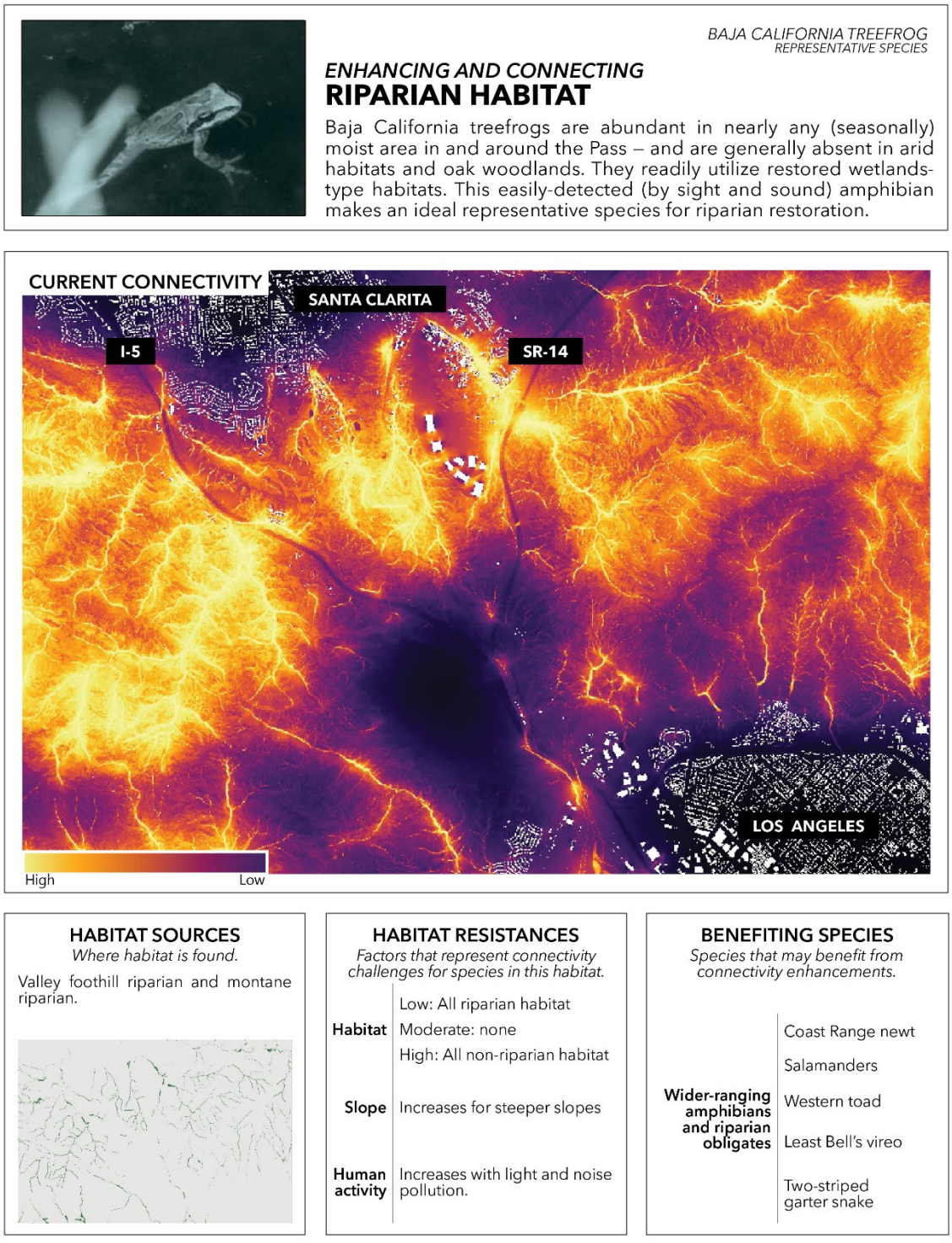
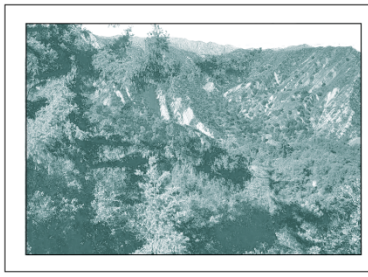


Figure 18. Fact sheet showing connectivity model inputs and outputs for riparian woodland focal habitat.

3.3.5 Montane Woodland (Representative Species: Bigcone Douglas-fir)

The CWHR Regional Dominance Types in the study area that include montane habitat are: montane hardwood, Sierran mixed conifer, montane hardwood-conifer, montane riparian, and montane chaparral. These habitats include two notable tree species, bigcone Douglas-fir and California bay. The highest elevations of the study area support an upper-elevation woodland where coast live oak is replaced by canyon live oak, and tree species like bigcone Douglas-fir and California bay appear. This community supports a highly distinctive shrub and herb layer as well, with manzanitas (*Arctostaphylos* spp.), silk-tassel bush (*Garrya* sp.), and many wildflower species not present below 2,000' in elevation. This ecosystem is "compressed" elevationally along with other natural communities in the vicinity of the Pass, with Douglas-fir occurring exceptionally low here, and lower-elevation trees such as valley oaks occurring fairly high (i.e., on ridges of the Santa Susana Mountains), producing a complex mosaic of habitat types. Within the Santa Susanas, bigcone Douglas-fir occurs as an isolated patch from larger patches in the San Gabriels and Sierra Madres. This patch is relatively low elevation and at the edge of the species range (the southwest edge) making it potentially significant as a climate change refuge for the species and associated montane woodland species. For these reasons, we selected the Douglas-fir as our representative species to define this habitat.

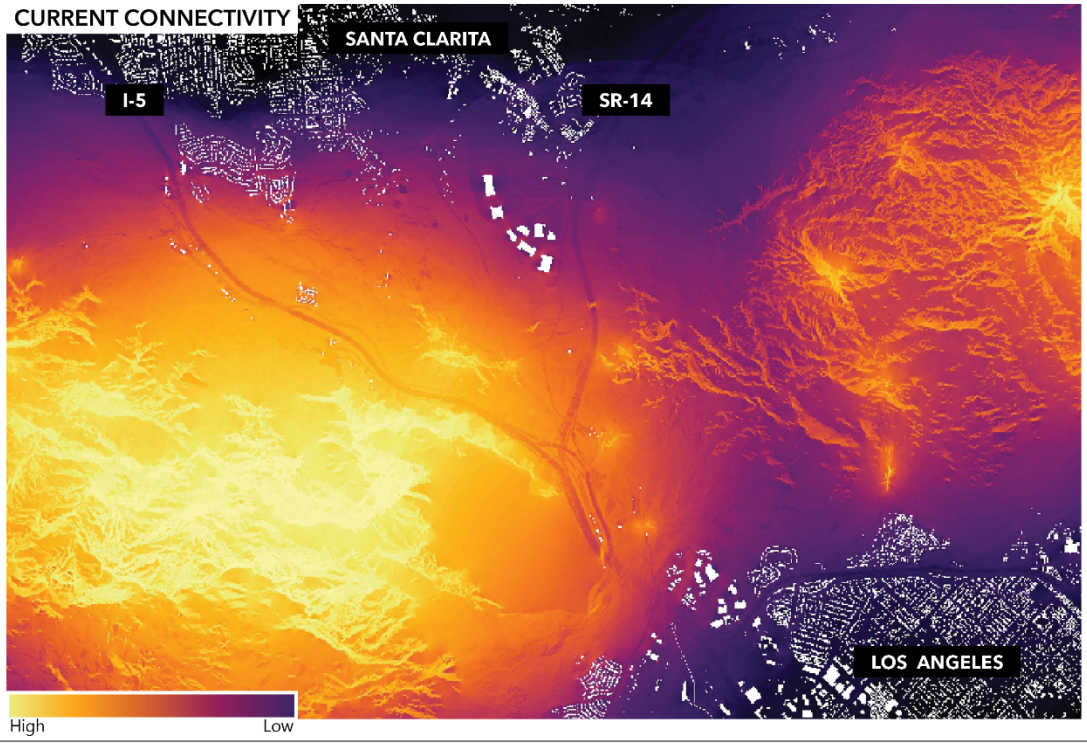
However, several wildlife species probably favor these upper-elevation habitats over lower ones, though they may range widely. For example, black bears approach their coastal distribution limit in the Los Angeles area at Newhall Pass, otherwise restricted to higher mountains in the area (they are absent, for example, in the Santa Monica Mountains and Puente-Chino Hills). Black bears (and bears in general) have been shown to utilize wildlife crossings elsewhere in North America and the world, and their local population is expected to be effectively blocked by the two freeways in the study area (unlike other local montane species, such as hairy woodpecker). Based on the few observations known from the study area, bears rarely drop down to lower elevations, such as residential areas of Santa Clarita, Granada Hills, and Sylmar, but would be expected to remain up in the dense chaparral and mixed evergreen woodland of the peaks on either side of the pass. Other montane species likely to occur in the vicinity of the Pass include mountain kingsnake.



ENHANCING AND CONNECTING
MONTANE WOODLAND HABITAT

BIGCONE DOUGLAS-FIR
REPRESENTATIVE SPECIES

This ecosystem is "compressed" elevationally along with other natural communities in the vicinity of the Pass, with Bigcone Douglas-fir occurring at exceptionally low elevations, and normally lower-elevation trees, such as valley oaks, occurring fairly high elevations. This has resulted in a complex mosaic of habitat types.



HABITAT SOURCES
Where habitat is found.

All montane habitats



HABITAT RESISTANCES
Factors that represent connectivity challenges for species in this habitat.

Habitat	Low: All montane types Moderate: All others High: Low elevation-south facing slopes
Slope	Increases for steeper slopes
Human activity	Increases with light and noise pollution.

BENEFITING SPECIES
Species that may benefit from connectivity enhancements.

Species shown to favor high-elevation connectivity	Black bear California bay Canyon live oak Hairy woodpecker Mountain kingsnake Mountain quail Stellar's jay

Figure 19. Fact sheet showing connectivity model inputs and outputs for montane woodland focal habitat.

3.5 Ecosystem Change Considerations

Expanding upon the connectivity considerations thus far emphasizing existing species and habitats, a full characterization of connectivity must also address more complex ecosystem processes, including both biotic and abiotic components and their natural and human-influenced processes of change. A key assumption about the resilience of connectivity measures proposed for the Pass is that ecosystem change is occurring, and the biotic patterns present today will not be the same in the future. This consideration is particularly relevant given accelerating climate change expected to occur within the 75+ year design life of the proposed wildlife crossing feature. Carbon emissions will drive global changes in temperature and precipitation for at least the next 20 years under all emissions scenarios (IPCC 2023), causing species range shifts in California (Spencer et al. 2010). Increased habitat connectivity to facilitate range shifts has been proposed as one part of the solution and has been identified as especially important in California's complex mix of urban, rural, and wild landscapes (Spencer et al. 2010, McCrea et al. 2016). The *California Climate Adaptation Strategy* identifies a goal of increasing landscape connectivity, which measures success by the number of terrestrial over/under passes built or retrofitted (State of California 2024).

While applicable information on specific climate tipping points expected to drive major changes in Southern California ecosystems and habitats is limited, the IPCC suggests that a 1.5 degree C change in global temperature rise will result in irreversible ecosystem change, increasing temperature extremes, and intensification of heavy precipitation and flooding events (IPCC 2023). IPCC (2023) predicts this tipping point to be reached in around 2040 at the current rate of warming, however, others argue that this temperature threshold will be reached much sooner (Lenton et al. 2023). According to Cal-Adapt, the Pass (at I-5 and the LA River/Santa Clara River watershed boundary) will experience an average of between 4.1 and 5.1 degrees F warming of annual average high temperatures and an increase of 11 to 15 extreme heat days by 2040 depending on the climate scenario. Considering the 75-year design life of an overpass crossing structure, in 2078 (construction is assumed to be completed in 2028), 5.3 to 8.7 degrees F warming of average high temperatures and an increase of 16 to 35 extreme heat days is predicted for the Pass (Cal-Adapt 2024). These changes will likely result in significant changes to existing species and habitat patterns in the Pass and across the region.

While overall annual precipitation is not currently projected to change significantly in the next 50–75 years in the Study Area, rain is predicted to be delivered in more intense storms during shorter wet seasons (Cal-Adapt 2024).

The Project is within a Santa Ana wind corridor at a fire-prone wildland urban interface, and most of the project area is exposed to wildfire at a frequency much higher than natural (see Appendix A, Figure A-3). While CalAdapt does not project significant climate-driven changes to the fire regime in this location, human factors such as extensive power line corridors throughout the Pass and development expansion in upwind (Santa Ana winds) areas will likely continue to accelerate vegetation type change, which will drive associated wildlife species range shifts.

In addition to increasing wildlife crossings, other frameworks for climate-responsive conservation planning are emerging and the project approach also integrates a conceptual framework called "conserving nature's stage" (CNS). CNS considers the pattern of microclimate and physiography—the stage upon which long-term biotic patterns and processes play out—when designing conservation plans and other connectivity enhancements (McCrea et al. 2016; Brown 2019; Gordon, Bailey & Larwood 2022). The diversity of biota in Southern California reflects the diverse physiography and microclimates that underpin it and

the Pass sits at the confluence of multiple regional ecological zones (see Section 1, Figure 3-Regional Ecological Subsections). The area is exposed to a relatively tight gradient of microclimates between the stronger coastal influence to the south and west, and more continental influence to the north and east (see Appendix A, Figure A-12). Geology and soil parent material are also diverse, with distinctly different composition in higher-elevation areas of the Pass in the San Gabriel Mountains vs. the Santa Susana Mountains (see Appendix A, Figure A-1). Lower-elevation physiography is more heavily shaped by alluvial processes of the Santa Clara and Los Angeles River watersheds, two major watersheds in the region with distinctly different form and microclimate patterns throughout their extents. Human influences throughout the Pass have also strongly shaped biotic patterns, including influences on wildfire, land clearing, and light and noise patterns.

Figures 13 and 14 present key factors for "nature's stage" that are recommended for consideration in connectivity program design. The National Hydrologic Dataset Hydrologic Unit 12 watersheds provide the major subwatersheds of the Los Angeles and Santa Clara rivers (Figure 13 and Appendix A, Figure A-9). Restoring connectivity of each of these watersheds across SR-14 and I-5 should be considered to provide riparian and aquatic connectivity between patches on either side. Restoring aquatic and riparian connectivity of lower reaches of the subwatersheds within the Cities of Santa Clarita and Los Angeles could support connectivity in the Pass by restoring connectivity between headwaters areas and the mainstems of the Los Angeles and Santa Clara Rivers. Figure 14 shows further subdivision of the ecological sections from Figure 3 using the same method to partition subregional-scale ecosystem units containing similar microclimate (Appendix A, Figure A-12, 13), physiographic (geology, slope, and elevation – Appendix A, Figures A-1, 2,14), and vegetation conditions (Calveg Wildlife Habitat Relationships – Appendix A, Figure A-5) (Barnes et al. 1982, McNab et al. 2007, Brown 2019). Providing connectivity within and between these zones would preserve the general pattern of ecosystems that may support long-term regional ecological resilience.

Protecting areas of cooler and moister conditions is a common conservation measure recommended for climate change adaptation. Patches of low-elevation montane conifer and montane hardwood woodlands within the project area demonstrate its existing climate refuge value as a relatively cool and moist microclimate suitable for these species. Figure 20below includes areas of existing riparian vegetation and stream corridors, existing montane habitat patches, and areas of northerly aspect above 600 meters (the current low-elevation limit of montane conifer and woodland patches in the Pass Area). These areas are assumed to be primary climate refuge areas and connecting them may improve long-term climate resilience of wildlife that favor cooler and moister microclimates in the Pass area.

While not currently included as a climate refuge factor, the present-day warmest and driest areas in the Pass may also be a factor to consider as conditions at these sites may eventually favor biota that does not currently exist in the Pass. Without nearby populations of suitable native plant species, these areas may become barren or dominated by invasive species. This potential conservation concern is an area of additional needed research and conservation planning guidance.

The combined influences of human- and climate-driven ecosystem change on such an ecologically diverse location will be especially complex and difficult to predict with specificity in the timeline necessary to support ongoing conservation decision making. Therefore, in addition to existing focal habitat connectivity, we recommend a crossing program that preserves the pattern of ecological features ("the stage") to accommodate ecosystem change processes and long-term movement potential for many species. Given the position of the Pass at the confluence of major regional ecosystems, these measures in this location may be important long-term climate resilience of broader Southern California ecosystems and wildlife.



Figure 20. Climate refuge factors. See Section 4.2, Permanence Criteria for more information.

3.6 Precedent Wildlife Crossings

Precedent projects are important tools for understanding current leading research and best practices in creating and strengthening ecological connectivity. By incorporating precedent research into the Feasibility Report development process, it is possible to compare methods of research and design and make informed decisions about methodology and project goals.

This report includes two precedent projects: the in-progress Wallis Annenberg Wildlife Crossing over US-101 at Liberty Canyon, and the *Interstate 15 Wildlife Crossings: Design Considerations for Focal Wildlife Species* study focused on the Santa Ana-Palomar Mountains Linkage. These projects were specifically selected as precedents due to their geographic proximity to the study area, their approaches to consideration of regional ecology and individual connectivity strategies, and their use of focal species to help inform crossing strategies and design.

The crossing at Liberty Canyon focuses on broader connectivity, with restoration work extending 12 acres out from the project site. It is a high-profile project that has effectively engaged communities and utilized positive public opinion as a means of getting accomplished and creating a sense of civic pride.

The crossing study for I-15 used a heavily species-specific approach to develop designs and strategies that meet the needs of the broadest range of wildlife possible. Focal species were chosen for reasons related to ecological function and dispersal, risk from traffic, probability of using the crossing, and known occurrences in the area.

An important commonality between these two projects is that both include upland over-crossings and riparian under-crossings components as a means of achieving comprehensive connectivity.



Figure 21. Fact sheet for precedent case study: Wallis Annenberg Wildlife Crossing across US-101 at Liberty Canyon.

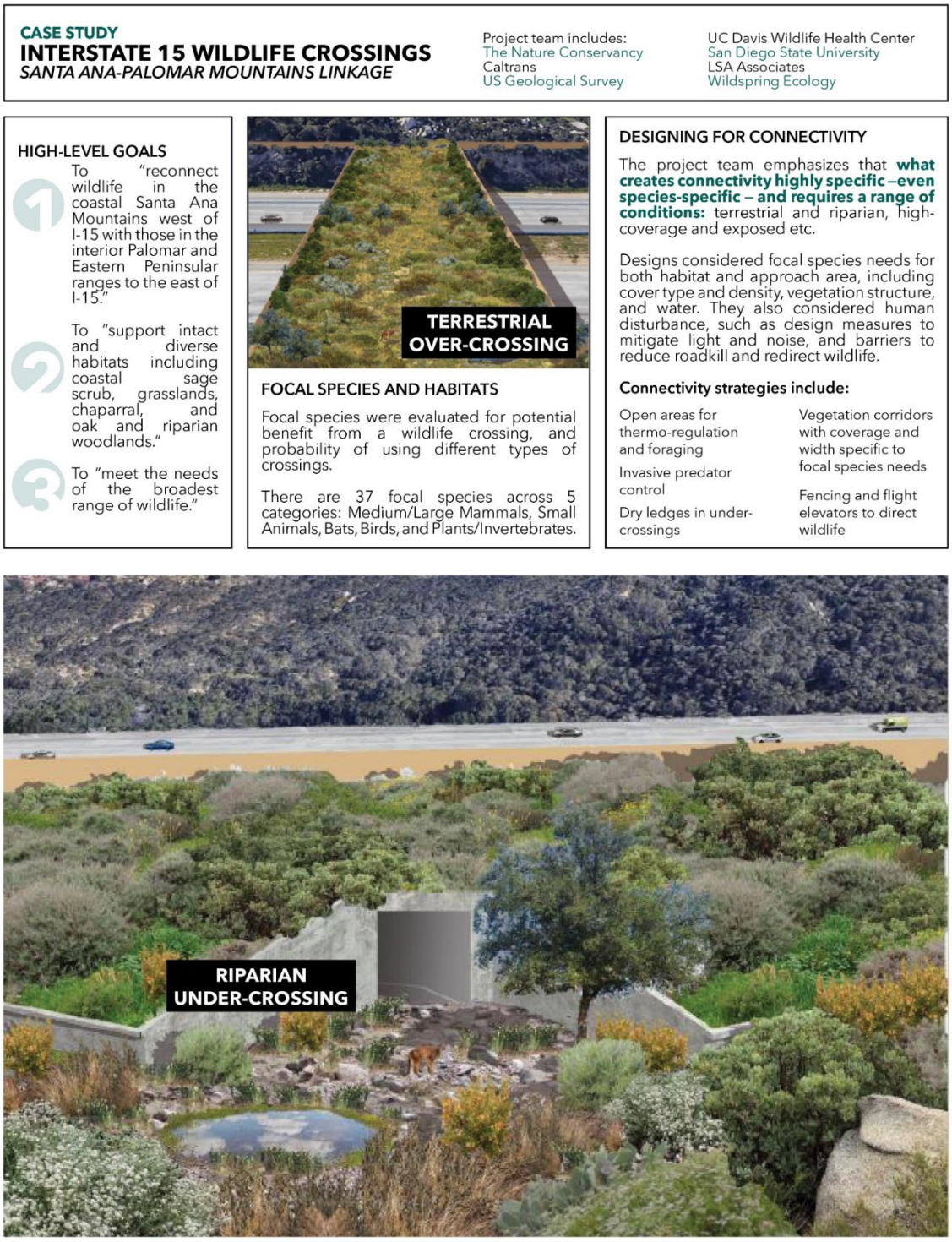


Figure 22. Fact sheet for precedent case study: I-15 Wildlife Crossings at Santa Ana-Palomar Mountains Linkage.

3.7 Science Basis Summary and Recommendations

Synthesizing the landscape context, habitat characterization, and precedent projects discussed above, the following should be considered in locating and design crossing alternatives:

- The Pass is an extremely biodiverse location at the meeting point of multiple regional ecosystems and watersheds. Robust connectivity measures are warrant here and crossings of both I-5 and SR-14 are integral to connectivity in the Pass. Success of a new I-5 crossing will depend on the quality of a crossing at SR-14.
- There are many good opportunities for mountain lion crossings throughout the Pass on both I-5 and SR-14. The existing SR-14 undercrossing at Los Piñetos may not be optimal for mountain lions and should be studied further. Permanence of this crossing is also dependent on the actions on adjacent private land to the west. Other crossing alternatives for SR-14 should be considered.
- Strive to provide multiple crossings of both SR-14 and I-5 that connect diverse ecological and habitat conditions to support diverse species movement and climate change resilience including:
    - Overhead crossings that may accommodate upland species and habitats adapted to drier conditions (e.g., in coastal sage scrub, chaparral, perennial grasslands);
    - Crossings at higher elevations and adjacent to cooler microclimates that may accommodate species at risk from warming and drying climate change stressors, including sloping structures to maximize northerly aspect on-structure (e.g., in montane conifer and hardwood woodlands, oak woodlands); and
    - Under-crossings that connect aquatic and riparian areas and associated species that prefer movement along riparian corridors, associate with moist conditions, and may serve as a climate refuge under potential future warmer and drier climate conditions (e.g., in southern riparian woodland and willow scrub vegetation).
    - Increase redundancy of the network by providing more than one crossing of each freeway (SR-14 and I-5) will increase options for movement and improve the likelihood that connectivity will be maintained if one crossing is impacted at some point in the future (e.g., wildfire, unforeseen land ownership change, maintenance needs, climate change, etc.). (Damstad, Olson & Forman 1996).
- Reconnect the pattern of subwatersheds, including major streams (South Fork Santa Clara River, Newhall Creek, Bull Creek) and watershed boundaries, within the broader Los Angeles and Santa Clara River watersheds.
- Maximize crossing width of overcrossings to provide diverse ecological conditions including both "core" vs "edge" habitat and a variety of habitat types, microclimates, and micro-physiography.
- Include robust landscape restoration on or beneath crossings, potentially including planting trees on overcrossings and restoring braided stream channels through under-crossings.
- Fencing strategies to protect wildlife along the freeways and channel movement to crossings should be studied.

4 CROSSING ALTERNATIVES SUITABILITY CRITERIA

To help guide decision-making around crossing locations and design features, alternatives were evaluated against three categories of suitability criteria:

Ecological Criteria – estimate of potential ecological value of connectivity measures for wildlife, habitats, and natural processes

Permanence Criteria – estimate of potential permanence, or resilience, of connectivity measures

Constructability Criteria – estimate of design and construction feasibility, complexity, and cost of crossing measures

The general approach to each criterion is described in the following sections. A ranking system was developed for each criterion to organize and qualitatively present numerous criteria in a relatively simple way for each alternative so they can be compared within a cross-disciplinary decision-making process. While such ranking systems have their limitations they are common within complex land and conservation planning processes. We believe that this approach has been effective, and decisions and recommendations are supported and defensible. Additional details on criterion ranking and alternatives analysis are given in Figure 24.

Criteria were applied iteratively throughout the alternatives analysis and recommendations refinement process, with review and guidance from the Technical Advisory Committee. During the first iteration of crossing site identification, ecological criteria and supporting models were used to identify crossing locations with the greatest potential to provide connectivity between areas for focal habitats. 17 alternative crossing locations were identified during this first iteration. Next, other key criteria, such as land conservation status or physical constraints like steep slopes, served as initial "filters" to identify six of the best locations for more detailed study out of the original 17 potential locations considered (see Figure 23). These six locations were then carried forward to more detailed suitability analysis of all criteria based on detailed design studies at each site (presented in Section 5). Once the full suitability analysis was completed, a comparison of criteria for the six sites informed the selection of two preferred crossing site alternatives to be carried forward in the next phase of the project and other more recommendations related to other potential crossing needs in the future (presented in Section 6). The overall suitability ranking results for the 17 sites is presented below in Figure 24.

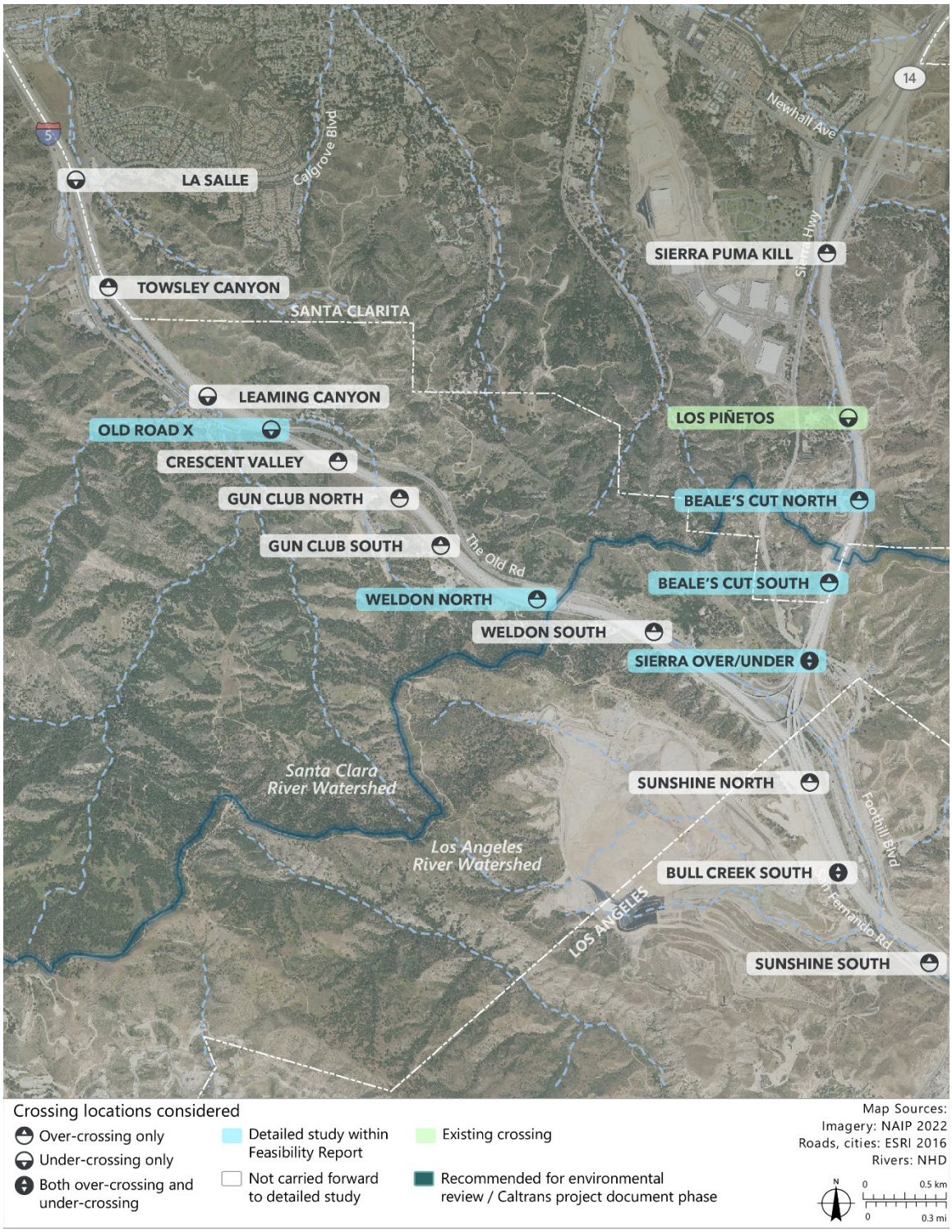


Figure 23. Crossing site alternatives carried forward to detailed study presented in Section 5.

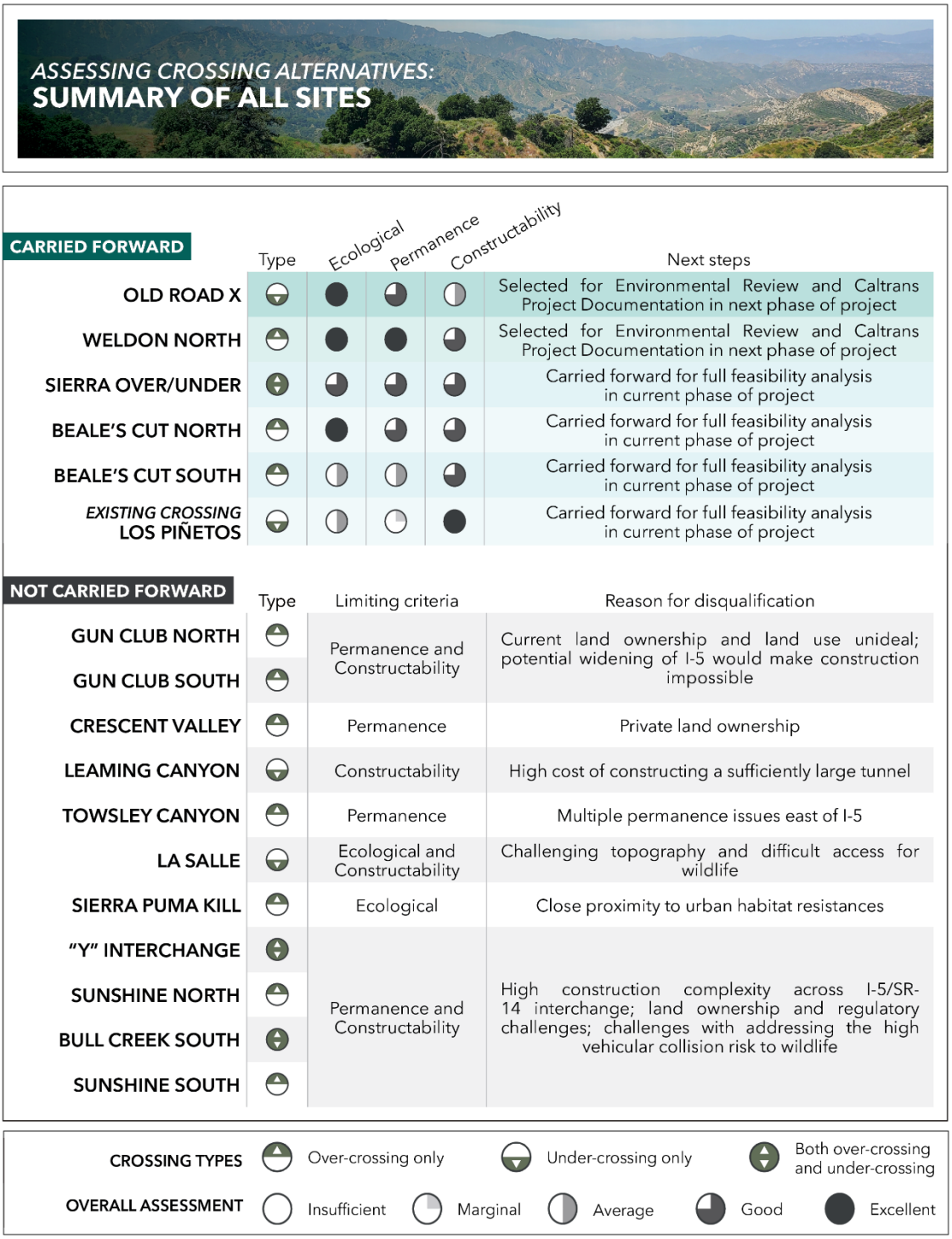


Figure 24. Suitability criteria results and ranking thresholds. The following matrix presents the overall criteria performance results and ranking thresholds for each of the 17 crossing sites considered. Detailed discussion of results for the 6 sites carried forward is in Section 5.

SUITABILITY CRITERIA SCORE EXPLANATIONS

ECOLOGICAL CRITERIA

An estimate of potential ecological value of connectivity measures for wildlife, habitats, and natural processes.

Assessment	Generalist / Chaparral	Oak woodland	Grassland / Scrub	Riparian Woodland	Montane woodland	Vehicular collisions	Watershed connectivity
Insufficient	No improvement from current conditions					No recorded collisions nearby	*(Not used)*
Marginal	Marginal improvement from current conditions					*(Not used)*	
Good	"Good" improvement from current conditions					Not used	Along small ephemeral creek or wash
Better	"Better" improvement from current conditions					One priority species collision	Weak along primary creek or across watershed boundary
Best	"Best" improvement from current conditions					Multiple priority species collisions	Strong connectivity along primary creek

PERMANENCE CRITERIA

An estimate of potential permanence, or resilience, of connectivity measures, due to both human and environmental factors.

Assessment	Conservation / land ownership status	Wildfire risk to habitat	Climate refuge value	Environmental co-benefit lift potential
Insufficient	Private land on both sides	Return interval much more frequent than pre-settlement on both sides	No refuge area adjacent	No restoration need adjacent
Marginal	Private land on one side	*(Not used)*	Minimal refuge area or corridor one side	*(Not used)*
Average	Private land but not expecting issues OR government-owned with potential challenges	Return interval more frequent one side, similar to pre-settlement other	Refuge area one side	*(Not used)*
Good	Private land with unlikely / no challenges OR government-owned	*(Not used)*	Refuge area both sides	*(Not used)*
Excellent	Conserved	Return interval similar to pre-settlement on both sides	Diverse refuge area (montane and riparian) both sides	Major restoration need / potential adjacent

CONSTRUCTABILITY CRITERIA

An estimate of design and construction feasibility, complexity, and cost of connectivity measures.

Assessment	Geotech	Traffic impact	Approaches / slopes	Utilities	Remediation need	Regulatory complexity	Construction complexity	Cost
Poor	High risk of liquefaction, landslide, settlement, and corrosivity	Closure of I-5 and SR-14 for multiple days	Steep and unmitigable	Major utilities on both sides	Major site remediation needed	Major hurdles, competing agency concerns, significant risks	Most complex	$75-100 million
Marginal	*(Not used)*	Requires facility closures at night	Major grading required on both sides	*(Not used)*				$50-75 million
Average	High landslide risk, low liquefaction risk	Minor road closures, long term changes	Major grading required on one side	Moderate utility constraints	Moderate, self-mitigating	Moderate concerns from agencies	Moderately complex	$25-50 million
Good	*(Not used)*	Minimal impacts to minor roads	Minor grading required on one side	*(Not used)*				$10-25 million
Excellent	Foundation on bedrock	Negligible impact	No significant grading required	No constraints from utilities	No site remediation needed	Least number of hurdles, no agency concerns	Least complex	< $10 million

Figure 25. Scoring explanations for all suitability criteria.

4.1 Ecological Criteria

Ecological criteria included connectivity modeling results for the 5 focal habitats described in Section 3, wildlife vehicle collision data, and consideration of the pattern of subregional watersheds and ecosystems. The criteria are described below and mapping of the 17 crossing locations and the criteria are included in the following figures.

Ecological Criteria 1–5 – Connectivity model results for the 5 focal habitats
Modeling data provides a useful basis for locating crossings because we assume that wildlife is more likely to use crossings that they can find and/or provide good access to suitable habitats. Connectivity modeling data provides spatially explicit mapping that can inform decision making around crossing locations. Crossings that demonstrate connectivity for mountain lion are a top priority, however most areas of the pass suggest strong potential for mountain lion use. Additionally, crossings that demonstrate the best connectivity for the most focal habitats are assumed to provide the best opportunity to maximize connectivity for the most biodiversity. Modeled results were considered along with field observations and expert opinion by team members to select the final rankings. Detailed description of connectivity modeling approach is in Section 3.1 and methods and results can be found in Appendix C.

Ecological Criterion 6 – Wildlife-vehicle collision data
Collision data was considered upon recommendation of the project's Technical Advisory Committee. The interchange of I-5 and SR-14 is one of the few clusters of mountain lion collisions in the state, an indication of a high-priority location for crossings structures (Shilling personal communication during TAC meeting 1, 8/27/23). Black bear and mule deer have also been hit in the Pass area (see Appendix A, Figure A-11).

Ecological Criterion 7 – Subregional watershed connectivity
Watershed connectivity was included as a criterion with the assumption that well connected watersheds will be more resilient to ecological change, including expected climate change. Consideration of watershed connectivity is also integrated in the connectivity program recommendations in Section 6. For comparison of individual locations and structures, structures that provide riparian connections along the major streams of subwatersheds (Newhall Creek, South Fork Sanat Clara River, and Bull Creek) were given higher value. Upland connections at major watershed boundaries (e.g., the boundary of the Santa Clara and the Los Angeles River watersheds) were also given a smaller value (compared to creeks) value for watershed connectivity with the assumption that top-of-watershed connections may provide landscape connectivity benefits to both watersheds and may play a role in cross-watershed movement and migration.

Other ecological criteria
Subregional ecosystem connectivity was also considered (Section 3, Figure 13) to account for which of the many subregional ecological zones were being connected based on the location of the crossing. Because no zone was assumed to have a higher priority than others, and therefore a single crossing in any zone received the same value, this criterion was not considered in individual crossing location comparisons and is not included in the matrix. However, this criterion is addressed in medium- and long-term recommendations in Section 6 that include evaluating additional crossing structures to support connecting multiple ecological zones to improve potential for long-term climate resilience in alignment with the "Connecting Nature's Stage" concept discussed in Section 3.

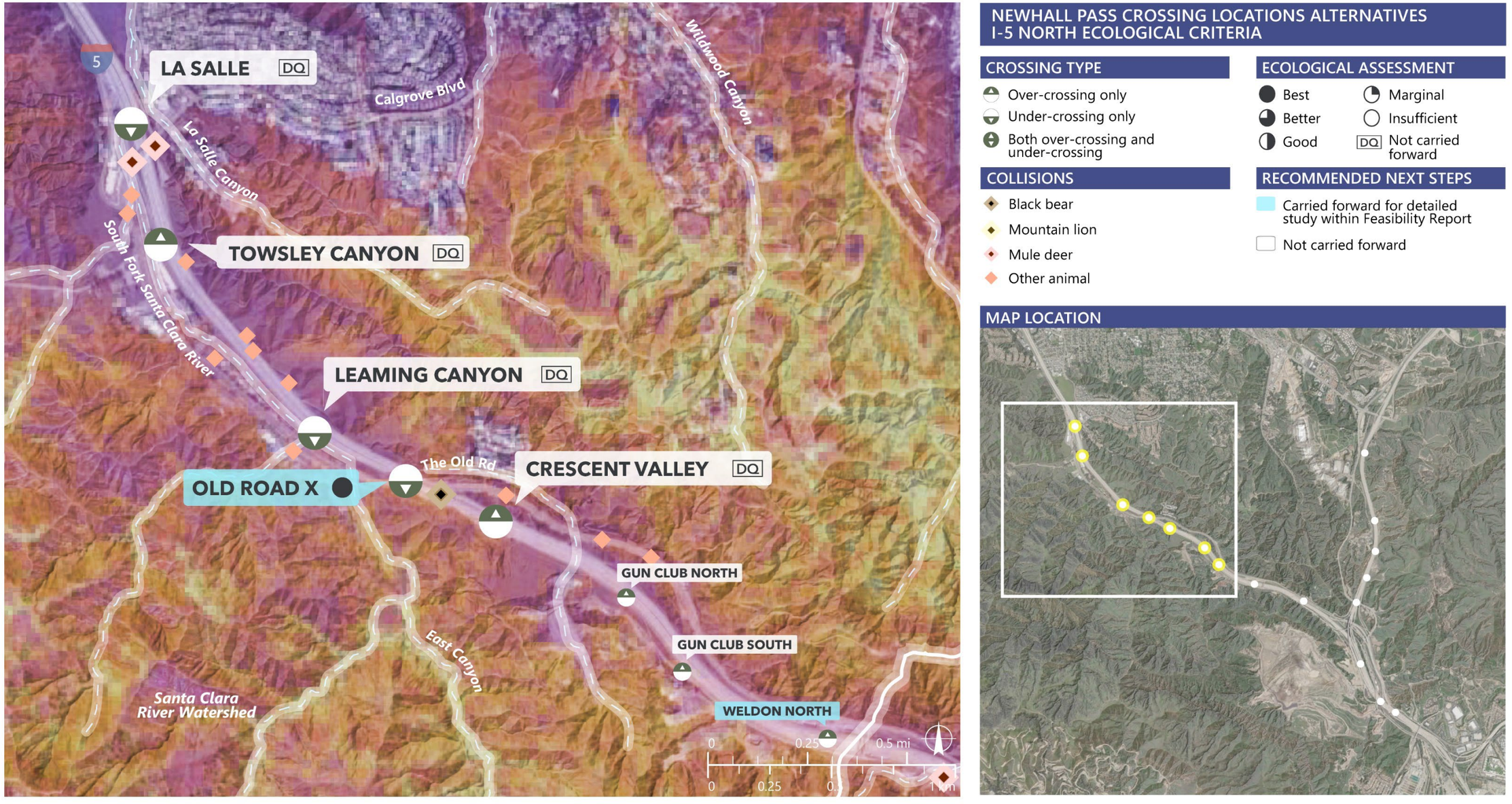


Figure 26. Ecological criteria maps of the northernmost I-5 crossing alternatives. Base layer shows the connectivity model output for chaparral/generalist focal habitat. See section 3.1 for connectivity model details .

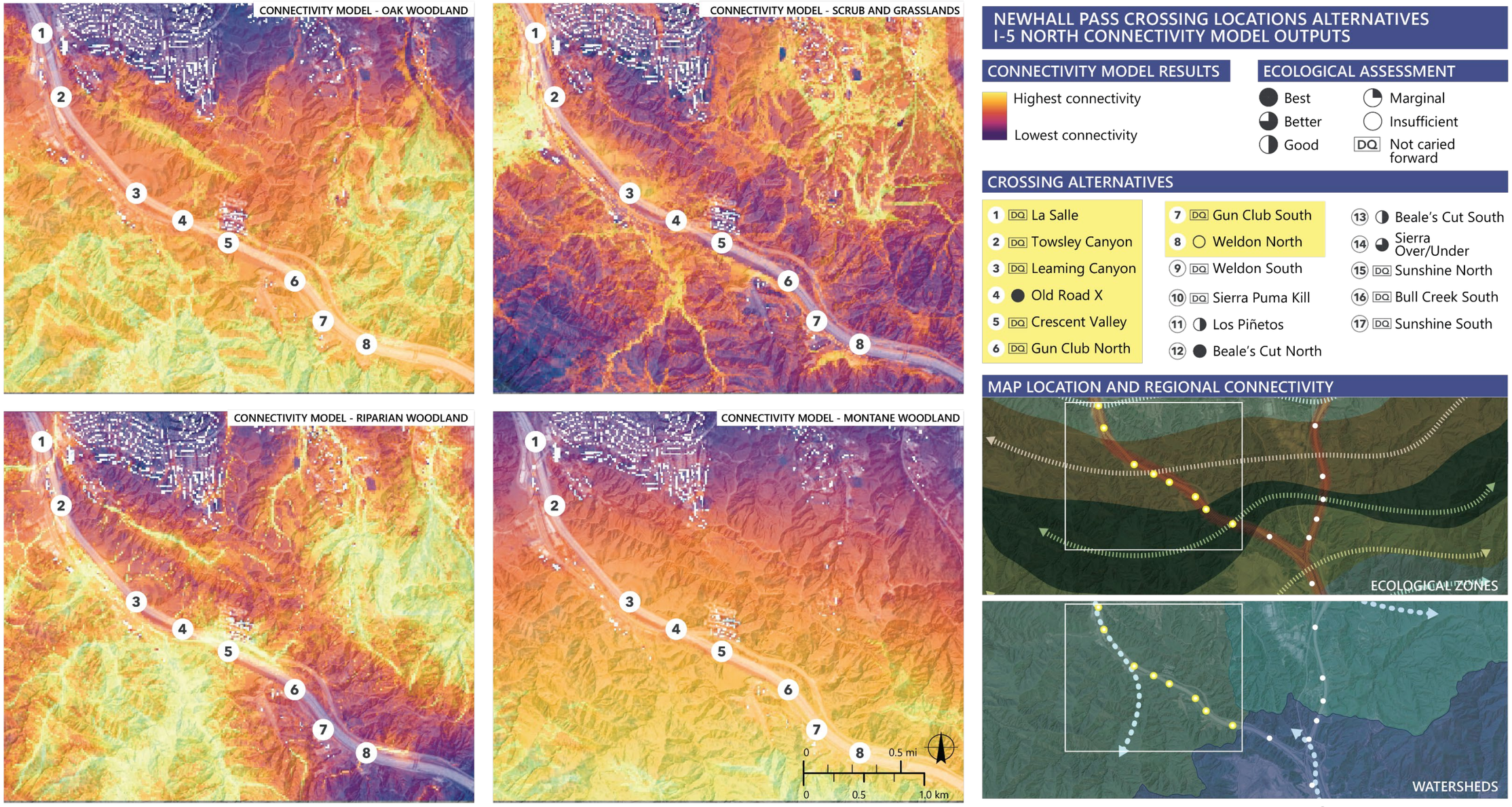


Figure 27. Connectivity model outputs for the northernmost I-5 crossing alternatives. See section 3.1 for connectivity model details. See Section 3.2 for watershed and ecological zones legend.

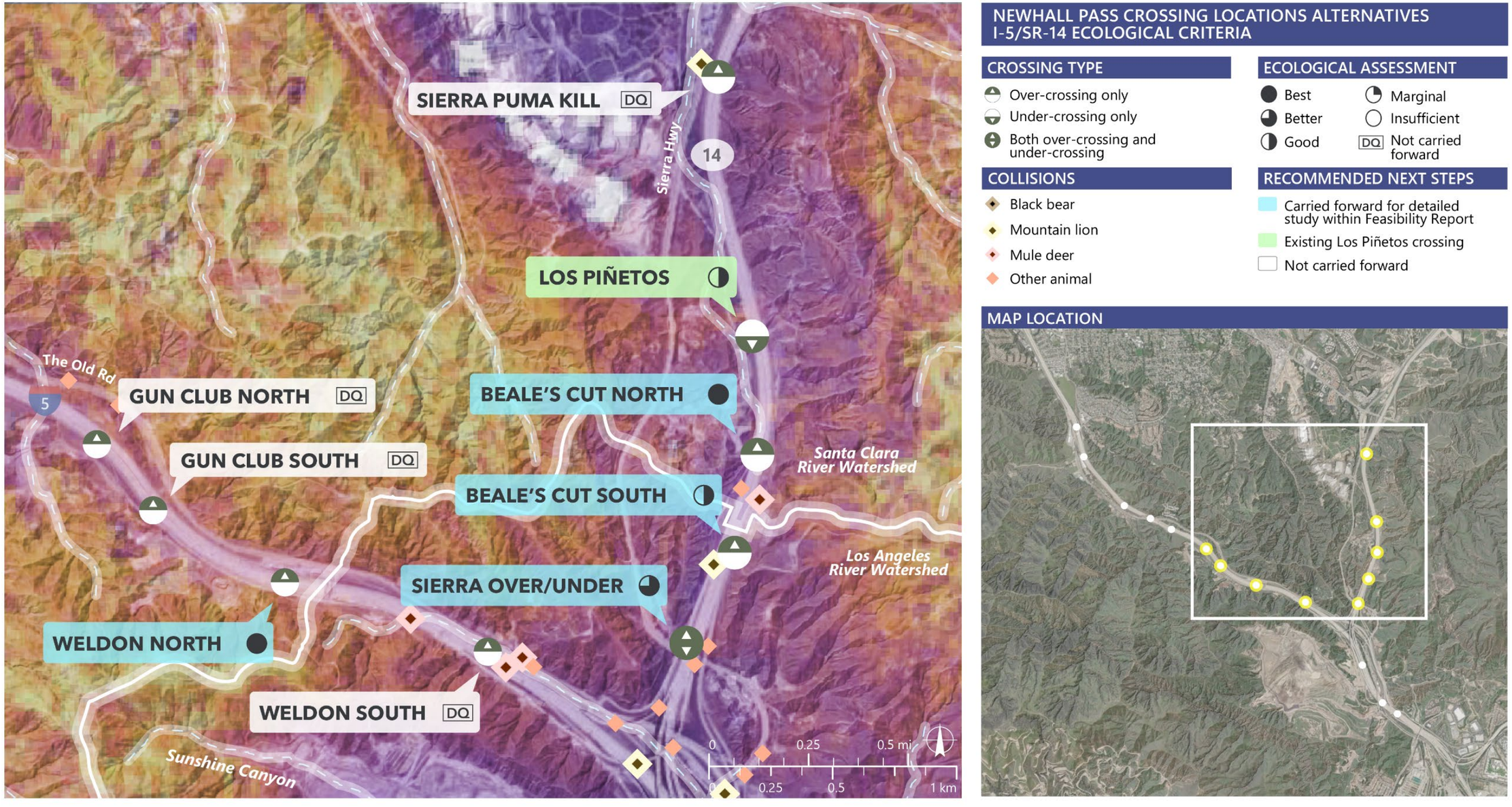


Figure 28. Ecological criteria maps of the middle I-5 and SR-14 crossing alternatives. Base layer shows the connectivity model output for chaparral/generalist focal habitat. See section 3.1 for connectivity model details.

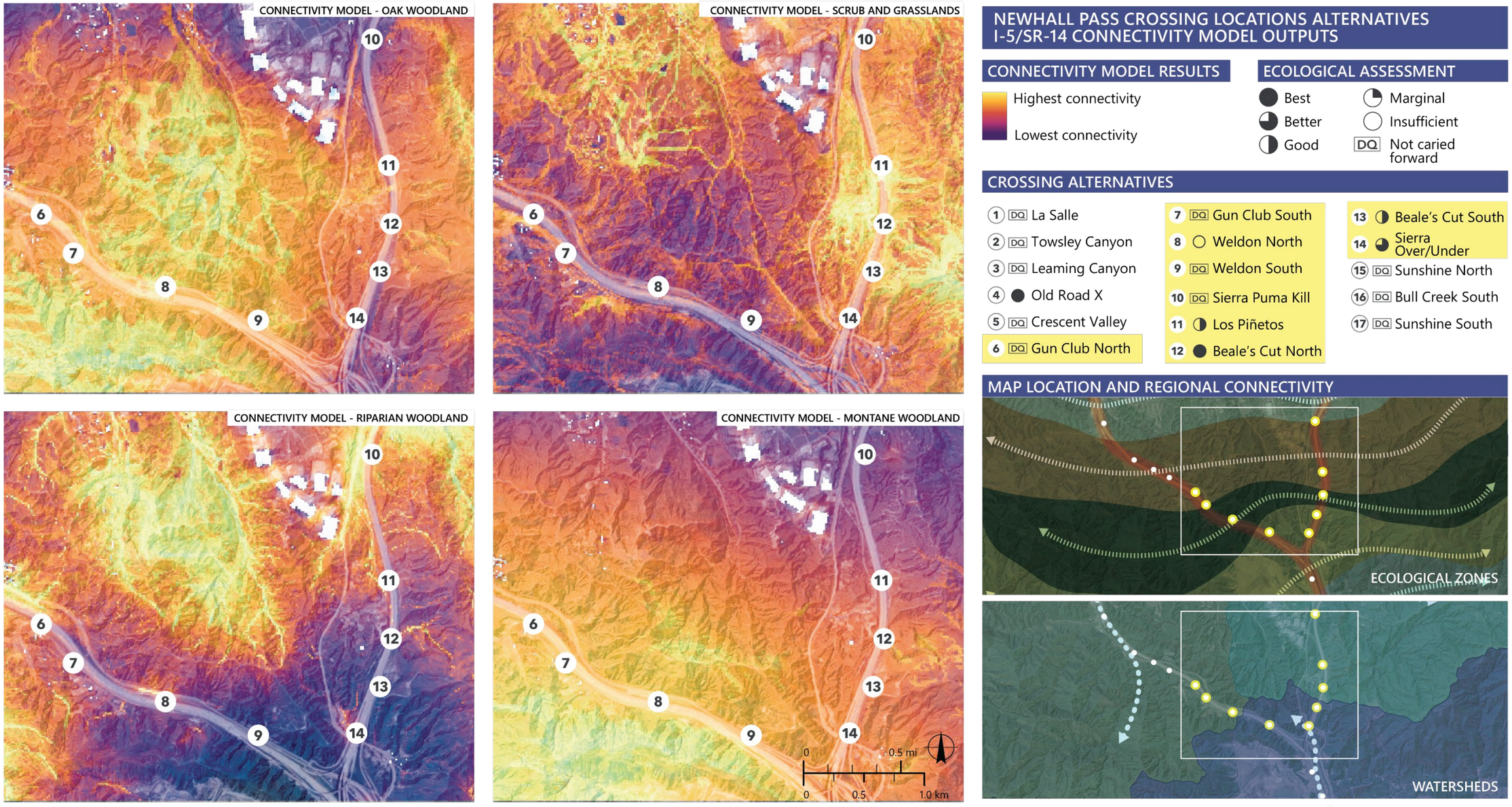


Figure 29. Connectivity model outputs for the middle I-5 and SR-14 crossing alternatives. See section 3.1 for connectivity model details. See Section 3.2 for watershed and ecological zones legend.

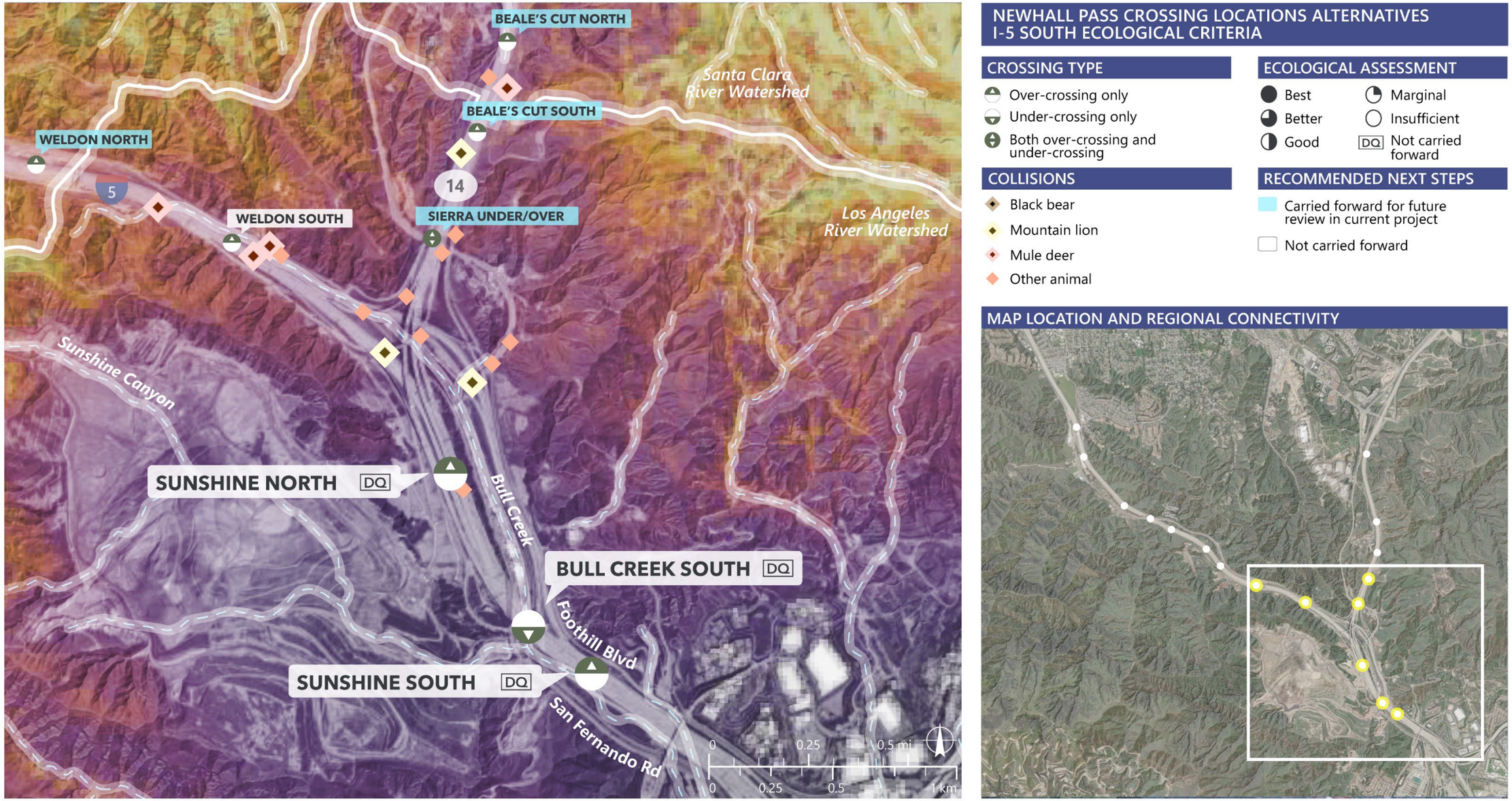


Figure 30. Ecological criteria maps of the southernmost I-5 crossing alternatives. Base layer shows the connectivity model output for chaparral/generalist focal habitat. See section 3.1 for connectivity model details.

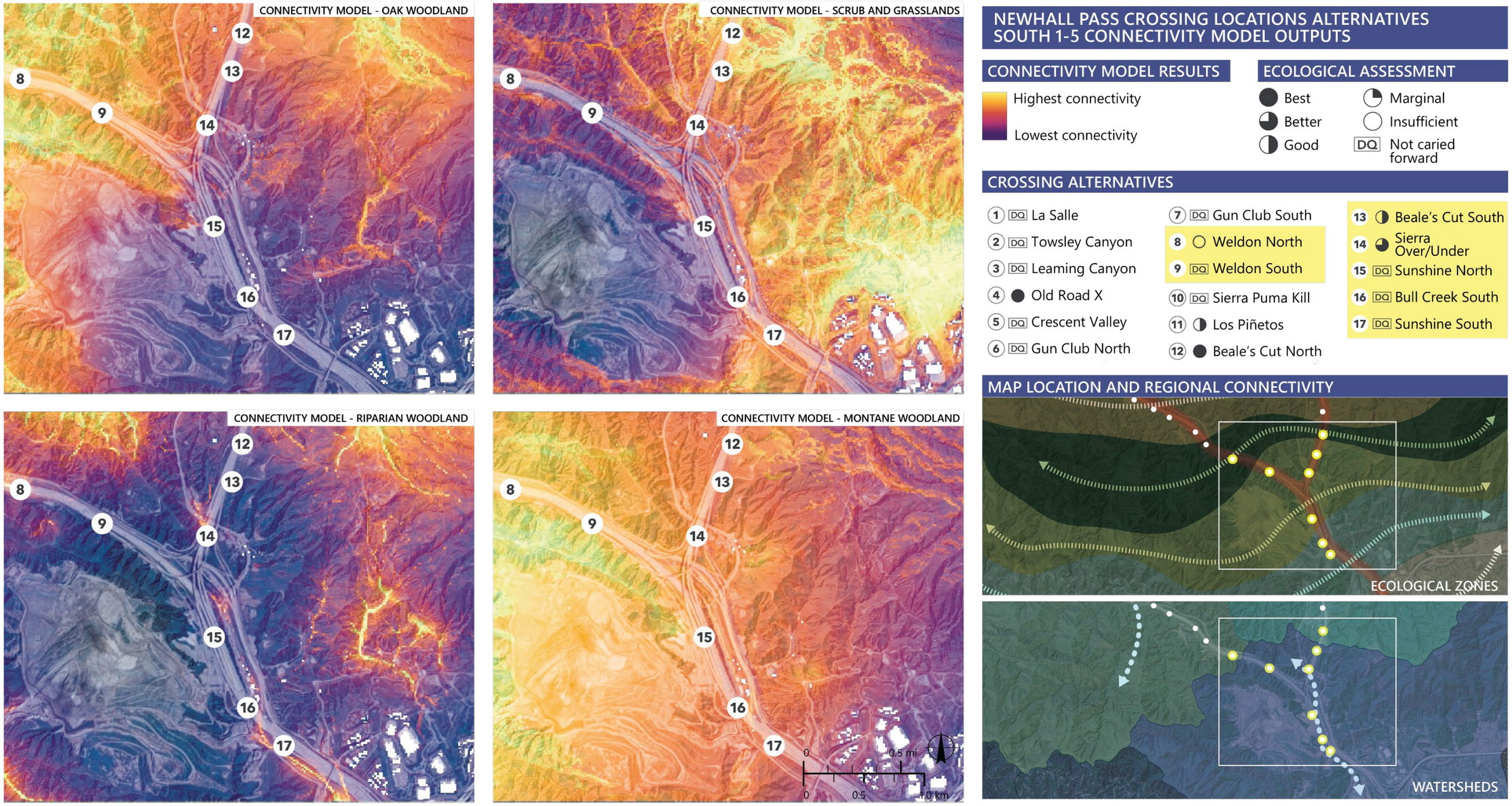


Figure 31. Connectivity model outputs for the southernmost I-5 crossing alternatives. See section 3.1 for connectivity model details. See Section 3.2 for watershed and ecological zones legend.

4.2 Permanence Criteria

Permanence criteria account for the potential permanence, or resilience, of crossing measure effectiveness for ecological connectivity. Permanence criteria are especially focused on patterns and processes on land adjacent to crossing locations that may impact their effectiveness, such as land ownership, exposure to unnaturally frequent wildfire, or potential climate change-driven habitat change. Because they are direct reflections of anticipated changes in the future, the rankings themselves may change in the future, as well. The following permanence criteria were considered for each crossing location followed by a summary of performance results and mapping in the following figures.

Permanence Criterion 1 – Land ownership/parcel conservation status
Land ownership of adjacent parcels was one of the primary limiting factors for crossing site selection. Land ownership information was assembled through a variety of sources including the 2023 California Protected Areas Database, the OnX parcel public access information, LA County Assessor's Office, and personal communications with stakeholders. Parcels classified as "conserved" were assumed to provide a permanent role in connectivity and unconstrained for the constructions of crossing structure alternatives (see Section 2, Figure 10, and Figures 31-33 below). "Potentially conservable" parcels were those owned by government entities or utility easements such as power lines and water infrastructure corridors. These parcels were assumed to provide a permanent role in connectivity and could potentially serve as sites for crossing structures. The team initially considered accounting for the potential that private parcels could be relied upon to provide connectivity to crossing locations because potential for private land acquisitions, compatibility of existing parcel land uses such as rural residential zoning, or environmental constraints such as steep slopes or protected trees on parcels could be preserved and contribute toward connectivity. However, it was decided that most private parcels present too many unknowns to assume a permanent role in crossing site connectivity and private lands were ultimately given low permanence values. Future land use and ownership changes on private parcels should be pursued and monitored and sites may be re-evaluated for permanence value. For example, key private parcels west of the existing Los Piñetos underpass could maintain existing connectivity benefits if protected into the future, but other crossing alternatives must be pursued if the land were developed and connectivity to the existing crossing structure from the west was lost.

Permanence Criterion 2 – Wildfire risk to habitat
Wildfire frequency is unnaturally high across much of the study area, which may degrade habitat and reduce ecological connectivity performance (see Appendix A, Figure A-3,4). This frequency has resulted in conversion of vegetation from chaparral and woodlands to scrub and non-native grasslands over time. While recent field visits and wet years have revealed that some frequently burned areas are recovering well, with ongoing elevated frequency, existing habitat is expected to continue this process of type conversion, which will change habitat type patterns and will likely impact wildlife movement, especially for species that rely on woodlands, such as mountain lions, and species adapted to montane woodland habitat types. Crossing locations in areas that are burning at natural or lower frequencies were given higher value. In the future, programs should be developed to maintain a more natural fire regime to ensure resilience of connectivity functions across the Pass area.

Permanence Criterion 3 – Climate change refuge value
Climate change impacts will accelerate during the 75-year design lifespan of major crossing structures, likely resulting in extensive landscape change. Anticipating these changes may improve the long-term function of crossing measures. At a regional scale, the isolated patch of low-elevation montane conifer and hardwood woodlands in the Santa Susana Mountains west

of I-5 represents a unique cool and moist ecosystem that may play an important role in the long-term climate adaptation for associated species within the region. Within the study area, areas of relatively cool and moist conditions were assumed to provide the best opportunities for climate refugia as future climate scenarios suggest warming and drying of local microclimates. Specifically, riparian areas, northerly aspects above 600 meters elevation, and existing montane conifer and montane hardwood patches were prioritized (see Appendix A, Figure A-13 and Section 3.5 for more information).

Permanence Criterion 4 – Potential for environmental co-benefits or "lift"
The final permanence criteria addressed the potential co-benefits of different crossing locations. Overpass measures will be highly visible from freeways, which may raise awareness of connectivity importance in the Pass and could increase public support for connectivity measures. Other co-benefits considered include potential remediation of contaminated or disturbed sites that would occur with construction of crossing measures at several crossing locations. Without a crossing, cleanup of these sites may not occur. While such measures may provide additional environmental lift for the project, they may also increase project cost and complexity, which is accounted for by the constructability criteria.

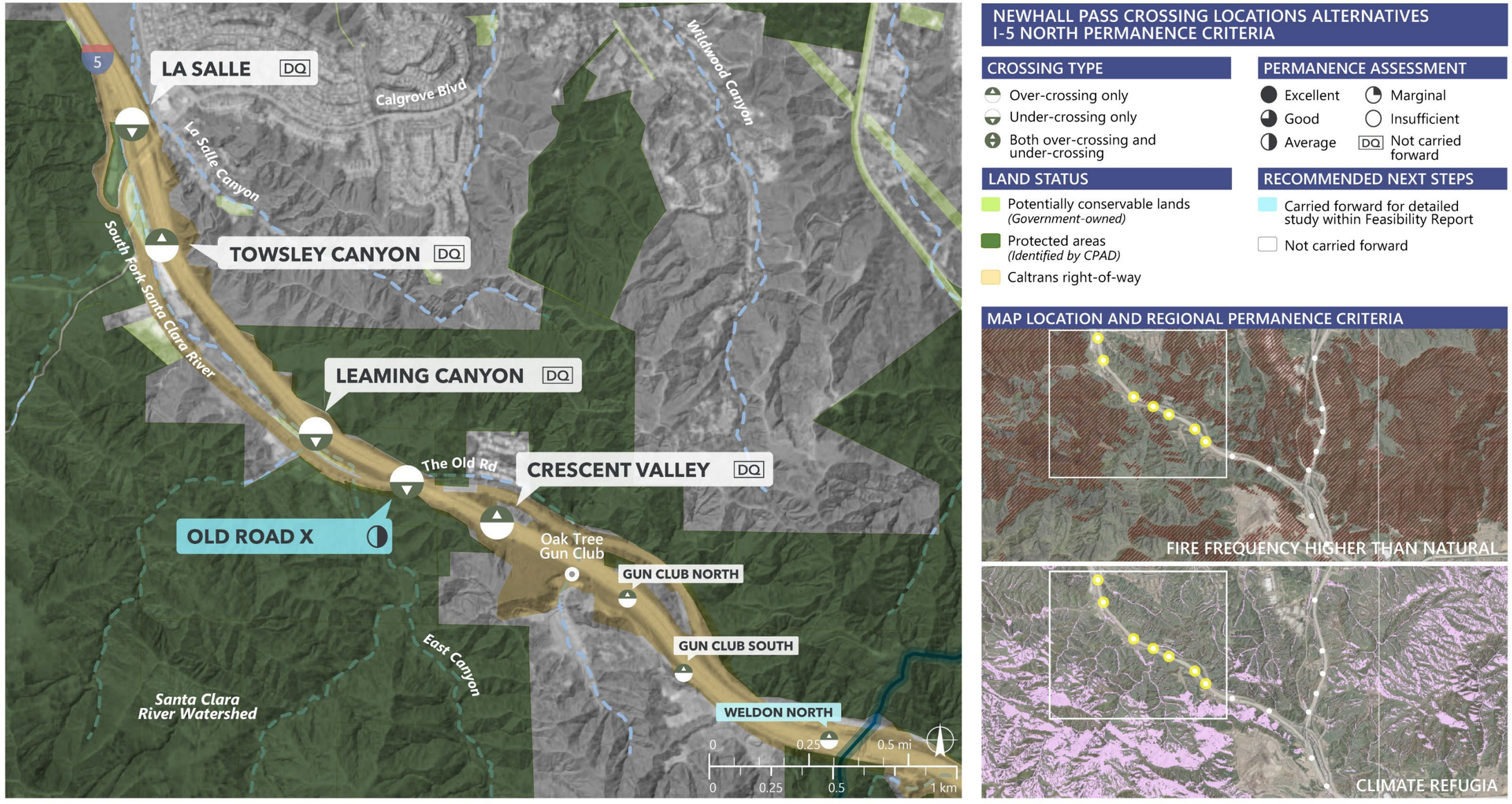


Figure 32. Permanence criteria maps of the northernmost I-5 crossing alternatives. Base layer shows land ownership/parcel conservations status as identified in the California Protected Areas Database. See Permanence Criterion 1 for more details. See Section 5.7 for detailed explanations of why sites were not carried forward.



NEWHALL PASS CROSSING LOCATIONS ALTERNATIVES I-5/SR-14 PERMANENCE CRITERIA

CROSSING TYPE

- Over-crossing only
- Under-crossing only
- Both over-crossing and under-crossing

PERMANENCE ASSESSMENT

- Excellent
- Good
- Average
- Marginal
- Insufficient
- DQ Not carried forward

LAND STATUS

- Potentially conservable lands *(Government-owned)*
- Protected areas *(Identified by CPAD)*
- Caltrans right-of-way

RECOMMENDED NEXT STEPS

- Carried forward for detailed study within Feasibility Report
- Existing Los Piñetos crossing
- Not carried forward

MAP LOCATION AND REGIONAL PERMANENCE CRITERIA

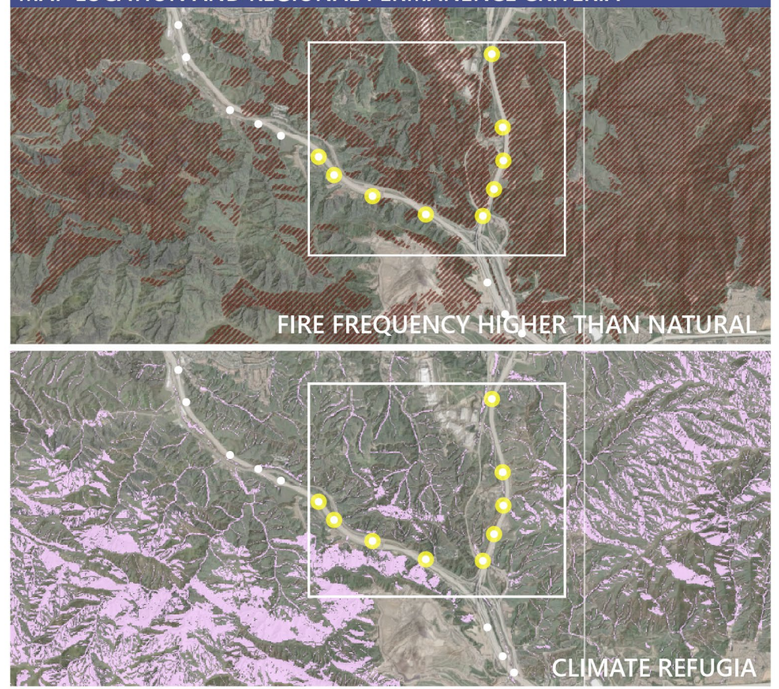


Figure 33. Permanence criteria maps of the middle I-5 and SR-14 crossing alternatives. Base layer shows land ownership/parcel conservations status as identified in the California Protected Areas Database. See Permanence Criterion 1 for more details. See Section 5.7 for detailed explanations of why sites were not carried forward.



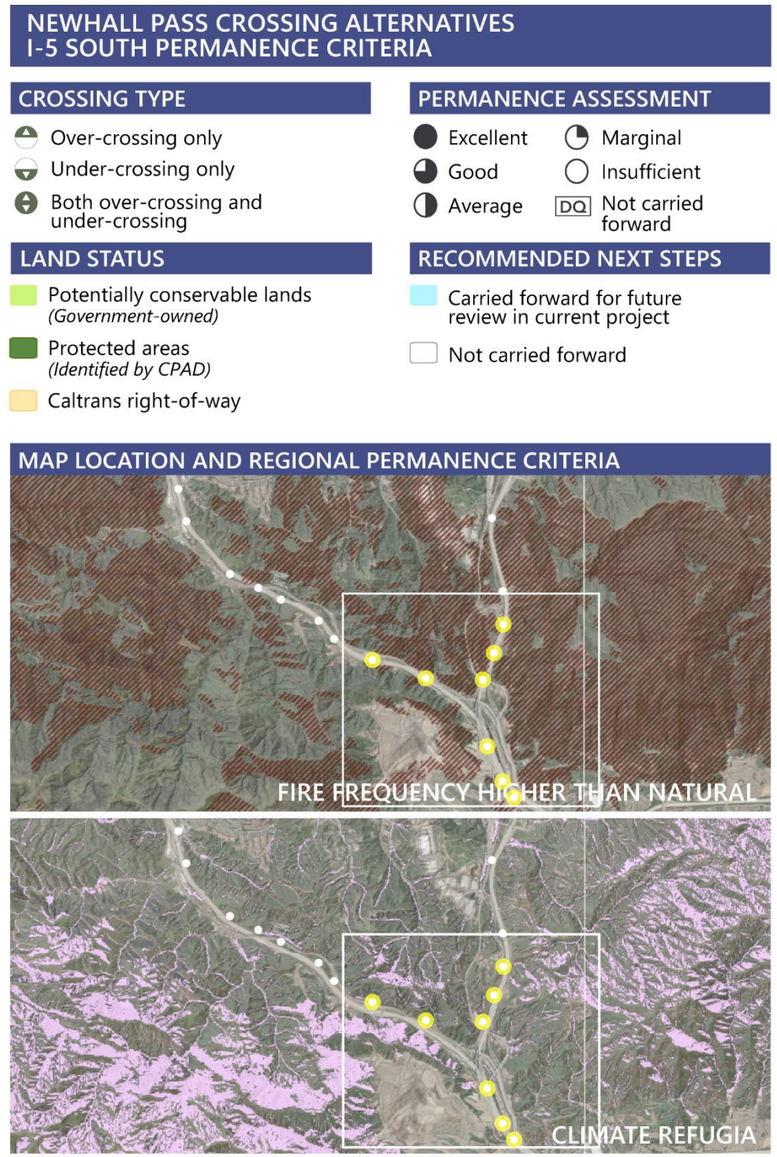


Figure 34. Permanence criteria maps of the southernmost I-5 crossing alternatives. Base layer shows land ownership/parcel conservations status as identified in the California Protected Areas Database. See Permanence Criterion 1 for more details. See Section 5.7 for detailed explanations of why sites were not carried forward.

4.3 Constructability Criteria

The constructability analysis accounts for the following eight criteria:

1. Geological And Geotechnical Conditions
2. Short- And Long-Term Traffic Impacts
3. Approaches And Slopes
4. Utilities
5. Environmental And Remediation Needs
6. Regulatory Complexity
7. Construction Complexity
8. Construction Cost

These criteria exert the greatest impact on the potential constructability of connectivity features at each crossing site. Constructability criteria analyzed in conjunction with ecological and permanence criteria will help prioritize and select alternatives to carry forward into the Environmental Document Phase. The following Section (Section 5) compares each crossing location at a conceptual level. Importantly, construction costs are only for comparison purposes at this early stage of planning and should not be used for budgetary planning or programming purposes.

The following provides a description of each constructability criterion:

Constructability Criterion 1 - Geological and geotechnical considerations
Geologic and geotechnical hazards were analyzed from as-built reports and logs, regional geological maps, state hazard reports and maps and other local and private data and publications to understand conditions for recommending bridge foundations for each crossing location. Conditions included potential for earthquake shaking, liquefaction, landsliding/slope stability, expansive soils, subsidence/settlement, fault rupture, corrosivity, and rippability risk. Crossing location sites with lower geologic and geotechnical hazards received favorable rankings. The Geotechnical/Geologic Hazard Assessment for Wildlife Crossing Alternatives Memo can be found in Appendix F.

Constructability Criterion 2 – Short- and long-term traffic impacts
Both short-term and long-term traffic impacts were assessed for each crossing location, with particular emphasis placed on their impact on I-5 or SR-14. Short-term impacts pertain to traffic disruptions during construction, encompassing lane closures and detours. Long-term traffic impacts involve permanent alterations to roadways, such as road re-alignment/reconfiguration, lane reductions, and speed changes. Throughout construction, I-5 and SR-14 will remain open to traffic with the exception of short-term night closures. Crossing location sites with minimal traffic impacts received favorable rankings.

Constructability Criterion 3 – Approaches and slopes
The steepness and slope direction of adjacent lands and approaches were assessed for each crossing location site. A flatter approach with a slope direction towards the crossing location received more favorable rankings.

Constructability Criterion 4 – Utilities
Considerable efforts have been made in choosing crossing location sites free of major utilities. Existing utility information was collected from Caltrans as-builts and DigAlert utility mapping service. However, it is important to note that not all the data required for a complete

understanding of utilities locations is currently publicly available, and some datasets may need to be requested from Caltrans in future phases. Major utilities in the area include the high-voltage electric transmission line traversing SR-14 and the 76" water main along Sierra Highway, both of which must be safeguarded in their current position. Other utilities in the vicinity encompass underground gas transmission and communication lines, oil pipelines, as well as both underground and overhead electrical infrastructure along Sierra Highway. Additionally, a gas line follows The Old Road route. Crossing location sites with lesser utility concerns received favorable rankings.

Constructability Criterion 5 – Environmental and remediation needs
Each crossing location site was evaluated for potential challenges in environmental clearance, including the complexity and likelihood of encountering challenges in environmental documentation. This Report assumes the Project will not be finalized in time to leverage the Statutory Exemption for Restoration Projects (SERP), as its authorization is only valid through December 31, 2024. Assumptions regarding its utilization are contingent on the legislature extending authorization. Additionally, because cultural and biological impacts have not been evaluated for each crossing location site, potential impacts remain unknown at this stage. Crossing location sites with minimal known environmental clearance and complexity received favorable rankings.

Constructability Criterion 6 – Regulatory complexity
The assessment entails identifying and evaluating potential permitting requirements and regulatory challenges associated with each crossing location site. Potential permits may be required from the California Department of Fish and Wildlife (CDFW), the US Army Corps of Engineers (USACE), and the Regional Water Quality Control Board (RWQCB), among others. Potential challenges navigating the approval process from Caltrans were also identified. Crossing location sites with minimal regulatory complexity received favorable rankings.

Constructability Criterion 7 – Construction complexity
The construction complexity was assessed for each crossing location site, including the number of structures required for the crossing, the extent of excavation/habitat restoration required, and the availability and length of construction access and staging areas. Locations with fewer required structures and reduced excavation and habitat restoration received favorable rankings.

Constructability Criterion 8 – Construction costs
Construction costs, focused primarily on road and structure expenses, were estimated for each crossing location site. These costs are provided solely to provide an estimate for comparison purposes and do not include the entirety of project development costs such as wildlife fencing, additional sound walls, landscaping, environmental mitigation, or other various expenses. Moreover, estimated costs do not include expenses related to right-of-way acquisition, design, construction management, agency management, contractor mobilization, or contingency.

The purpose of the estimated costs is to offer a relative range of construction expenses to compare the six identified crossing location sites. These estimated costs should not be utilized or cited for budgetary planning or programming purposes. The costs are based on exhibits shown in Appendix D and may have discrepancies with the designs shown in Section 5.

4.3.1 Crossing Structure Types

A range of potential types of overcrossing structures were identified for the Project. The most common and feasible bridge types for the Project are described below. Construction methods are also discussed, including the need for staged construction, roadway closures, or falsework

(temporary structures to support construction). Note that fiber-reinforced polymer structures were not considered for this project due to lack of durability in fire-prone areas.

Type of Structure 1 - Concrete Slab
Concrete Slab Structures are one of the simplest structure types. The span ranges are fairly limited to 16 to 65 feet per span, reducing the favorability of this bridge type as an overcrossing for I-5 or SR-14. This type of structure is a viable option where short tunnel crossings are proposed. Cast-in-place slabs can be either conventionally reinforced or post-tensioned. Post-tensioning the slab can allow for a shallower structure depth and longer spans. Precast, prestressed slab units can be utilized to decrease construction time and eliminate the need for falsework.



Figure 35. Concrete slab structures; spans range – 16 to 65 feet per span.

Type of Structure 2 – Cast-in-place Box Girder
Cast-in-place concrete box girder is the most common bridge type in California. Caltrans and contractors are very familiar with this structure type, which leads to competitive bids and more streamlined permitting and construction. Box girder bridges can be conventionally reinforced or post-tensioned to allow for longer span lengths and shallower structure depths. Cast-in-place concrete box girders require falsework to support the concrete forms during construction, which can add to in-field construction duration.



Figure 36. Cast-in-place concrete box girder; spans range – 50 to 250 feet per span.

Type of Structure 3 – Precast Concrete Girder
Precast concrete girders include several types, the most common of which in California are the I-girder and California wide-flange girders. Precast girders are furnished in a precaster shop and do not require falsework during construction, which can be advantageous if the bridge is spanning a body of water, over an environmentally sensitive area, or an area with limited space or access including limited vertical clearances over roadways. Precast girders can be used to accelerate the construction schedule, as there is no on-site cure time for the concrete girders. Precast girders are transported to the project site and erected with a crane. Utilizing precast concrete girders in remote locations or with locations with overhead utility lines may introduce complexity during construction. Erection of precast girders requires temporary short-term road closures. Girder erection typically takes place during nighttime construction with short-term lane closures when traffic volumes are at their lowest.



Figure 37. Precast concrete girders; spans range- 50 to 200 feet per span.



Figure 38. Typical girder erection. Beam being unloaded from a flatbed truck.



Figure 39. Typical girder erection. Girder being set onto bridge supports.

Type of Structure 4 – Prefabricated Precast Concrete/ Steel Plate Arch
Precast concrete arch and steel plate arch structures are composed of precast concrete arch or prefabricated steel units connected to form a continuous arch. Arch systems can be constructed faster than a traditional cast-in-place concrete structure. In this report, the precast concrete/ steel plate arch may be referred to as a tunnel due to their long length-to-width ratio.

The concrete arch is considered an "off-the-shelf" proprietary system and will encounter unique challenges during project delivery that the previously mentioned types of structures avoid. Typically, the engineering firm leading the design effort will coordinate with suppliers during the design phase on the specifications, headwalls, wingwalls, and foundation types. The design firm will detail all structural components besides the arch. Once the construction contract for the project is awarded, the winning supplier will furnish the design of the precast concrete/ steel plate arch. Issues during design that may arise include coordination that must happen between the supplier and designer during design to ensure that the details for other structural items fit with the arch design. Additionally, the supplier is often not under contract and may be unresponsive to inquiries and cause delays. Furthermore, joints between arch units may lose watertightness and lead to maintenance issues. Lastly, there are no precast concrete arch suppliers on the Caltrans pre-approved materials list.

Due to these challenges, this type of structure was only evaluated for use on local roads such as The Old Road and Sierra Highway and is not suitable for use within Caltrans's ROW (I-5 and SR-14).



Figure 40. Steel plate arch structures; spans range- 5 to 65 feet per span.



Figure 41. Precast concrete arch structures; spans range - 12 to 102 feet per span.

Type of Structure 5 – Cast-in-Place Concrete Arch

Cast-in-place concrete arch structures are one-of-a-kind structures that provide high vertical clearances above roadways, long horizontal spans, and are architecturally significant. These structures have deep foundation supports located at the concrete arch supports and concrete girder ends with a total of four locations, all of which may be located outside of the roadway lanes. A concrete arch bridge is a signature bridge providing an aesthetically pleasing experience for the drivers crossing below. A concrete arch is constructed using a temporary falsework structure, which allows for traffic to remain open during construction with minimal night closures when traffic volumes are lowest.



Figure 42. Cast-in-place concrete arch structure; span ranges – 200 to 700 feet.

4.4 Other Suitability Considerations

While not accounted for in the ranking structure as the other criteria above, additional considerations were identified and noted throughout the site evaluation process. These are addressed in recommendations and site evaluations discussed in Section 5 and include cultural, socio-economic, planning, land use, and environmental themes. One significant cultural consideration is the Fernandeno Tataviam cultural perspectives and goals,. Discussions towards the integration of tribal considerations are ongoing and will be addressed in the future phases of this project. Additional considerations include a potential nexus with disadvantaged communities of the nearby San Fernando Valley and the City of Los Angeles, the potential relationship to historical preservation activities associated with Beale's Cut historical site near the Pass west of SR-14 (see Figure 33 above for location marker), trails and recreation programs planned for the Pass such as the Santa Clarita Coast to Crest Trail and the Rim of the Valley corridor, and potential recreation impacts such as unauthorized trail building within the Pass.

5 CROSSING DESIGN ALTERNATIVES

Each crossing location "site" and crossing strategy was evaluated at a conceptual level using the ecological, permanence, and constructability criteria outlined in Section 4, along with other factors. The resulting qualitative assessment provided an understanding of the suitability of each location for a wildlife crossing. The sites that proved to be most suitable for potential implementation in the near-term will be carried forward to the next (Environmental Documentation) phase through the CEQA/NEPA process. Additional sites may be appropriate to advance in the longer term. Six crossing sites were evaluated below: Old Road X, Weldon North, Los Piñetos, Beale's Cut North, Beale's Cut South, and Sierra Over Under.

Of those, two of the I-5 crossings were identified to be carried forward to the Environmental Documentation phase as alternatives for crossing structures and supporting habitat restoration: Old Road X and Weldon North. The remaining crossings evaluated are located on the SR-14 and adjacent frontage roads. While none of these are to be carried forward as part of this project, they represent important potential sites and should be considered as grossly feasible for future phases of connectivity work for the Newhall Pass region. The 11 sites not carried forward to this level of detailed evaluation fell out of consideration early due to a combination of infeasibility due to ownership, constructability, and or ecological limitations, as discussed in Section 5.7. These sites may also be appropriate for re-evaluation in future phases of conservation planning in the Pass.

Particular attention should be paid to the permanence criteria evaluation. "Permanence" indicates the extent to which the connectivity function of a landscape can be expected to persist into the future. In this analysis, some permanence conditions may not necessarily be permanent. For example, private parcels that are not available now for permanent conservation uses may change ownership to owners that are willing to sell or donate, in whole or by easement, permanent conservation uses, thus (greatly) increasing the permanence criteria suitability ranking for a crossing location.

The next page shows the preliminary design footprints of each crossing alternative, followed by an initial high-level comparison of the ecological, permanence, and constructability criteria for each crossing alternative. These figures may have discrepancies with the exhibits shown in Appendix D from which estimated costs were based on.

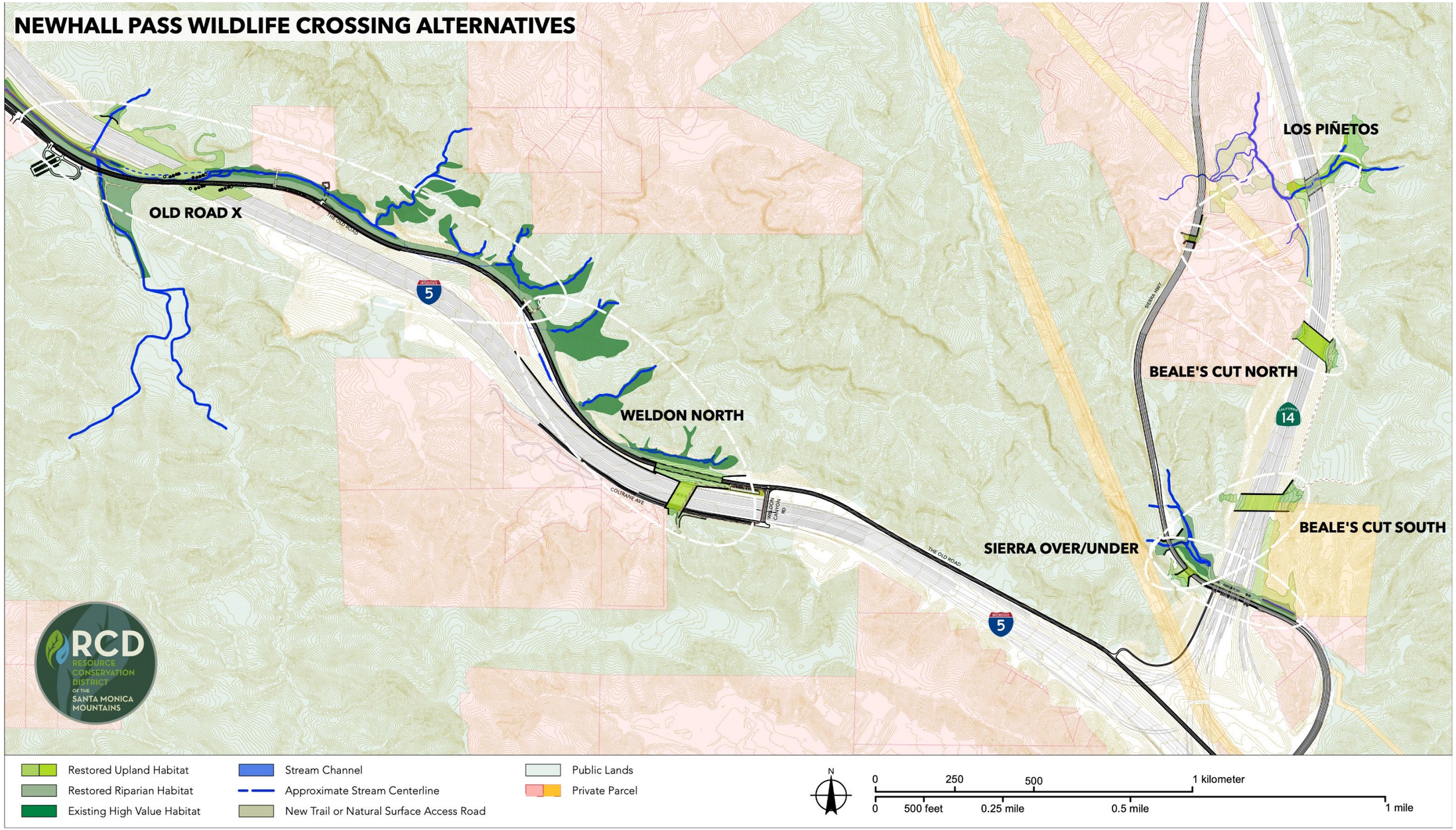


Figure 43. Map showing locations and designed footprints for each crossing alternative considered.



ECOLOGICAL CRITERIA

Ecological criteria are used to measure expected connectivity benefit. These criteria include modeling results for focal habitats, wildlife vehicle collision data, and alignment with the pattern of subregional watersheds.

CROSSING ALTERNATIVES

	Generalist / chaparral	Oak woodland	Grassland / scrub	Riparian	Montane	Collisions	Watershed connectivity	Overall
OLD ROAD X	◕	◕	◑	●	◑	◕	●	●
WELDON NORTH	●	●	◔	◑	●	◕	◕	●
SIERRA OVER/UNDER	◕	◑	◑	◕	◑	●	◕	◕
BEALE'S CUT NORTH	●	◕	●	◑	◕	●	◕	●
BEALE'S CUT SOUTH	◕	◔	●	◔	◔	●	◑	◑
LOS PIÑETOS	◑	◑	●	◑	◑	◕	◑	◑

ASSESSMENT RUBRIC

○	**Insufficient**	No improvement from current conditions	No recorded collisions nearby	Not used
◔	**Marginal**	Marginal improvement from current conditions	Not used	
◑	**Good**	"Good" improvement from current conditions	Not used	Along small ephemeral creek or wash
◕	**Better**	"Better" improvement from current conditions	One priority species collision	Weak along primary creek or across watershed boundary
●	**Best**	"Best" improvement from current conditions	Multiple priority species collisions	Strong connectivity along primary creek

Figure 44. Summary of ecological criteria assessments for the six alternatives selected to move forward. For more information regarding ecological criteria, see Section 4.1.



PERMANENCE CRITERIA

Permanence criteria account for the potential permanence, or resilience, of crossing measure effectiveness for ecological connectivity, with a focus on patterns and processes on land adjacent to crossing locations that may impact their effectiveness over time, such as land ownership, wildfire risk, and climate change.

CROSSING ALTERNATIVES

	Conservation / land ownership status	Wildfire risk to habitat	Climate refuge value	Environmental co-benefit lift potential	Overall
OLD ROAD X	◕	◕	◕	◕	◕
WELDON NORTH	◑	●	●	●	●
SIERRA OVER/UNDER	◑	◔	◕	◕	◕
BEALE'S CUT NORTH	◑	◔	●	●	◕
BEALE'S CUT SOUTH	◕	○	◔	◑	◑
LOS PIÑETOS	○	◑	◑	◔	◔

ASSESSMENT RUBRIC

○	**Insufficient**	Private land on both sides	Return interval much more frequent than pre-settlement on both sides	No refuge area adjacent	No restoration need adjacent
◔	**Marginal**	Private land on one side	Not used	Minimal refuge area or corridor one side	Not used
◑	**Average**	Private land but not expecting issues OR government-owned with potential challenges	Return interval more frequent one side, similar to pre-settlement other	Refuge area one side	Not used
◕	**Good**	Private land with unlikely / no challenges OR government-owned	Not used	Refuge area both sides	Not used
●	**Excellent**	Conserved	Return interval similar to pre-settlement on both sides	Diverse refuge area (montane and riparian) both sides	Major restoration need / potential adjacent

Figure 45. Summary of permanence criteria assessments for the six alternatives selected to move forward. For more information regarding permanence criteria, see Section 4.2.



CONSTRUCTABILITY CRITERIA

Constructability criteria account for factors that may have a significant impact on the ability for an intervention to be constructed at a given site. This includes both physical factors of the site itself, as well as any impacts that constructing the site would have on its surroundings.

CROSSING ALTERNATIVES

	Geotech	Traffic impact	Approaches / slopes	Utilities	Remediation need	Regulatory complexity	Construction complexity	Cost	Overall
OLD ROAD X	◑	◑	●	○	◑	◑	◔	◑	◑
WELDON NORTH	◕	◔	◕	◕	◕	◕	◑	◔	◕
SIERRA OVER/UNDER	◔	◕	◕	◔	◔	○	◕	●	◕
BEALE'S CUT NORTH	◑	◑	◕	◕	◕	◑	◑	◑	◕
BEALE'S CUT SOUTH	◑	◕	◑	●	●	◕	◔	○	◕
LOS PIÑETOS	◕	◕	●	◑	◕	◕	◕	●	●

ASSESSMENT RUBRIC

	High risk of liquefaction, landslide, settlement, and corrosivity	Closure of I-5 and SR-14 for multiple days	Steep and unmitigable	Major utilities on both sides	Major site remediation needed	Major hurdles, competing agency concerns, significant risks	Most complex	$75-100 million
○ **Poor**								
◔ **Marginal**	Not used	Requires facility closures at night	Major grading required on both sides	Not used				$50-75 million
◑ **Average**	High landslide risk, low liquefaction risk	Minor road closures, long term changes	Major grading required on one side	Moderate utility constraints	Moderate, self-mitigating	Moderate concerns from agencies	Moderately complex	$25-50 million
◕ **Good**	Not used	Minimal impacts to minor roads	Minor grading required on one side	Not used				$10-25 million
● **Excellent**	Foundation on bedrock	Negligible impact	No significant grading required	No constraints from utilities	No site remediation needed	Least number of hurdles, no agency concerns	Least complex	< $10 million

Figure 46. Summary of constructability criteria assessments for the six alternatives selected to move forward. For more information regarding constructability criteria, see Section 4.3.

5.1 Old Road X (I-5 undercrossing/viaduct)

5.1.1 Description

The Old Road X project proposes a concrete slab structure undercrossing located at I-5, PM 47.89. The crossing involves elevating The Old Road to make it a viaduct. The path for wildlife is under the viaduct, which requires excavation and habitat restoration of a reach of the South Fork of the Santa Clara River. The Old Road under existing conditions is a four-lane road with two lanes of traffic in each direction separated by a K-rail concrete barrier. The Old Road crosses under I-5's Gavin Canyon Bridge, which has a minimum vertical clearance of 57 feet. I-5 currently has four northbound lanes and five southbound lanes. A widening project is underway to widen I-5 to six northbound lanes and seven southbound lanes. Crescent Valley, a manufactured home community (23500 The Old Road), has an asphalt driveway located about 630 feet east of I-5. East and Rice Canyons Trailhead (24255 The Old Road) has a gravel driveway entrance approximately 370 feet west of I-5 and another gravel driveway entrance approximately 850 feet west of I-5.



Figure 47. Prints at Old Road X site. Photo credit: Clark Stevens.

OLD ROAD X
CROSSING ALTERNATIVE

The following series of illustrations show The Old Road X crossing site pre and post project implementation.

Illustration 1 (left) shows existing conditions without the lane expansion currently underway.

Illustration 2 (right) shows existing conditions without the I-5 freeway deck, exposing the existing columns as well as those already constructed for the planned lane expansion.

Illustration 3 (next page, left) shows the site post implementation with The Old Road and I-5 removed for visual understanding. Importantly, illustration 3 highlights what wildlife would experience moving through the crossing - the columns supporting the elevated Old Road and I-5 interspaced throughout the restored riparian connection.

Illustration 4 (next page, center) shows the site post implementation with The Old Road elevated in its new form as a viaduct.

Finally, illustration 5 (next page, right) shows the site post implementation with all roads in their respective locations.

Comparing illustration 1 + illustration 5 as a pair or illustration 2 + illustration 3 as a pair shows a side-by-side analysis of comparable infrastructural elements that currently exist and would exist post project completion.

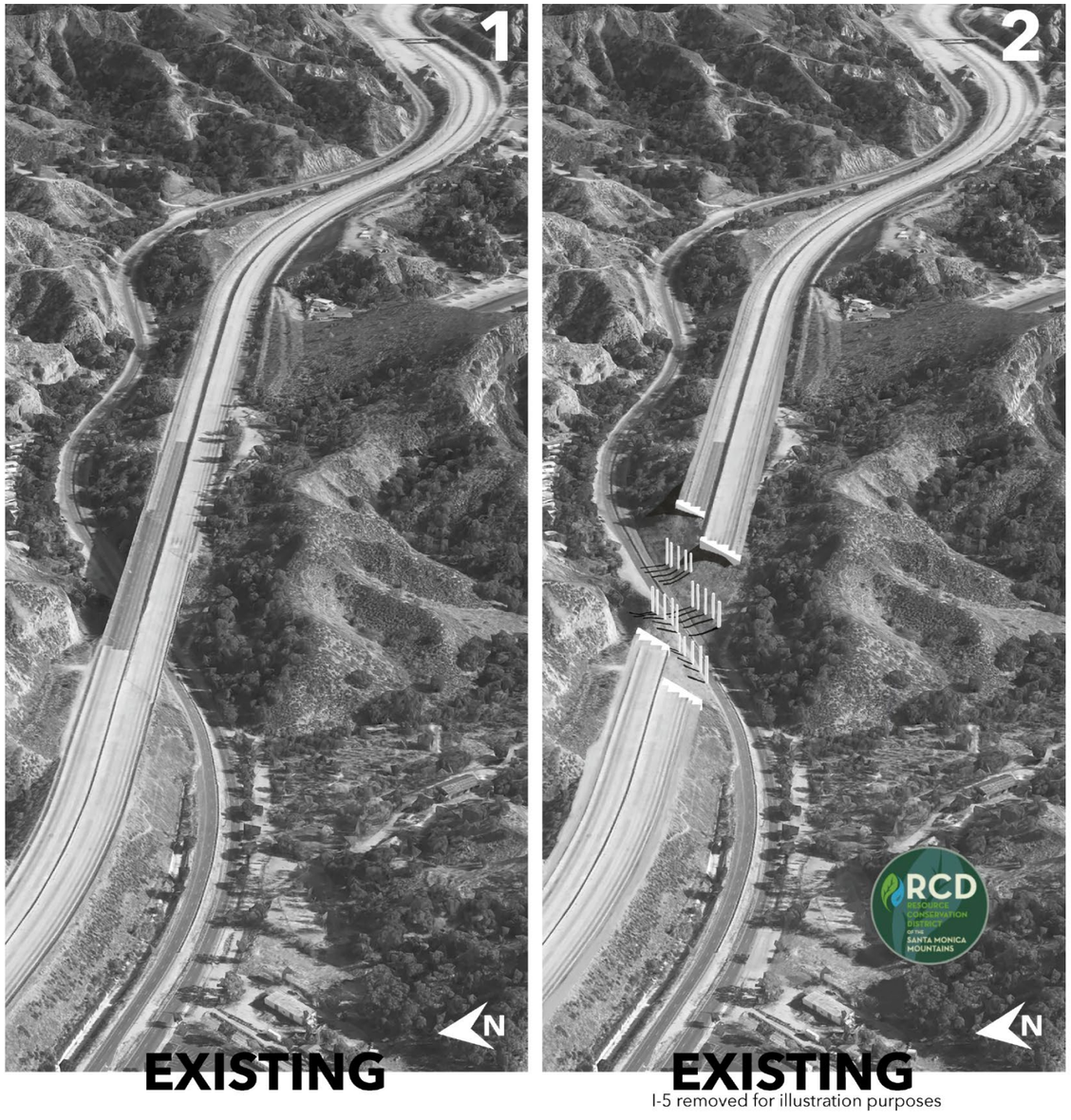


Figure 48. Existing conditions at Old Road X (left) and existing conditions with I-5 removed for visual purposes (right)

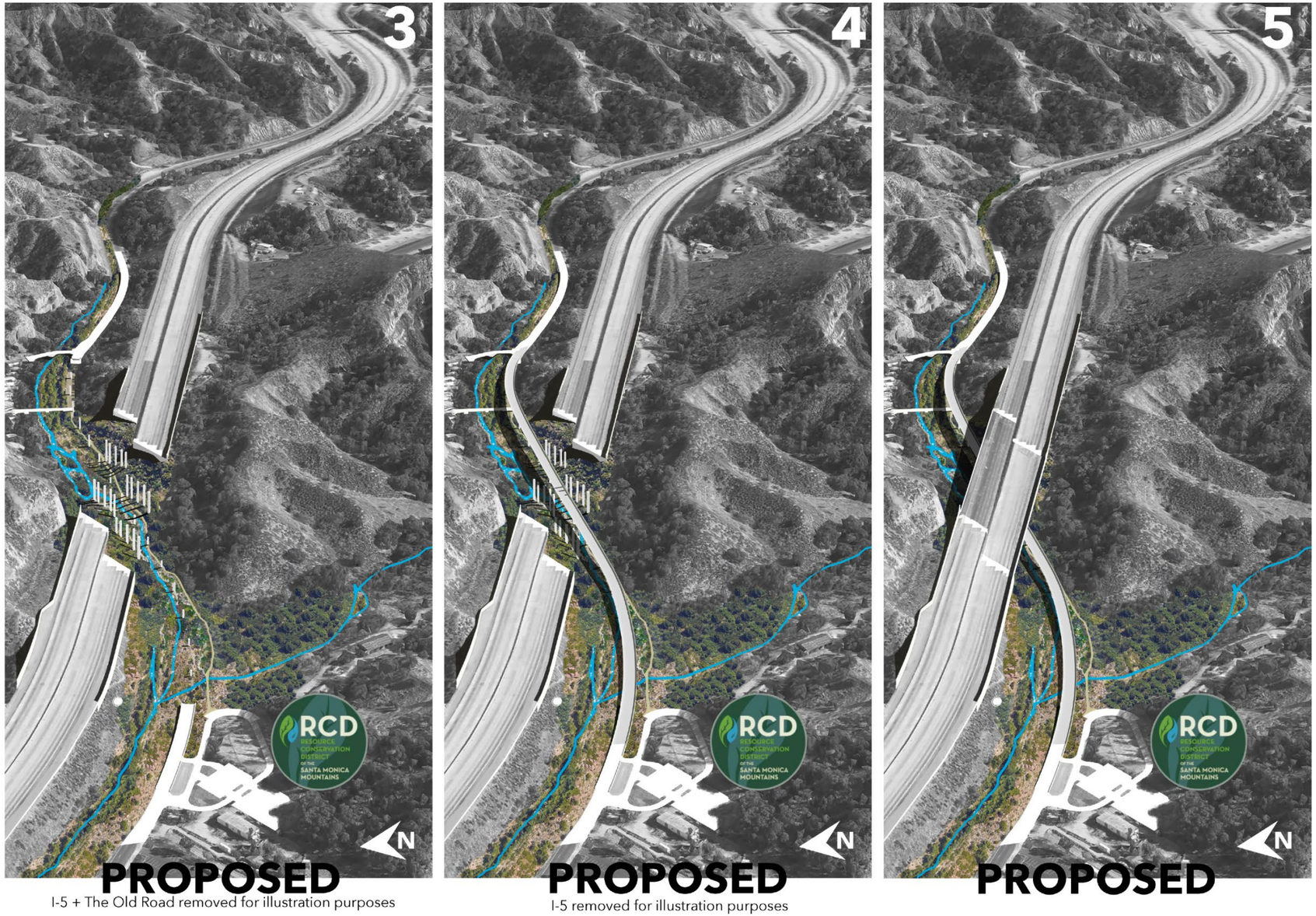


Figure 49. Proposed conditions at Old Road X with I-5 and proposed Old Road viaduct removed for visual purposes (left), I-5 removed (center), and proposed condition without removal for visual purposes (right)

5.1.2 Design Strategy

The site conditions suggested a unique combination of crossing elements aimed at enhancing core habitat to provide an effective wildlife passage. The design strategy proposes moving, narrowing, and lifting the Old Road into a viaduct, daylighting and restoring a reach of the South Fork of the Santa Clara River (South Fork), and widening the area of quality riparian habitat to encompass the confluence of several streams.

This design alternative proposes to narrow and elevate ~1,800 feet of a four-lane section of The Old Road highway to two lanes beginning at East Canyon Park and extending to the existing two-lane section from Weldon Canyon to the south within its minimum clearance from the underside of the freeway decks above, allowing for restoration of the stream channel and adjacent riparian habitat below. The approach would allow for up to 40 feet of clearance from the stream below to the underside of the viaduct.

The elevated viaduct would result in a broad confluence area connecting the East Canyon tributary with the restored channel of the South Fork, resulting in a broad floodplain uninterrupted by roadways, other than a single permeable lane for maintenance and emergency egress from Crescent Valley in case of evacuation (which has been all too frequent due to wildfire threat). This route would primarily serve as a hiking trail during the day, and wildlife trail at night. The habitat would only be interrupted by widely spaced column structures, rather than the current four lanes and median strip of the current Old Road.

South of the viaduct section heading toward the Pass and current two-lane section, the Old Road would maintain two-lane width (instead of the current four-lane width in this section) and be realigned to the western half of its former graded surface area. This will allow restoration of buffering habitat adjacent to the mature oaks that have established on the constrained banks of the stream and for a restored riparian bench, resulting in a much wider natural habitat cross-section for wildlife passage in the north-south direction. This enhanced riparian passage zone is proposed to extend north to intersect a number of east-side tributaries and lateral passage slopes that would allow passage into the core habitat of the 'Y' area—the open space habitats between I-5 and SR-14. Moving from west to east from East Canyon, the first of these is found between the freeway and Crescent Valley community, a second passage at the first tributary entering the South Fork just north of Crescent Valley, and finally (and most favorably) through existing oak woodland slopes in the vicinity of the Newhall Pass Open Space Trailhead. To the north of the viaduct along the existing channelized section of the South Fork, another connection opportunity exists at an existing culvert under I-5 that currently supports wildlife passage as documented by NPS field monitoring.

Placemaking opportunity exists within the unique structure and function of the underpass viaduct, as well as in the connection it offers the Crescent Valley community via recreational passage to East Canyon trailhead and to East Canyon recreational users via a trail that could connect ultimately to the Newhall Pass Open Space system east of the South Fork. The Old Road X alternative also contributes to the "Crest to Coast" concept/trail– a goal of the managers of the Santa Clarita Open Space preserve. The design strategy for improving recreational access includes relocating the parking that currently blocks East Canyon and adding more parking capacity. Onsite fill from the stream restoration under I-5 could be added and compacted to achieve favorable gradients to the north edge of the maximum project extent.

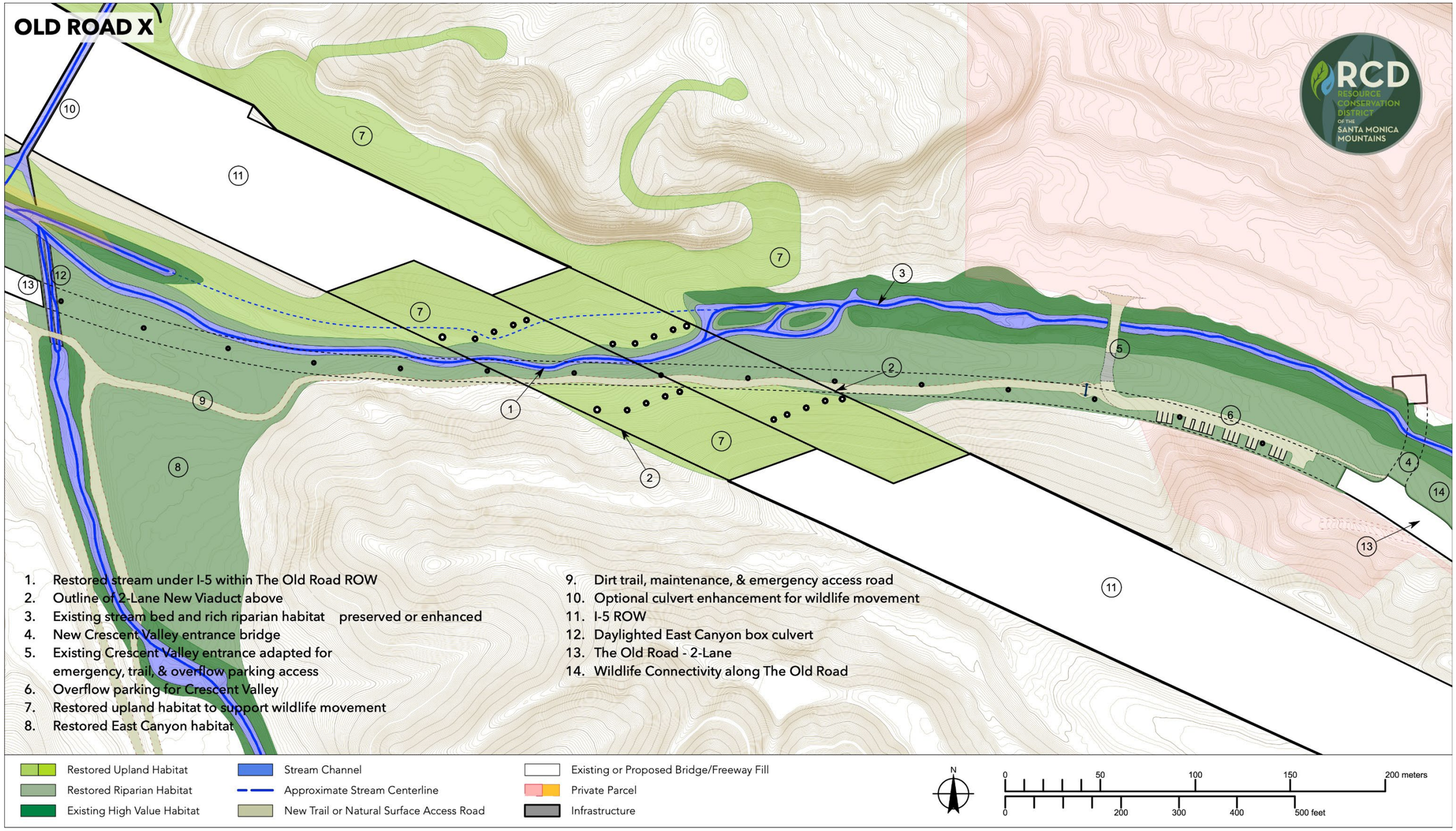


Figure 50. Plan view of Old Road X alternative preliminary crossing design.

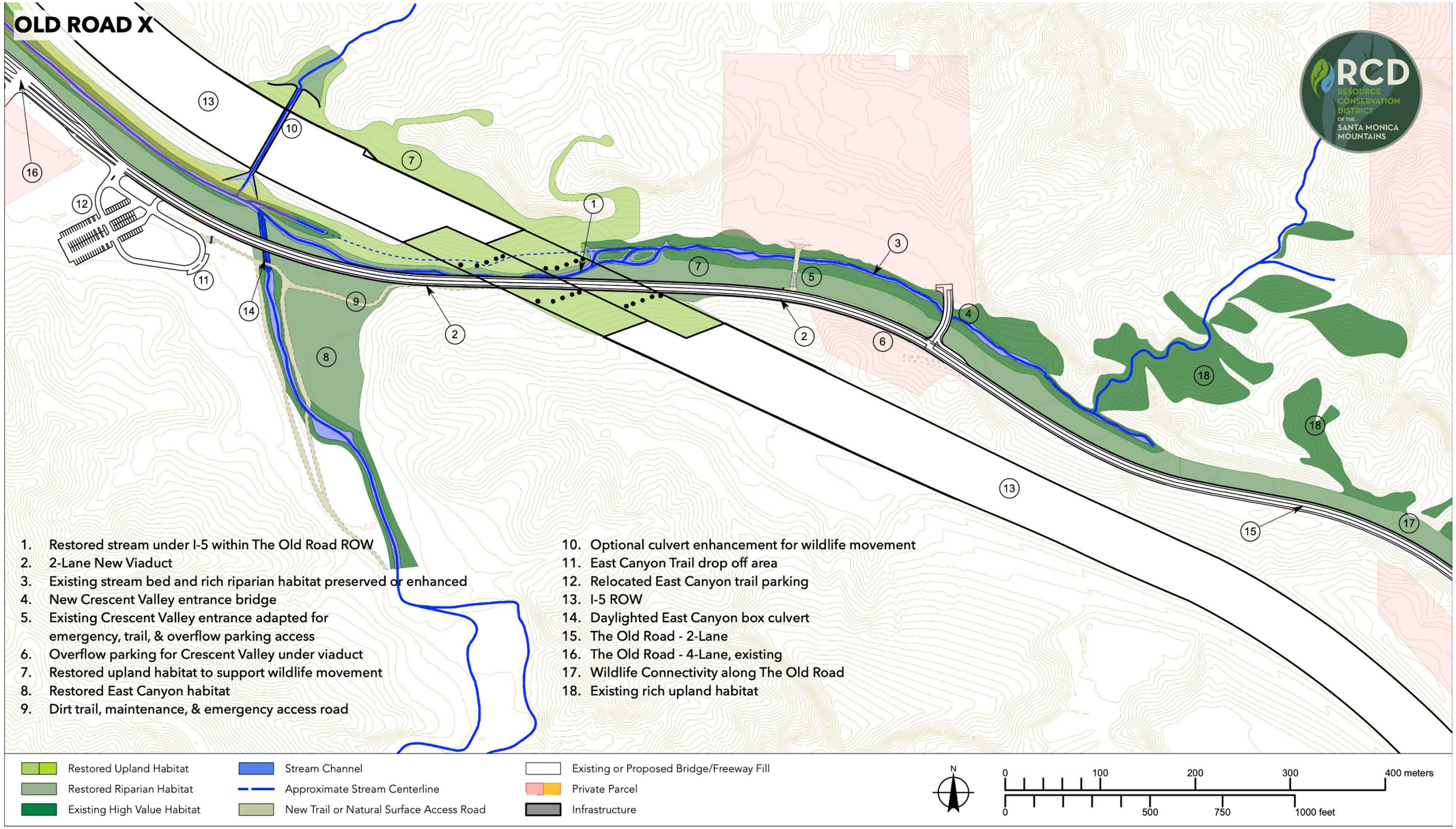


Figure 51. Plan view of Old Road X alternative preliminary crossing design with broader site context.

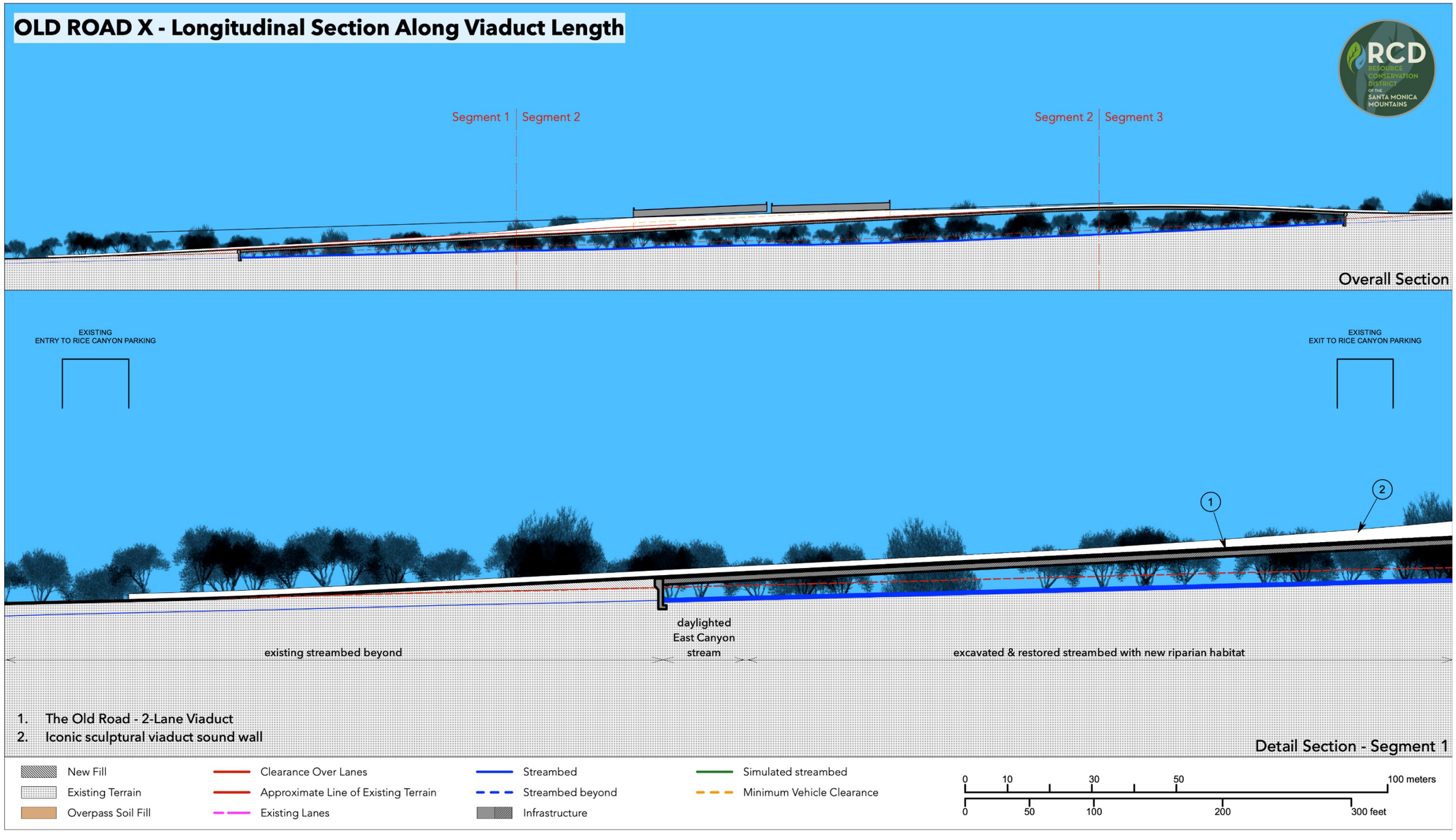


Figure 52. Cross-section of Old Road X alternative preliminary crossing design, Segment 1.

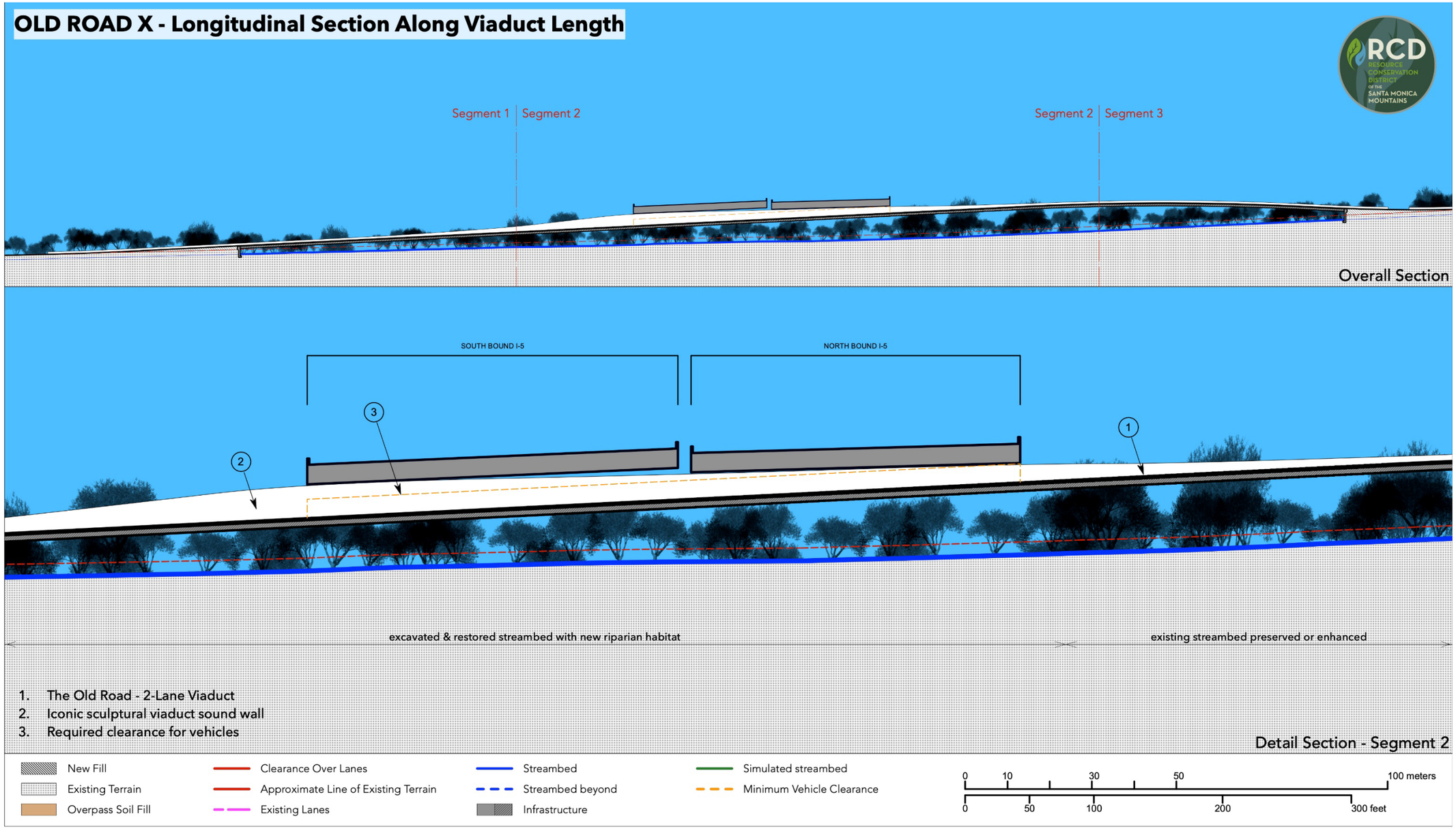


Figure 53. Cross-section of Old Road X alternative preliminary crossing design, Segment 2.

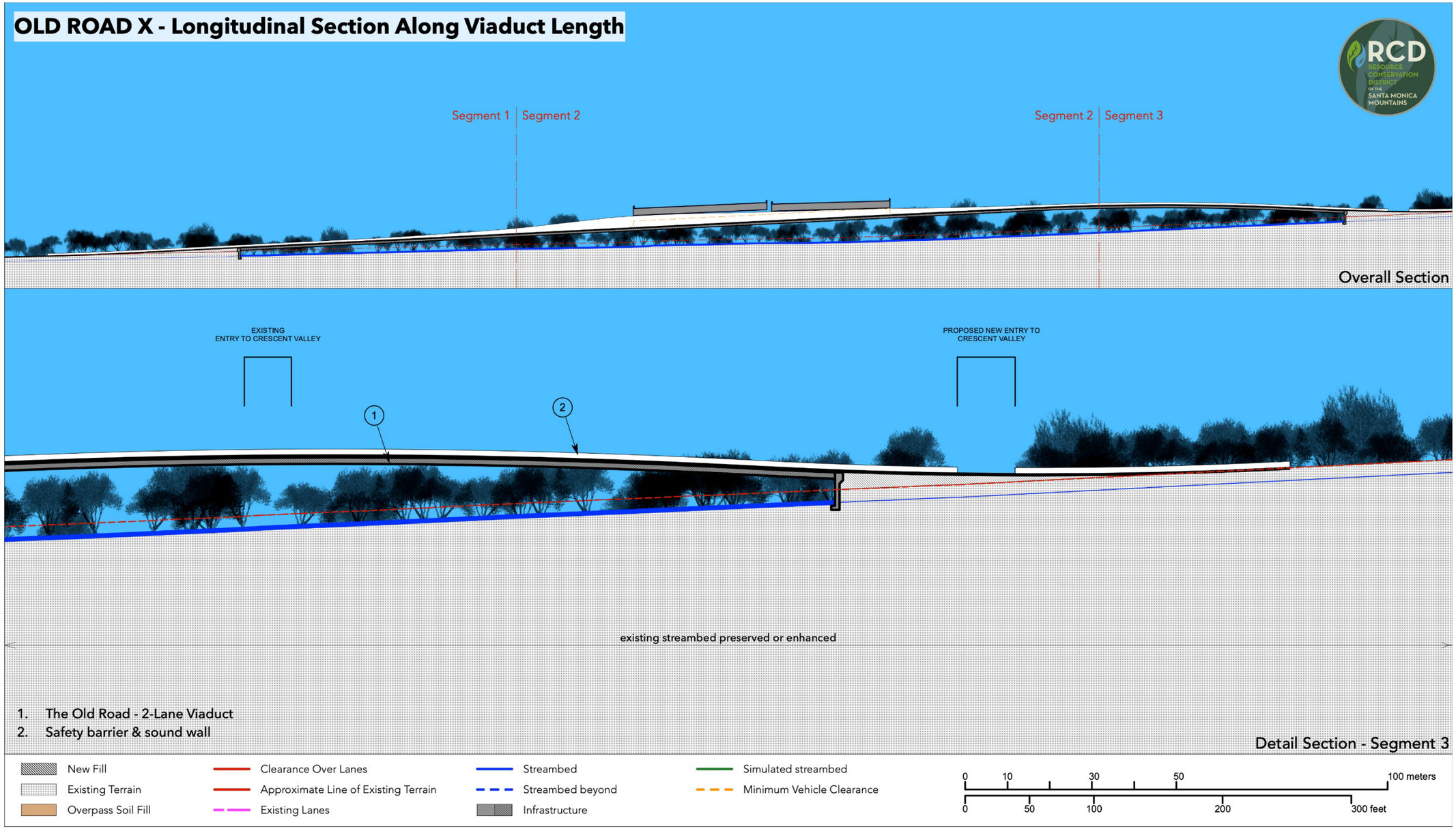


Figure 54. Cross-section of Old Road X alternative preliminary crossing design, Segment 3.

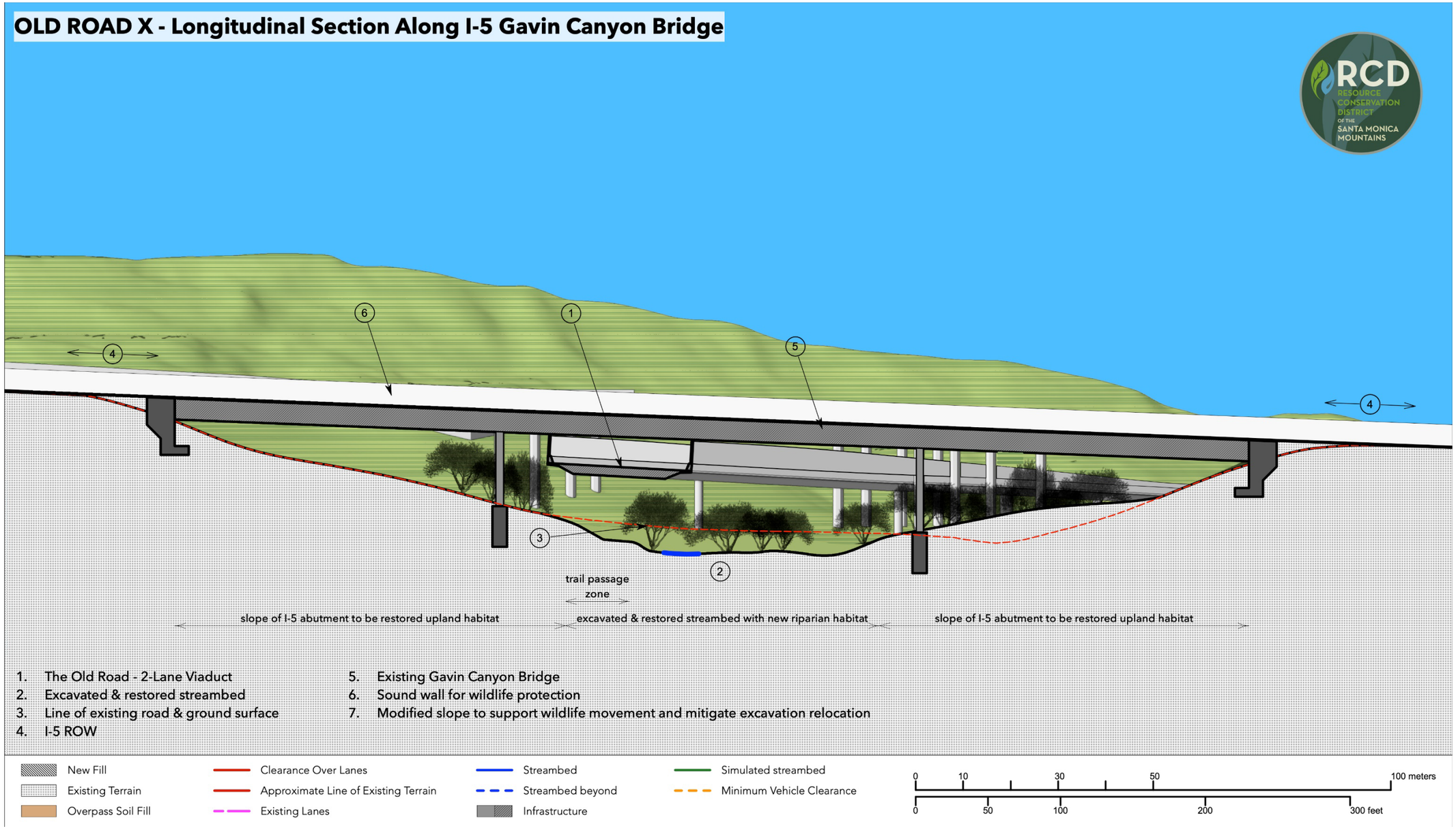


Figure 55. Cross-section of Old Road X alternative preliminary crossing design along Gavin Canyon bridge.

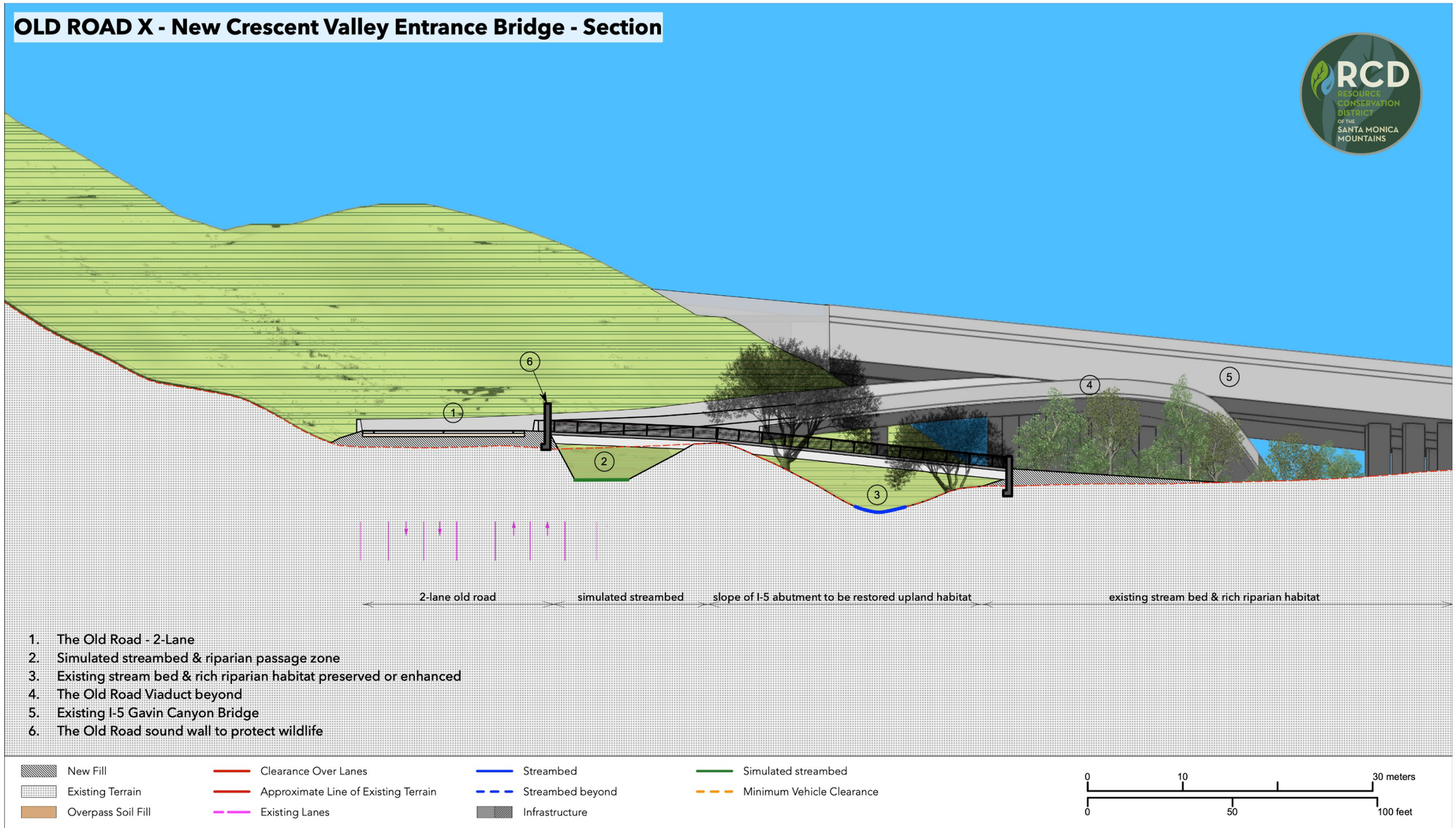


Figure 56. Cross-section of Old Road X alternative preliminary crossing design at new Crescent Valley entrance bridge.

Criteria performance rankings for this alternative are as follows:

5.1.3 Ecological Criteria

Table 1. Ecological criteria for Old Road X crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Old Road X Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Better	Based on modeling, Omniscape suggests Old Road X to be the best riparian habitat connection along I-5 which is good for mountain lions. Connections to the underpass are somewhat constrained from the east due to vegetation conditions, slopes, and development, which is why this location did not receive "best" ranking.
Riparian	Best	Omniscape modeling suggests Old Road X to be the best riparian habitat on I-5 in the study area.
Montane	Good	Montane species are nearby but not abundant in immediate surroundings. Riparian underpasses are more suitable for montane hardwood vegetation types than montane conifer types which prefer steeper northerly-facing slopes.
Oak woodland	Best	Omniscape results suggest excellent connectivity of oak woodlands due to high quality patches of this vegetation type on both sides of I-5 in this location.
Scrub and grasslands	Good	Riparian habitat is emphasized here, but there are patches of scrub nearby, especially to the north (site has much more scrub nearby than Weldon North).
Watershed connectivity	Best	Connects and enhances the South Fork of the Santa Clara, a key watershed in the region.
Wildlife collision records	Better	A black bear collision record on August 3, 2017, 14:09.
Overall Ecological	Best	Best for riparian connectivity along I-5 and provides relatively good connectivity for all other focal habitats. See discussion below.

Ecological assessment discussion

Despite being constrained by the concrete barriers of I-5 and the Old Road, mature trees and high-quality habitat have established in pockets adjacent to both major transportation corridors. Although the Old Road filled most of the riparian corridor and constrained the South Fork to the extreme eastern edge on one side of its former valley, mature oaks now occupy the steep fill slopes on the new bank of the South Fork. Therefore, restoring the former bank gradients is not advisable or possible, so instead the Project proposes to create a riparian adjacent area—effectively a large swale next to the embankment.

Citizen knowledge, a National Park Service study, and road collision data further support the idea that Old Road X is a utilized, but currently unsafe, wildlife passage point (NPS 2023). A black bear was hit here but survived (August 3, 2017, 14:09). This crossing offers the best

riparian connection of all the crossing sites considered and could restore 1,500 linear feet of stream channel and create a broad adjacent riparian habitat where currently roads and graded shoulders exist. While native fish species are not currently documented in this portion of the South Fork, the proposed high-quality, but typically ephemeral in most years, aquatic connection would provide an additional quarter mile of connected habitat if watershed-wide native fish recovery efforts eventually include the South Fork. Along the proposed habitat extension along Old Road to the south of the viaduct, montane habitat can be reached, and scrub habitats are found close by.

5.1.4 Permanence Criteria

Table 2. Permanence criteria for Old Road X crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Old Road X Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Good	Crescent Valley community limits some connectivity to the east, but it can be designed around.
Wildfire risk to habitat	Good	Moderate risk of overburning on the east side and risk exists nearby on west side but not close enough to be penalized in the scoring process.
Climate refuge value	Good	Includes a riparian corridor and is near higher-elevation northerly aspect areas with montane conifer habitat.
Environmental co-benefit lift potential	Good	Proposed lane reductions along Old Road, safety improvements, creek daylighting of the South Fork, and restored riparian connection between the South Fork and East Canyon, all confer benefits beyond the immediate crossing structure component of the project.
Overall Permanence	Good	See discussion below.

Permanence assessment discussion
On the west side of I-5, East Canyon was protected and preserved as open space with high-quality riparian habitat leading into core habitat areas in the Santa Susana Mountains. A feasible passage for wildlife past the Crescent Valley community (a concentrated nodal development of modular mobile homes to the north) bolstered the site's potential and evidence suggests it is not preventing wildlife from moving through the area. Given Old Road X is a riparian corridor shaded by I-5 and elevated Old Road, it offers good climate refuge value.

5.1.5 Constructability Criteria

Geological and Geotechnical	**Average**
The Old Road X project is situated approximately 0.5 miles from the Northridge blind thrust fault zone, indicating a moderate to strong potential for earthquake shaking. The proposed location site has natural slopes composed of sedimentary bedrock and a moderate to high probability of landslides in the event of an earthquake. The potential for corrosive soils is high due to high sulfate concentrations. The proposed location site is considered to have low to moderate probability for landslides and expansive soils. The site is considered to have low probability for liquefaction, subsidence/settlement, fault rupture, and rippability risk. Soil conditions consist of stiff to hard clayey soils and deep foundations are recommended for this location.	

Traffic Impacts	**Average**
The construction of the overpassing will be executed in two construction stages and result in short-term traffic impacts. The project will ensure at least one lane of traffic is available in each direction on The Old Road during the construction of the viaduct. Stage 1 involves maintaining two lanes of traffic on The Old Road while constructing the viaduct on half of the existing road. In Stage 2, traffic is diverted to the fully constructed viaduct. The long-term traffic impacts of constructing an overpassing structure entail minimal disruption to I-5 traffic, as all construction activities will occur beneath I-5 Gavin Canyon Bridge. However, adjacent properties may experience impacts at their driveways and parking lots, potentially necessitating driveway realignments. The Old Road X alternative proposes a reduction in lanes, and a reassessment of the existing 55- mph speed limit may be warranted.	

Approaches and Slopes	**Most suitable**
Since approach slopes are an important consideration for overcrossings, a key advantage to Old Road X is there is no disruption to the surface of habitat other than re-creation of naturalized stream bed. Minimal gradients, a low quantity of cut/fill, good orientation, and good habitat potential are the slope evaluation criteria and so contributed to Old Road X receiving the highest evaluation for Approaches and Slopes on I-5 in the Study Area.	

Utilities	**Least suitable**
Existing utilities include underground gas, water, communication duct banks, 4–16" oil pipes, and overhead street lighting along The Old Road. Coordination for the relocation of these utilities will be needed.	

Environmental and Remediation Need	**Average**
Environmental impacts are associated with the proposed location. The crossing site will require environmental clearance for the restoration of a creek. The level of environmental documentation required is contingent upon the possibility of utilizing the SERP (Statutory Exemption for Restoration Projects (SERP) and the identification of potential impacts determined through technical studies. Impacts from the creek restoration will most likely be self-mitigating. Cultural resources may also be present.	

Regulatory Complexity	**Average**
Restoration of a creek will require permitting from the US Army Corps of Engineers (USACE), California Department of Fish and Wildlife (CDFW), and Regional Water Quality Control Board (RWQCB). While the anticipated impacts on I-5 are expected to be minimal, coordination and road permitting will be necessary with Los Angeles County and Caltrans to work on The Old Road.	

Construction Complexity	**Marginal**
This location involves reconfiguring The Old Road and adjacent driveways and will require a new creek bridge structure at the mobile home community and an at-grade driveway at the north parking lot. Construction access is limited under I-5, and Old Road traffic will be maintained. Construction staging and access are available on The Old Road.	

Cost	**Average**
Item	**Cost**
Bridge Structural Cost	$34,870,000
Roadway Cost/Drainage/Grading	$4,755000
Mobilization, Construction Management, Design	$13,870,000
Contingency	$9,910,000
Total (rounded)	$63,500,000

Overall Constructability	**Average**

5.2 Weldon North (I-5 overcrossing north of Weldon Bridge)



Figure 57. Weldon North crossing location, looking west. Photo credit: Stillwater Sciences.

5.2.1 Description

The Weldon North alternative, named after its location north of the existing Weldon Bridge, presents a large, landscape-scale overcrossing opportunity. Weldon North is located at I-5 PM R46.82. This alternative has two possible configurations. The proposed configuration shown in Figures 59, 60, and 61 includes a prefabricated arch overcrossing at The Old Road on the north end, and a precast concrete girder overcrossing structure at I-5 that spans over Coltrane Ave at the south end. The proposed configuration shown in Figures 62, 63, and 64includes the same precast concrete girder structure overcrossing at I-5 and a prefabricated arch overcrossing at The Old Road on the north end but does not span over Coltrane Ave. Both proposed overcrossing design alternatives serve as pathways for wildlife.

The existing Old Road consists of a two-lane road with one lane of traffic in each direction at the crossing location and transitions to a four-lane road about 500 feet west of the crossing location. Coltrane Avenue consists of a two-lane road with one lane of traffic in each direction. The proposed crossing site is located at Newhall Pass Trailhead on Coltrane Avenue and is about 340 feet east of a soils manufacturing yard gravel driveway. Weldon Canyon Road Bridge is being reconstructed about 800 feet south of the site. The Old Road centerline alignment is proposed to be shifted south by approximately 60 feet. Rankings provided are for the configuration that expands over Coltrane Ave (Figures 59, 60, and 61) only.

WELDON NORTH
CROSSING ALTERNATIVE

Illustration 1 (left) shows the existing conditions at crossing site alternative Weldon North.

Illustration 2 (right) shows the site post project implementation, with the bridge deck spanning both The Old Road and Coltrane Avenue.

The project's restoration extends beyond the immediate bridge and connects to draws along The Old Road. The narrowing of The Old Road from four lanes down to two lanes makes this essential habitat restoration possible. The option to create a grade level crossing at Coltrane Avenue instead is shown in the plan and section diagrams.

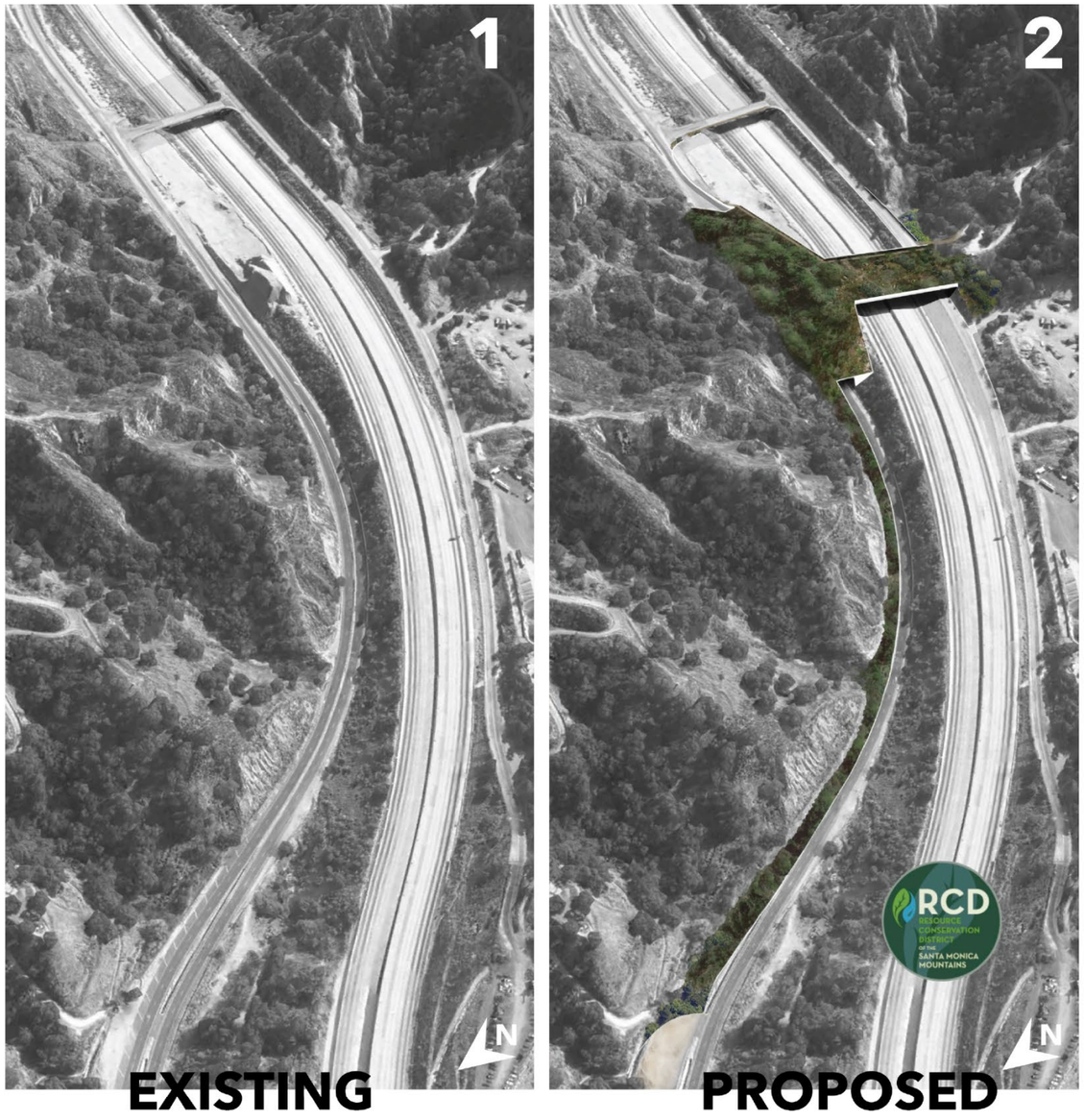


Figure 58. Existing conditions at Weldon North (left) and existing conditions with I-5 removed for visual purposes (right)

5.2.2 Design Strategy

The design strategy involves a comprehensive deck spanning Coltrane Avenue, I-5, and Old Road. The site's wildfire frequency is relatively similar to natural and offers excellent climate refuge potential given its capacity to support montane species with transitional upland and chaparral habitat. Shallower soils on the main deck hosting shrub, grassland, and chaparral species connect to deeper soils hosting woodland/montane species on either side of the span. Narrowing the Old Road and retaining into the slope at the deck's northern terminus results in a tunnel spanning hundreds of feet. The east-facing slopes are well suited for oak woodland restoration and connect to existing mature oak stands northeast of the main deck that offer clear passage to the interior of the 'Y'. An extension of the project along the northern edge of Old Road links the main deck crossing to a bowl of extensive oak woodland slopes, to a further series of connective habitats in the vicinity of the Newhall Pass Open Space Trailhead (see Figure 59, callout 6). However, cut faces and steep embankments along Old Road to the north limit the average width of the connecting habitat restoration of the South Fork Santa Clara River, and could bottleneck movement in that direction. The southern terminus of the main deck span also requires deep-fill areas in which oak- and toyon-associated woodland may be enhanced. Sound walls along both sides of the main deck, combined with habitat that promotes wildlife separation, would buffer human noise and light pollution.

The project also involves grading and altering the existing motorway trail to facilitate wildlife access to the gravel wildlife pathway feature embedded in the existing Weldon Bridge. The proposed design narrows appropriately to direct wildlife away from the adjacent private property abutting the southwestern corner of the main span. Approach slopes were considered in detail to ensure other necessary easements and trail access is maintained or enhanced.

Opportunities exist to phase construction over time or altogether modify the design to a grade-level crossing at Coltrane Avenue. The latter requires maximum signage and strategies protect wildlife, such as wildlife crossing lights for traffic.

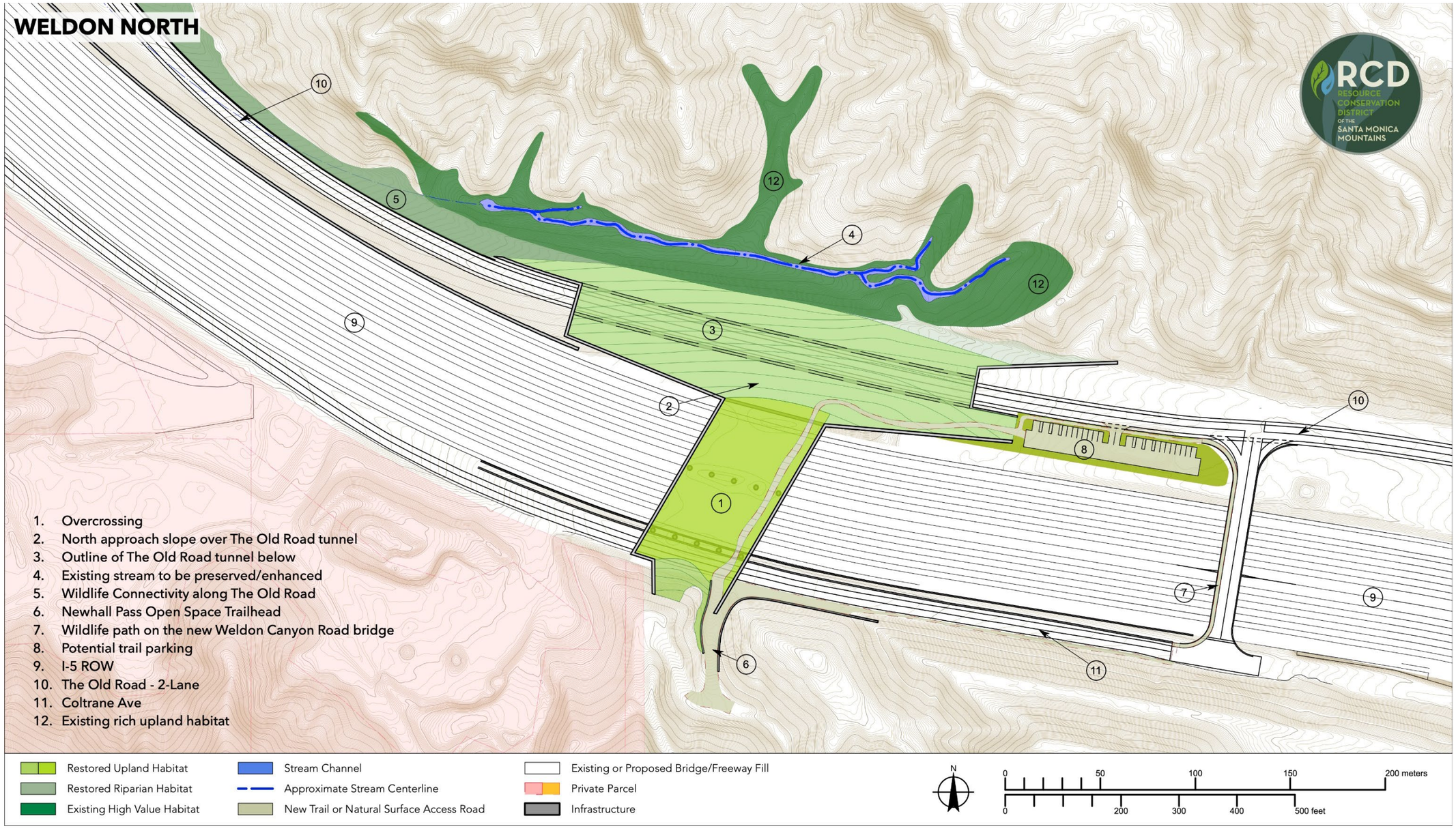


Figure 59. Plan view of Weldon North alternative (with Coltrane Ave over-crossing) preliminary crossing design.

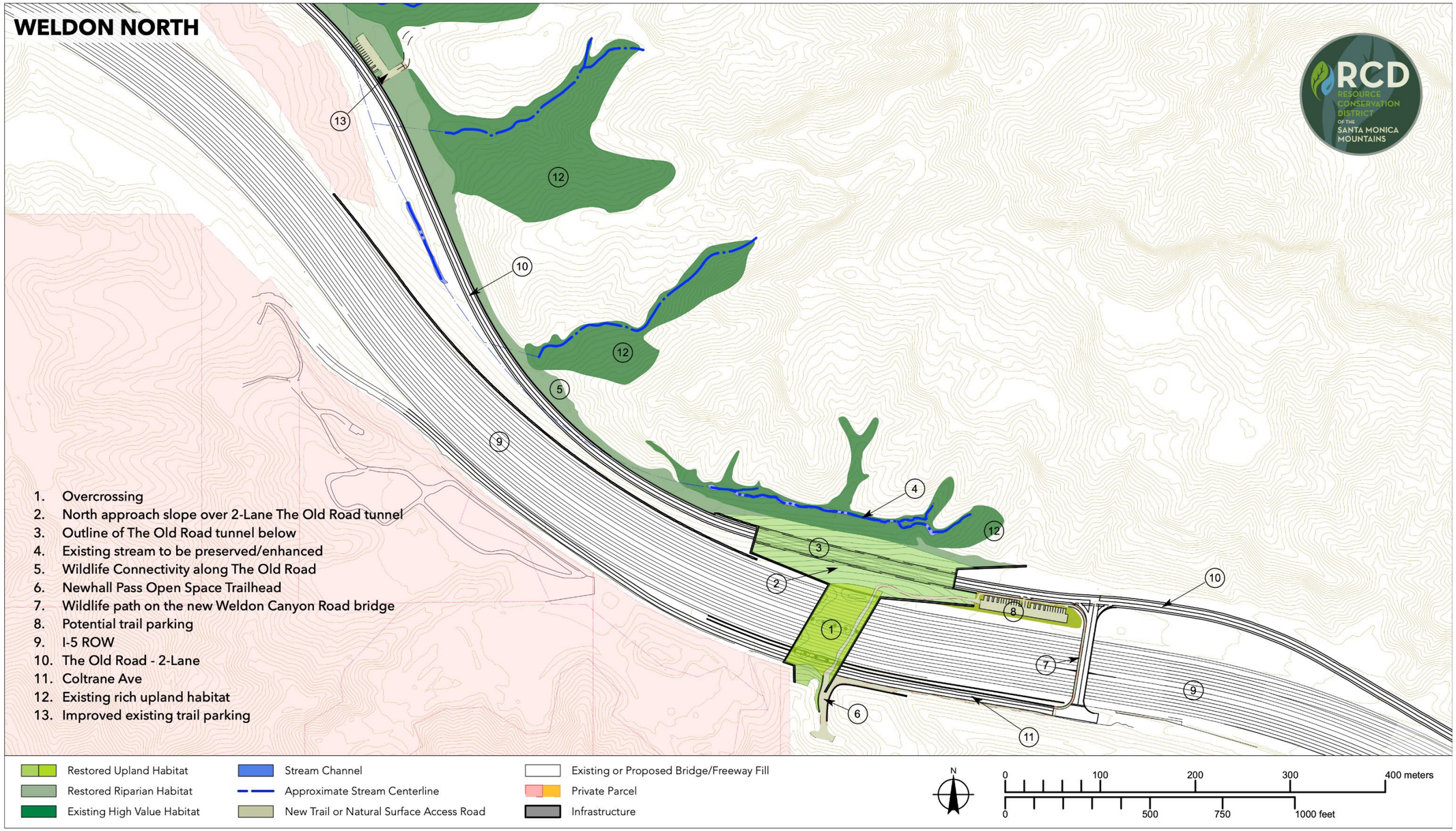


Figure 60. Plan view of Weldon North alternative (with Coltrane Ave over-crossing) preliminary crossing design with broader site context.

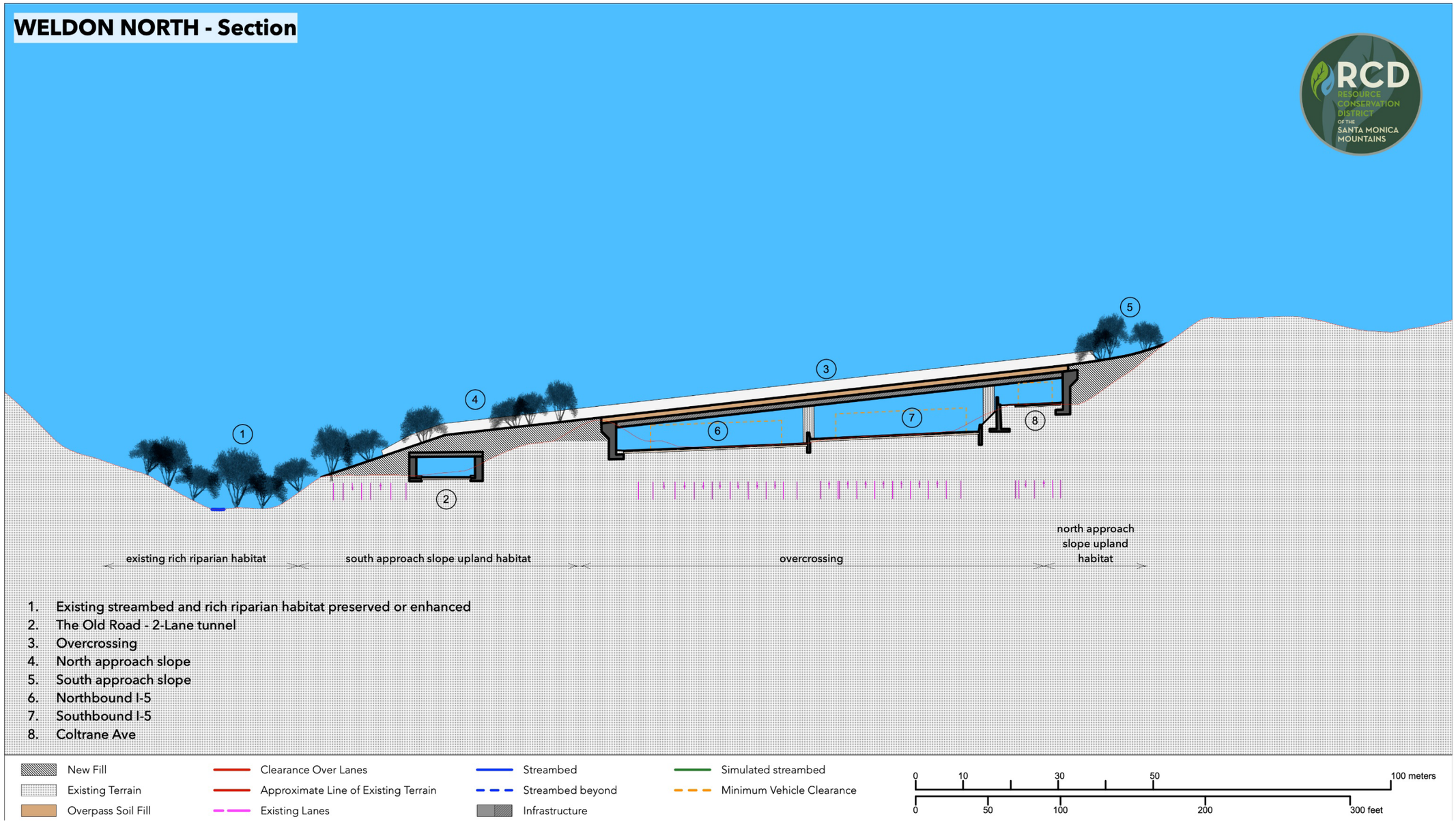


Figure 61. Cross-section of Weldon North alternative (with Coltrane Ave over-crossing) preliminary crossing design.

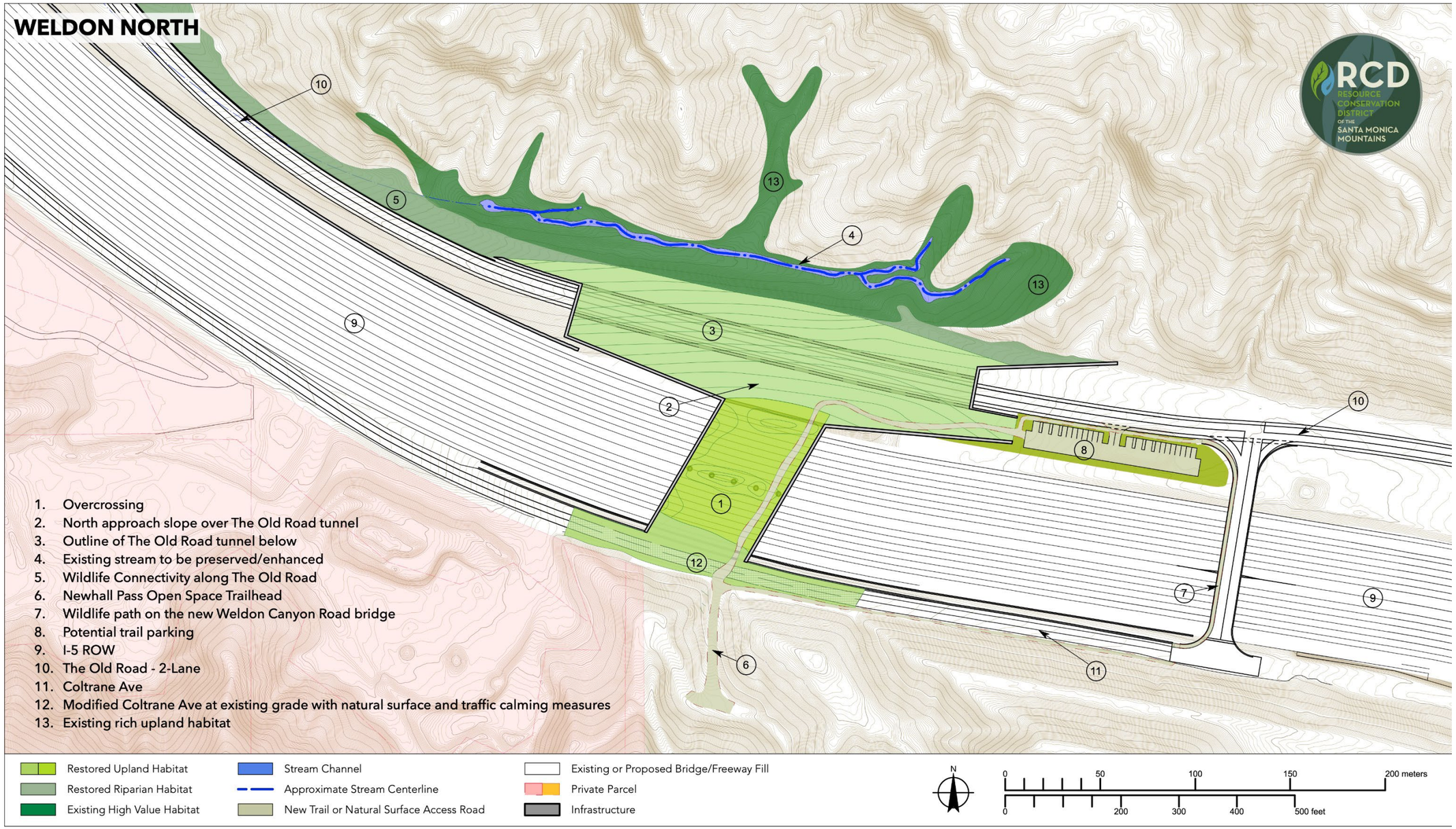


Figure 62. Plan view of Weldon North alternative (with Coltrane Ave at-grade crossing) preliminary crossing design.

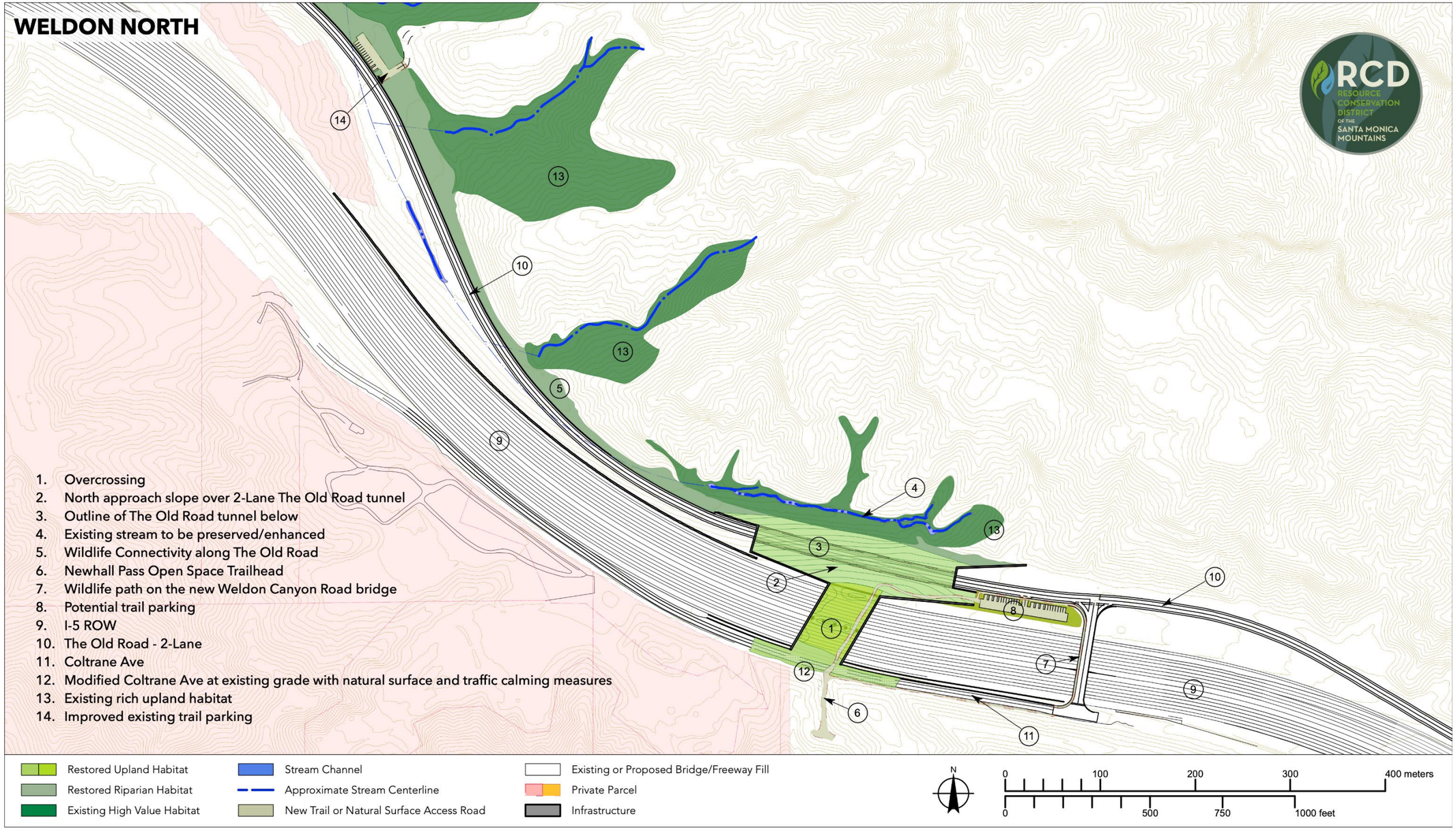


Figure 63. Plan view of Weldon North alternative (with Coltrane Ave at- grade crossing) preliminary crossing design with broader site context.

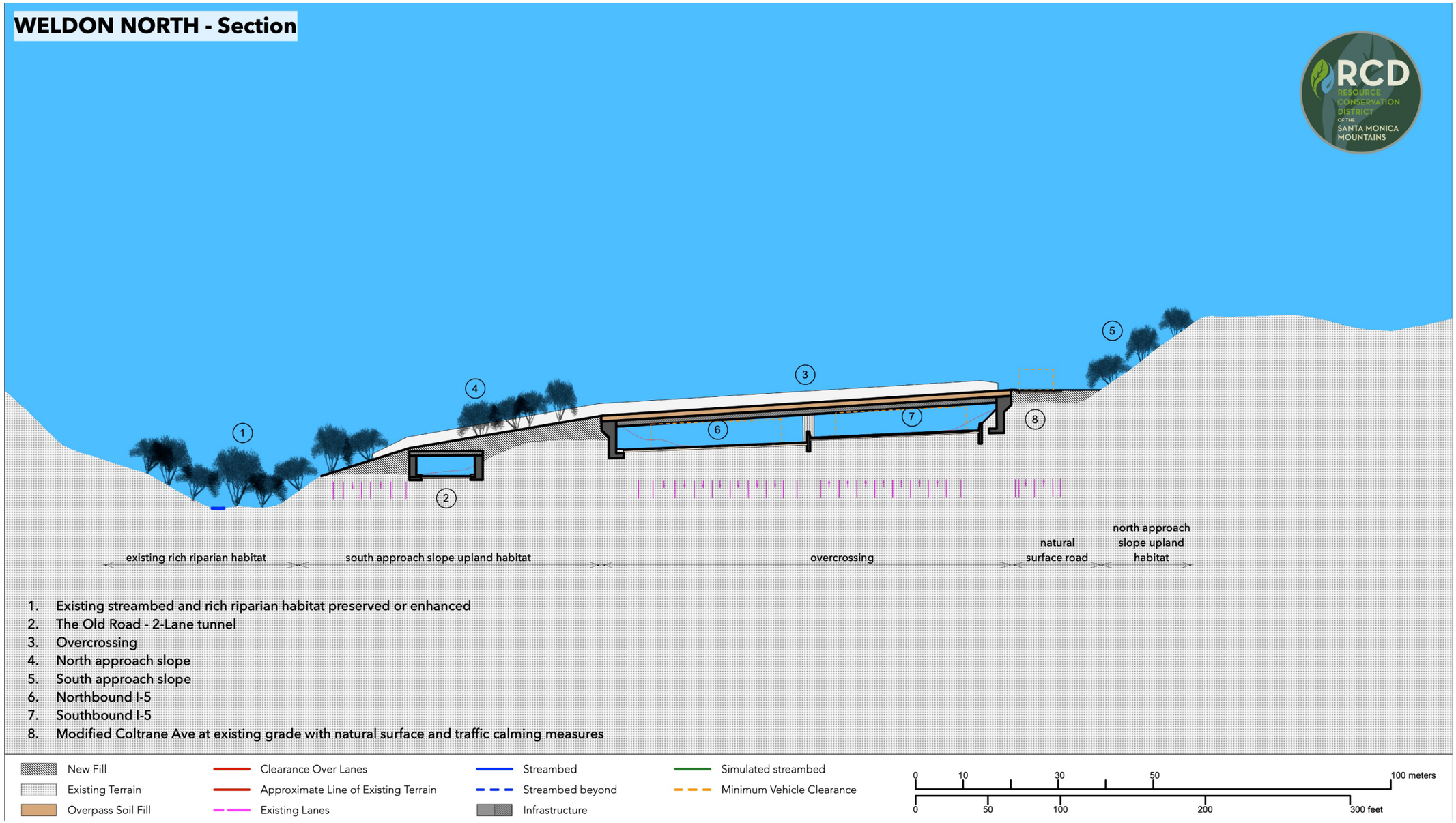


Figure 64. Cross-section of Weldon North alternative (with Coltrane Ave at-grade crossing) preliminary crossing design..

5.2.3 Ecological Criteria

Table 3. Ecological criteria for Weldon North crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Weldon North Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Best	High quality habitat on both sides is confirmed by modeling that suggests excellent connectivity opportunities. NPS collar data shows extensive mountain lion activity to the west.
Riparian	Good	Quality riparian habitat exists nearby to the east, but crossing won't include riparian habitat directly.
Montane	Best	Best crossing modeled on I-5 for montane habitat connectivity. Extensive existing habitat is adjacent to the west. Crossing structure could potentially include montane plant species due to east aspect.
Oak woodland	Best	Best location modeled for oak woodland connectivity.
Scrub and grasslands	Marginal	Modeling suggests that connectivity is limited due to little scrub habitat adjacent to the west. However, benefits to scrub species may still occur, particularly for those that favor upland conditions compared to the more riparian conditions at the Old Road X alternative.
Watershed connectivity	Better	Adjacent to North Fork Santa Clara and at the watershed boundary of the LA River and the Santa Clara River watersheds.
Wildlife collision records	Better	Deer collisions have been recorded nearby.
Overall Ecological	Best	Best for montane and mountain lion connectivity along I-5. See discussion below.

Ecological assessment discussion

Omniscape habitat and species connectivity modeling, along with road collision data and mountain lion collar data from NPS, confirmed the site's ecological potential. The location offers the best oak woodland connection and the best possibility for hosting montane habitat adjacent to and possibly on the crossing itself; on I-5, this crossing is the best for montane habitat. A cluster of deer collisions nearby suggests crossing attempts are being made. Mountain lion collar data from NPS west of the site suggests strong potential for mountain lion use. This location was also the preferred location for a crossing in the *DRAFT LA Metro and Caltrans Recommendations for Improved Wildlife Permeability* (National Park Service 2023).

5.2.4 Permanence Criteria

Table 4. Permanence criteria for Weldon North crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Weldon North Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Good	The small area of private land on the west can be designed around and is not a major impact to connectivity.
Wildfire risk to habitat	Excellent	Generally, both sides experience a natural fire regime. Nearby moderate risk exists but site was not penalized in the evaluation process.
Climate refuge value	Excellent	Montane conifer adjacent and riparian adjacent provide the best climate refuge value of all crossing sites studied.
Environmental co-benefit lift potential	Excellent	Restoration of Caltrans laydown yard east of I-5 may provide significant ecological benefits. High visibility of overcrossing structure from I-5 raises conservation awareness.
Overall Permanence	Excellent	Best overall permanence ranking of all crossing locations studied. See discussion below.

Permanence assessment discussion
Moderate slopes and protected land to the north (Gateway Ranch Open Space) and south (MRCA, Michael D Antonovich Open Space managed by County of Los Angeles) earmarked the site as a possible crossing location in NPS (2023). The small area of private land on the west can be designed around and does not impede connectivity potential. Generally, both sides of the crossing location experience a natural fire regime and nearby risk is moderate but will not categorically impact connectivity. The site includes existing montane conifer woodland adjacent to the west and riparian adjacent to the east giving it the highest possible climate refuge potential. Its environmental co-benefit/lift includes restoration of a Caltrans laydown yard and the visibility of the overcrossing structure raising conservation awareness.

5.2.5 Constructability Criteria

Geological and Geotechnical	**Good**
Weldon North is situated between the Northridge blind thrust fault zone (~0.6 miles) and the Sierra Madre fault zone (~0.8 miles), indicating moderate to strong potential for earthquake shaking. The proposed location site has natural slopes composed of sedimentary bedrock and a moderate to high probability of landslides in the event of an earthquake. The proposed location site is considered to have a low to moderate probability of corrosive soils risks and a low probability of liquefaction, expansive soils, land subsidence/settlement, fault rupture, and rippability risks. Since shallow bedrock is anticipated at the site, shallow foundation is feasible at this location.	

Traffic Impacts	**Marginal**

Detours will not be required at proposed location. Temporary night closures and lane reconfigurations will be required to place the girder and deck assemblies, resulting in short-term traffic disruptions near the proposed location. However, all lanes may remain open during regular peak hours.

Long term traffic impacts may occur at The Old Road due to reduced lanes and a possible reduction of the exiting 55 mph speed limit. The proposed overcrossing structure will not affect traffic on I-5, and its implementation may potentially eliminate animal/vehicle collisions associated with wildlife crossings.

Temporary closures on Coltrane Ave will be required during the construction of the overcrossing, resulting in short-term traffic impacts near the proposed location site. Long-term traffic effects are expected to be minimal overall in the location.

Approaches and Slopes	**Good**

Weldon North has moderate to good approach slopes but requires some grading and a moderate quantity of cut/fill to the north of the main deck span. From west to east: Weldon North scores well on the slope criteria because the west side of the spanning deck can continue over both I-5 and Coltrane to intersect the approach slope from the west so little to no grading is required for access. Additionally, the east side the plane of the deck would stop at the eastern abutment at a distance that allows for a gentle fill slope to the edge of the existing riparian zone on the eastern edge of Old Road. However, for that slope to be continuous, the Old Road would need to shift towards the west, requiring retaining walls and a tunnel section to allow that slope to pass over the top. The ultimate slope condition for approach is therefore excellent but would require a significant amount of fill material to achieve that condition.

Utilities	**Good**

Existing utilities at proposed location site includes underground gas and overhead street lighting along The Old Road. Coordination with the utility owner may be required for relocation of utilities.

Environmental and Remediation Need	**Good**
Environmental impacts are associated with the proposed location site. The crossing site will require environmental clearance for the restoration of a creek. The level of environmental documentation required is contingent upon the possibility of utilizing the SERP (Statutory Exemption for Restoration Projects) and the identification of potential impacts determined through technical studies. Impacts from the creek restoration will most likely be self-mitigating. During construction of the proposed overcrossing, the process of road realignment may contribute to potential exposure to hazardous materials such as aerial deposited lead which may be present in the Caltrans staging area. Further coordination with the Department of Toxic Substance Control may be required to mitigate these impacts.	

Regulatory Complexity	**Good**
While the anticipated impacts on I-5 are expected to be minimal, coordination and road permitting will be necessary with Los Angeles County and Caltrans to work on Old Road.	

Construction Complexity	**Average**
Construction on Old Road entails road reconfiguration, necessitating a lay-down and staging area within the Caltrans right-of-way devoid of I-5 traffic disruption. Potential construction accessibility challenges may arise at this location along the south side of Coltrane Ave. The primary access point for construction activities will be situated along Old Road.	

Cost	**Marginal**
Item	**Cost**
Bridge Structural Cost	$45,830,000
Roadway Cost/Drainage/Grading	$4,170,000
Mobilization, Construction Management, Design	$17,500,000
Contingency	$12,500,000
Total (rounded)	$80,000,000

Overall Constructability	**Good**

5.3 Los Piñetos (undercrossing enhancements)

5.3.1 Description

Los Piñetos is located at SR-14 PM R25.98. This crossing site involves an existing unpaved undercrossing at SR-14 at Los Piñetos Road and a new overcrossing bridge on Sierra Highway. Los Piñetos offers a safe, grade-separated passage for wildlife, but it could benefit from further enhancement and restoration. Oil and gas companies in the past created artificial levees and channelized the end of Newhall Creek causing disruption to natural sediment transport and for the Los Piñetos underpass to accumulate sand. The road/trail at the western outlet of the underpass is also disrupting sediment transport.



Figure 65. Existing Los Piñetos undercrossing. Photo credit: Max Yasuda.

5.3.2 Design Strategy

Enhancing Los Piñetos to and constructing a new major crossing at I-5 is the most expedient option to create a connection across the entire 'Y' between the San Gabriels and the Santa Susanas. The design strategy includes excavation and improvement of the confluence at Los Piñetos within the public Caltrans right-of-way to connect Newhall Creek riparian habitat with the oak woodland to the west. The topography along Sierra Highway presents opportunities for culvert enhancements and small crossings. Sierra Highway sits on a fill ridge and mature oaks have established on its slope. The embankment is tall enough and long enough that an undercrossing that is similar to but smaller than the proposed Old Road X strategy, is also possible (not shown in figures). The width of crossings may need to be adjusted to accommodate oaks or intact riparian habitat.

The crossing options over Sierra Highway that would support Los Piñetos could also pair with crossing options further south on SR-14: Beale's Cut North and Beale's Cut South alternatives.

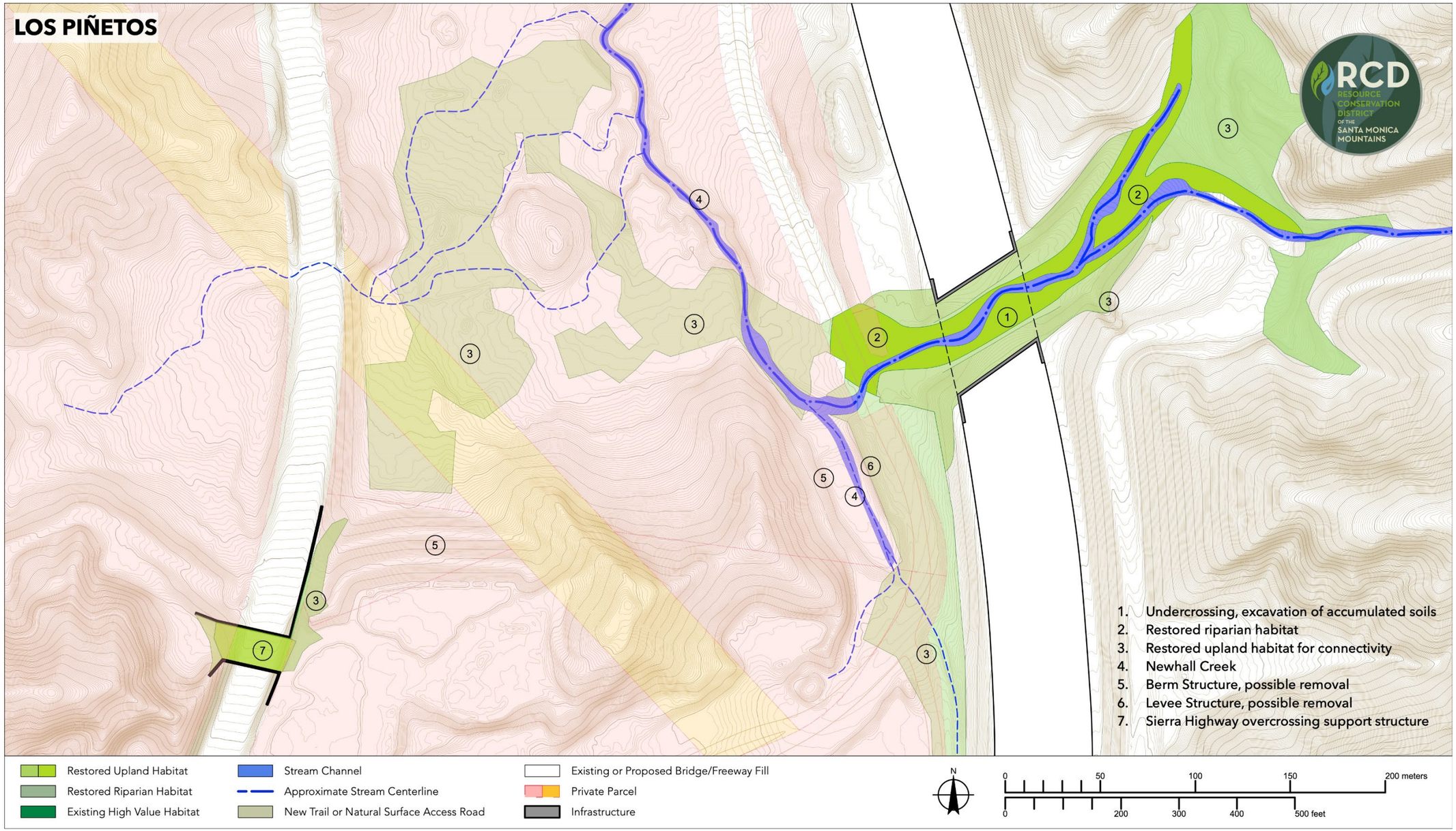


Figure 66. Plan view of Los Piñetos preliminary crossing design.

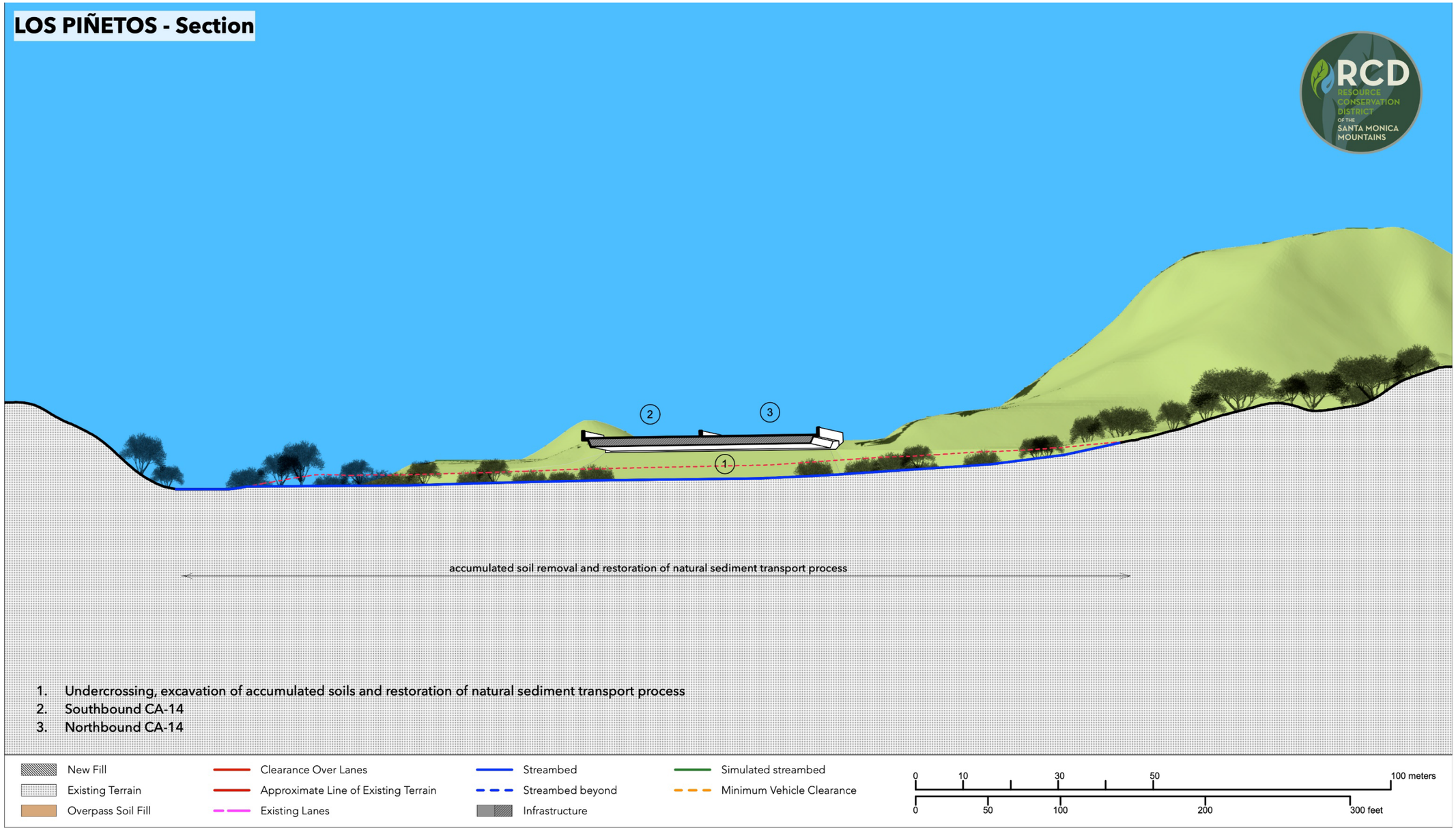


Figure 67. Cross-section of Los Piñetos alternative preliminary crossing design.

5.3.3 Ecological Criteria

Table 5. Ecological criteria for Los Piñetos crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Los Piñetos Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Good	Despite camera traps, there has been no documented mountain lion use of this existing undercrossing. Habitat to the east is marginal and steep slopes and position away from the primary ridgeline of the San Gabriels (at Beale's Cut) may make the site difficult to find or access by mountain lions.
Riparian	Good	Connects a small branch of Newhall Creek, but riparian habitat potential is limited. Poor riparian habitat on the east side due to small size of subwatershed and overburning. Creek is channelized with check dams to the west.
Montane	Good	Bigcone Douglas-fir cones were found in the wash demonstrating that there is montane habitat upstream in the watershed, however overburning is a threat to all woodland vegetation types.
Oak woodland	Good	Very good oak woodland habitat is present on private land west of the crossing. Oak woodlands on the east side may recover if overburning is controlled.
Scrub and grasslands	Best	High quality scrub habitat exists nearby on both sides. Roadrunners have been documented using the undercrossing.
Watershed connectivity	Good	The drainage small with limited ephemeral flow or riparian vegetation. It does provide a watershed connection for Newhall Creek under the SR-14.
Wildlife collision records	Better	Deer and lion collisions have been recorded nearby.
Overall Ecological	Good	See discussion below.

Ecological assessment discussion

Assuming the permanence issues are resolved, high-quality scrub in the immediate vicinity and oak woodland to the west of the Los Piñetos undercrossing offers good connecting habitat for wildlife. Coyotes, greater roadrunners, and American badgers have been documented using Los Piñetos to cross under SR-14. Other species including bobcats, mule deer, and grey foxes utilize the surrounding area (Freidin et al. 2011).Mountain lions have not been documented utilizing the passage. Omniscape modeling shows constrained habitat areas east of Los Piñetos, which may explain the lack of mountain lion activity. Similar to Old Road X, there are montane woodlands in the subwatershed providing potential montane connectivity benefits. The watershed and wash is very small and ephemeral though, and offers only limited watershed connectivity potential to the east within the broader Newhall Creek watershed.



Figure 68. American Badger using the existing Los Piñetos undercrossing.

5.3.4 Permanence Criteria

Table 6. Permanence criteria for Los Piñetos crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Los Piñetos Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Insufficient	The future of the private land on the west side of Weldon North is largely unknown
Wildfire risk to habitat	Average	Low risk of overburning on the west side, moderate to high risk on the east
Climate refuge value	Average	Riparian habitat exists nearby and there is potential for restoration. Bigcone Douglas-fir cones found in the wash indicate montane habitat in the upper part of the watershed
Environmental co-benefit lift potential	Marginal	Potential restoration of drainage into Newhall Creek but the creek is ephemeral.
Overall Permanence	Marginal	See discussion below.

Permanence assessment discussion
Private land running north and south between the 14 and Sierra Highway poses a significant challenge to long-term permanence and necessitates potential purchases. Navigating these permanence issues is essential to ensure that easily constructible barriers to wildlife movement, such as fencing, and habitat degradation don't undermine potential future investment at this site or the I-5 crossing sites which it connects. There is low risk of overburning on the west side and moderate to high risk on the east. Riparian habitat is nearby

and potential exists for restoration of montane conifer habitat in the upper part of the watershed. Restoration could also include improved drainage into Newhall Creek, although the creek is ephemeral with limited flow.

5.3.5 Constructability Criteria

Geological and Geotechnical	**Good** 
Los Piñetos is situated proximally to the Northridge Blind Thrust fault zone (~0.25 miles or less), indicating a moderate to strong potential for earthquake shaking. The proposed crossing location has natural slopes composed of sedimentary bedrock and has a low to moderate probability of landslides in the event of an earthquake. Liquefaction risk at the proposed site location is moderate to low. Risks associated with expansive soils, ground subsidence, and fault rupture are low. Seismically induced settlement risk is also assessed as low. Further testing is recommended to assess corrosivity conditions. Ground anchoring is feasible if widening the existing underpass is required.	

Traffic Impacts	**Good** 
There are no traffic impacts anticipated on SR-14. Short-term traffic impacts are expected for Sierra Highway during the construction of the bridge structure.	

Approaches and Slopes	**Most suitable** 
Los Piñetos is similar to Old Road X in that it is already a grade separated crossing with no requirement for additional approach slope creation. The approaches on both sides and actual habitat should be improved as riparian/dry wash where disruption of sediment transport has filled the underpass with sand. It entails a low quantity of cut/fill to improve approach and clear sediment deposited at the opening. An opportunity exists for more significant riparian restoration where a large concrete stabilized berm has channelized the upper most portion of Newhall Creek to the west. The Sierra Highway overcrossing component of Los Piñetos (also serves the Beale's Cut North alternative) is proposed as a small deck span at the southern edge of a large oak woodland. The east side is accessed via a moderate slope from that oak woodland up to the crossing approximately 30ft above the road. The west side of the spanning deck meets a level area (no grading required). The accompanying over-crossing of Sierra Highway also requires minimal grading and has a good orientation and habitat potential.	

Utilities	**Average**
An existing overhead electrical and communication line will need to be relocated underground on Sierra Highway. Other major utilities on Sierra Highway include underground gas transmission, oil, communications, electrical, and a fiber optic transcontinental facility. Coordination with utility owners for relocation may be needed.	

Environmental and Remediation Need	**Good**
Environmental impacts are associated with the proposed location site. The crossing site will require environmental clearance for the restoration of a creek. The level of environmental documentation required is contingent upon the possibility of utilizing the SERP (State Environmental Policy Act) and the identification of potential impacts determined through technical studies. Impacts from the creek restoration will most likely be self-mitigating.	

Regulatory Complexity	**Good**
Creek restoration permits from the US Army Corps (USACOE), California Department of Fish and Wildlife (CDFW), and Regional Water Quality Control Board (RWQCB.) are required.	

Construction Complexity	**Good**
The project necessitates the construction of a single overcrossing bridge structure. Staging and laydown areas for the bridge structure will be designated along Sierra Highway, with construction access primarily routed from Sierra Highway. Staging areas and construction access will be located along Remsen Street for the habitat restoration under SR-14.	

Cost	**Most suitable**
Item	**Cost**
Bridge Structural Cost	$7,700,000
Roadway Cost/Drainage/Grading	$700,000
Mobilization, Construction Management, Design	$2,940,000
Contingency	$2,100,000
Total (rounded)	$13,500,000

Overall Constructability	**Most suitable**

5.4 Beale's Cut North (SR-14 overcrossing)

5.4.1 Description

Two alternatives are named after Beale's Cut, an historic passage through the mountains at the crest of the Pass constructed pre-automobile. The Beale's Cut North alternative is located at SR-14 PM R25.67. This crossing alternative involves a cast-in-place concrete box girder bridge overcrossing SR-14 just north of the crest of the Pass. SR-14 in existing conditions is a 12-lane road with six lanes of traffic in each direction. The Sierra Highway crossing opposite Los Piñetos, discussed in Section 5.2.3, could support full connection paired with Beale's Cut North, given its proximity.

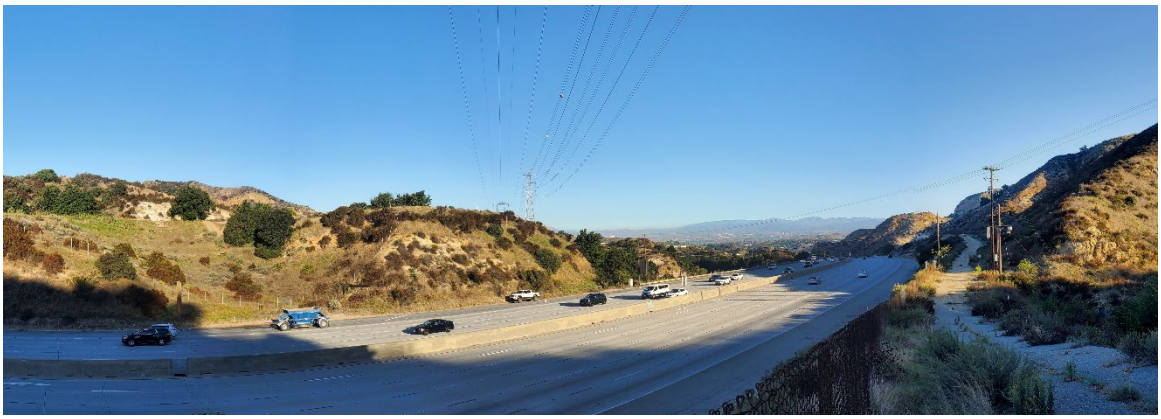


Figure 69. Beale's Cut North alternative (SR-14 looking north). Photo credits: Stillwater Sciences.

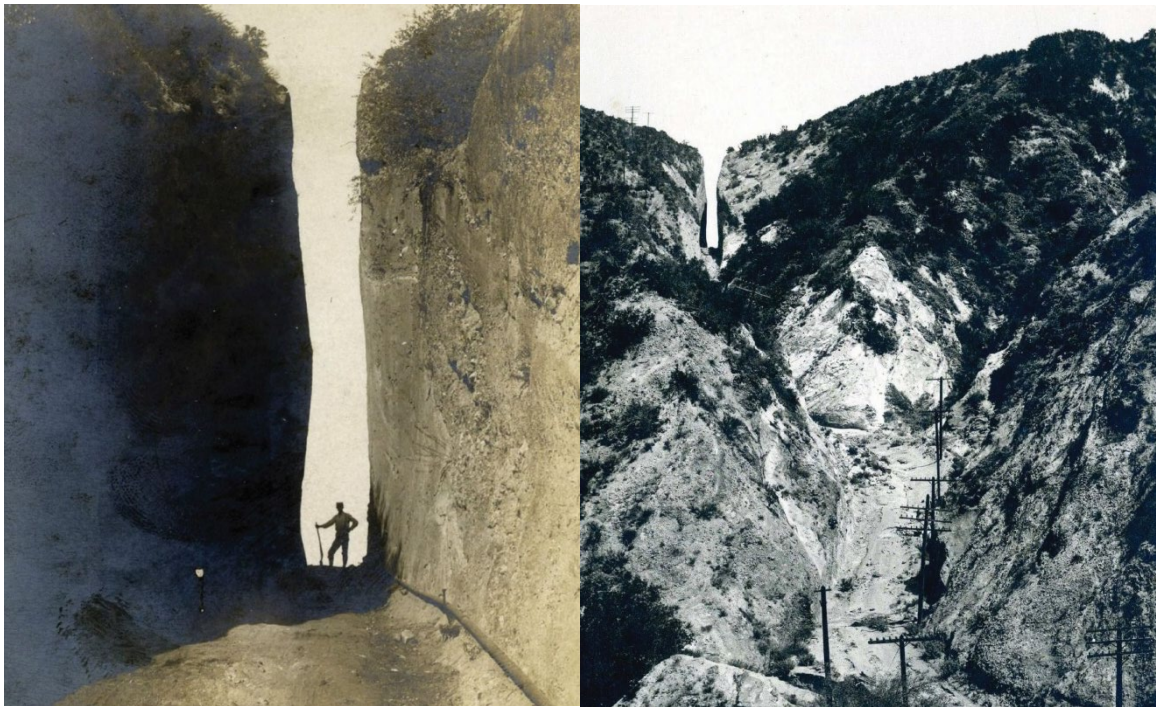


Figure 70. Historic Beale's Cut, circa 1907-1910 (left) and 1912-1914 (right). Photo credits: Michael J. Semas Collection.

5.4.2 Design Strategy

The proposed structure is an elevated level box girder overcrossing. A bridge pier is proposed in the median of SR-14, with existing lanes realigned around it. The west end of the crossing lands in a flattened area constructed for past oil and gas extraction near the southern end of a privately-owned parcel and approximately 1000' from Beale's Cut. The east end of the crossing lands in an area of existing fill at the mouth of a small canyon at the upper end of an ephemeral drainage of Newhall Creek. Two ridges on either side of the canyon lead to the primary ridgeline of the San Gabriels just uphill.

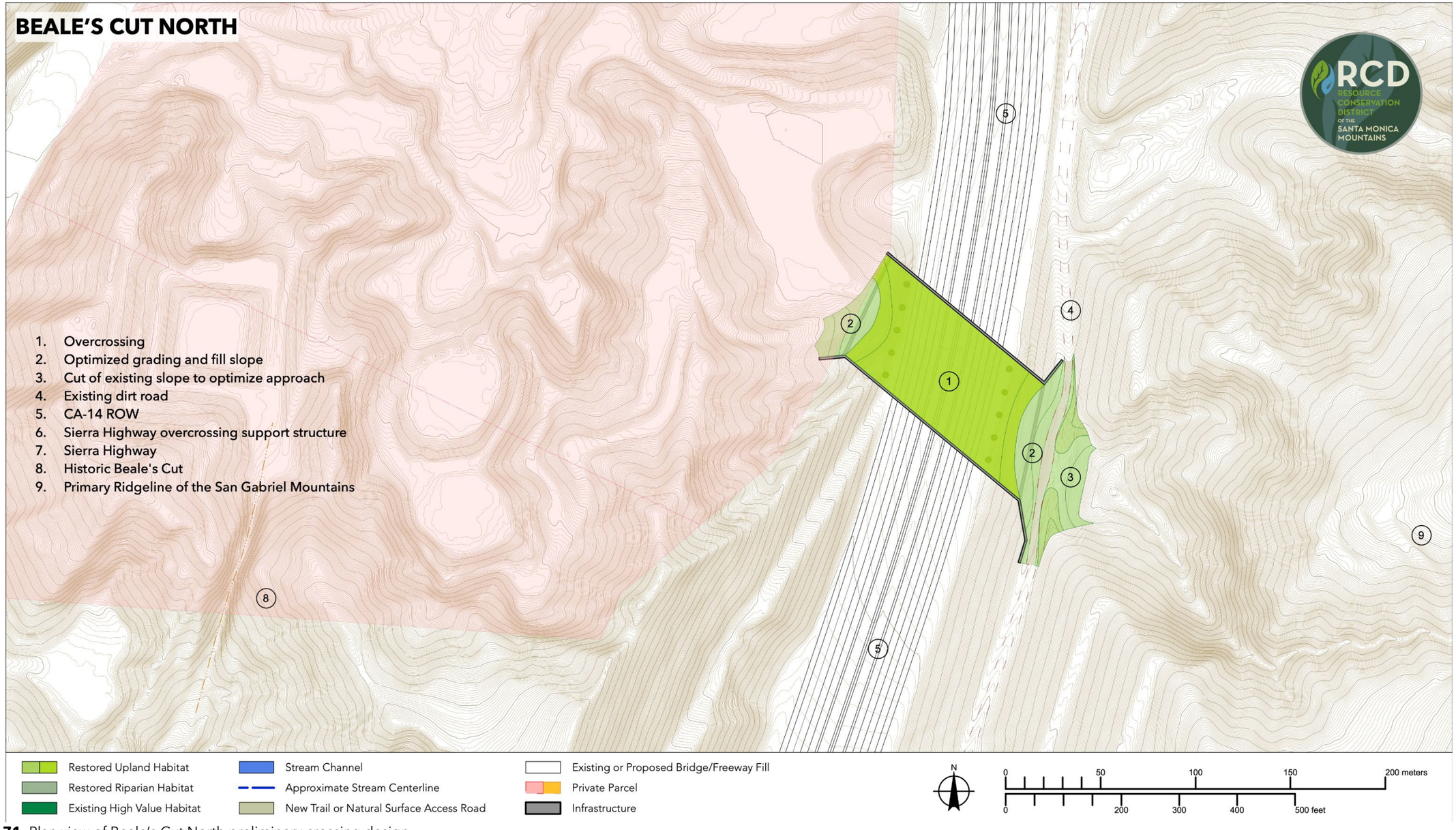


Figure 71. Plan view of Beale's Cut North preliminary crossing design.

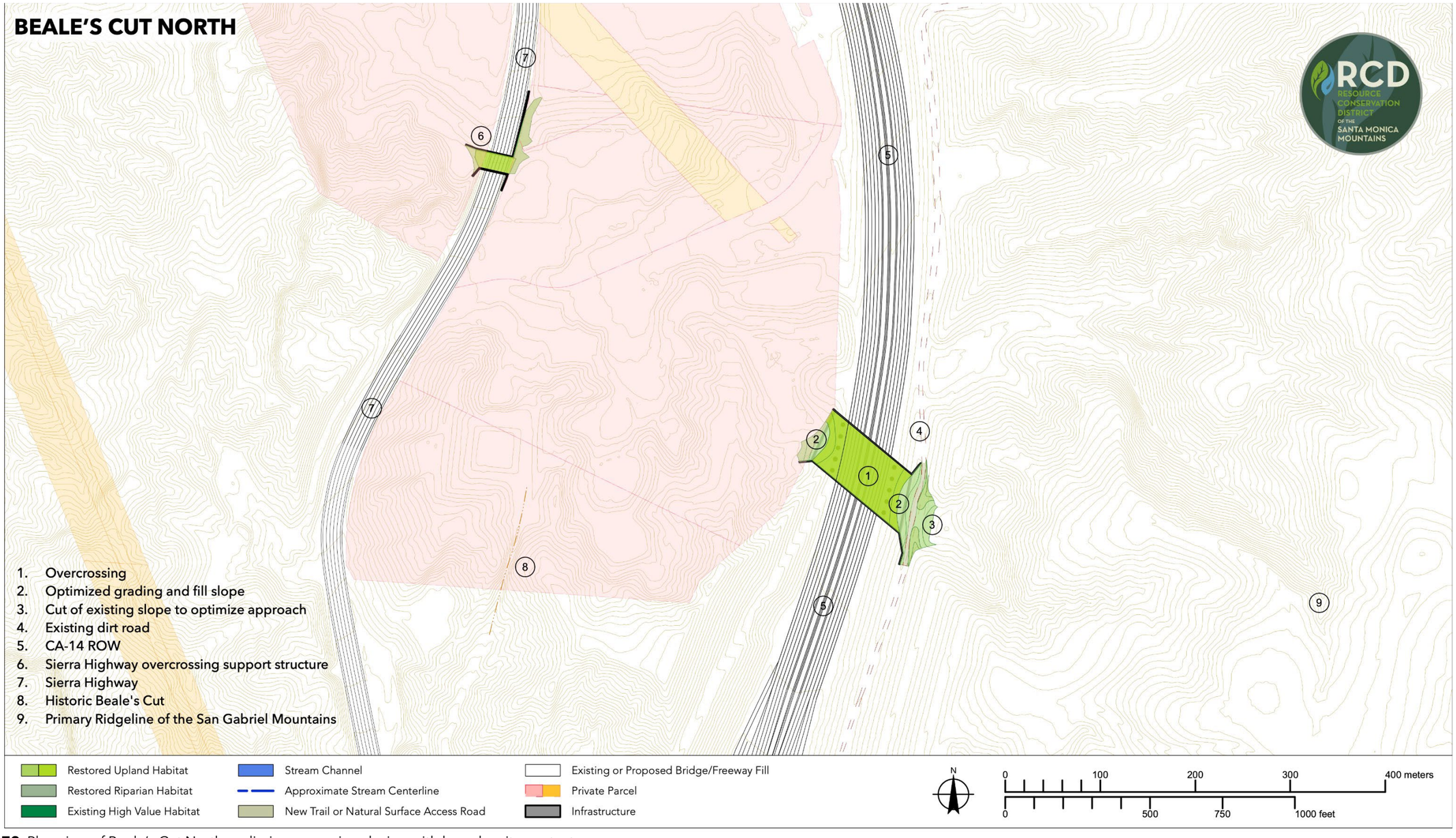


Figure 72. Plan view of Beale's Cut North preliminary crossing design with broader site context.

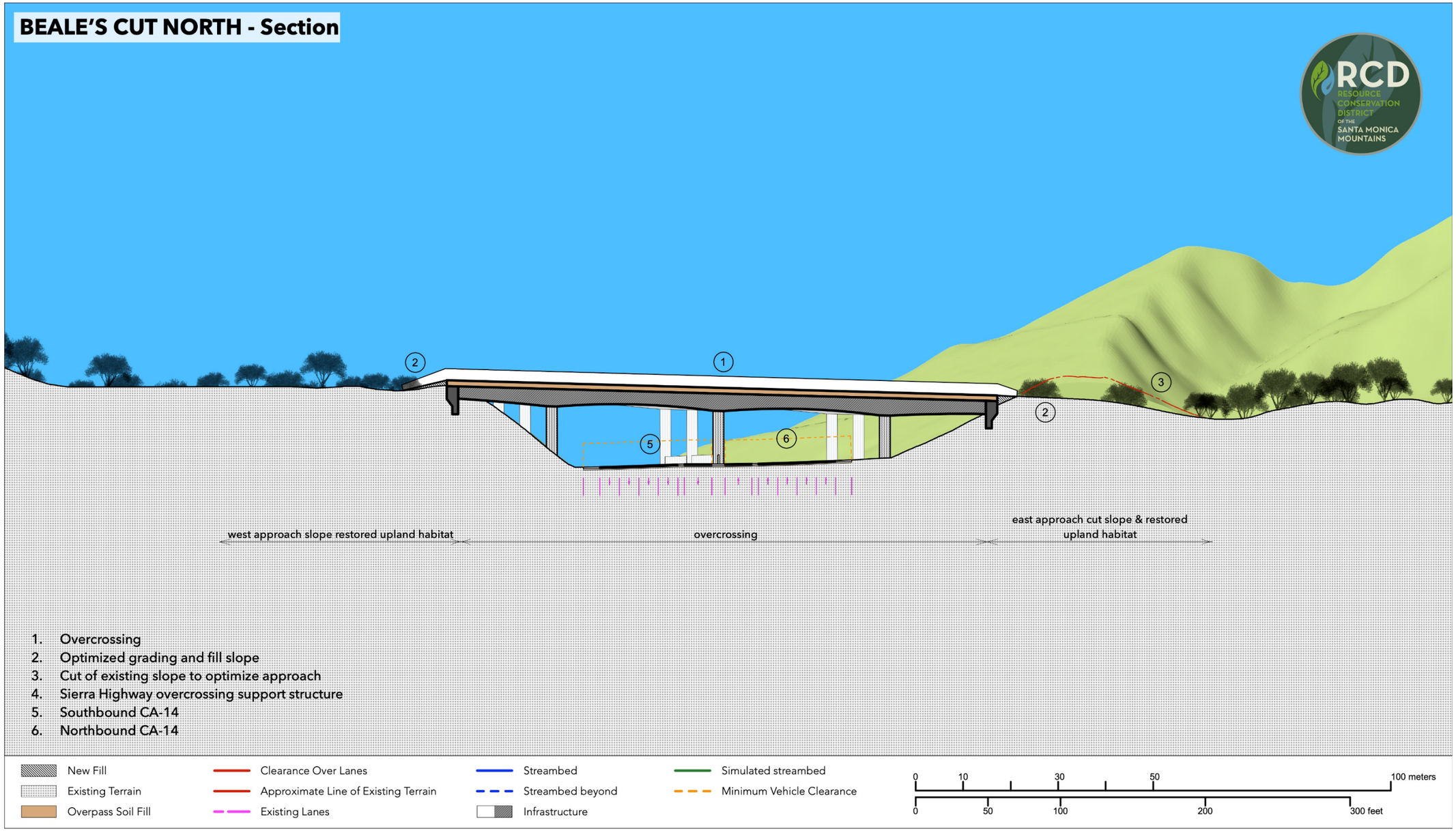


Figure 73. Cross-section of Beale's Cut North preliminary crossing design.

5.4.3 Ecological Criteria

Table 7. Ecological criteria for Beale's Cut North crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Beale's Cut North Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Best	Offers the best adjacent habitat of SR-14 options because it is near the cluster of mountain lion-vehicle collisions, is along the primary ridgeline of the San Gabriels with favorable slopes for movement and has the best adjacent vegetation quality of all SR-14 crossing options.
Riparian	Good	An upper drainage of Newhall Creek flows ephemerally beneath SR-14 (piped) at this location. An overcrossing structure would accommodate a restored stream course, but since the crossing structure meets the at the bottom of the canyon on the east side, wildlife following the stream course would likely be drawn to the crossing.
Montane	Better	This is the only crossing location of SR-14 with existing montane habitat directly adjacent. This is the best location on SR-14 for montane connectivity. With appropriate design, this location may support montane plant species on-structure due to favorable aspect.
Oak woodland	Better	Modeling results suggest "better". Offers relatively good oak woodland habitat on both sides compared to other SR-14 options.
Scrub and grasslands	Better	Although a lot of scrub exists around the site, it is more woodland habitat than the others.
Watershed connectivity	Better	Location is adjacent to a culvert of Newhall Creek under SR-14. Site is along the primary ridge of the San Gabriel Mountains just north of the watershed boundary of the Santa Clara and Los Angeles Rivers (in the Santa Clara River watershed).
Wildlife collision records	Best	Near mountain lion road collision cluster.
Overall Ecological	Best	See discussion below.

Ecological assessment discussion

An overcrossing at Beale's Cut North provides the best overall connectivity potential along SR-14 based on Omniscape modeling and other considerations. Its location along the northern slope of the primary ridgeline of the San Gabriel Mountains suggests a natural location for wildlife movement, especially woodland species. The higher elevation, northerly aspect of adjacent areas provides climate refuge value with montane and oak woodland habitat types present. High quality chaparral and scrub habitats are present on adjacent on ridges. Riparian habitat connectivity appears slightly better than other alternatives in the Newhall Creek watershed. It is also furthest away from edge effects from development to the north of the Los Piñetos alternative.

5.4.4 Permanence Criteria

Table 8. Permanence criteria for Beale's Cut North crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Beale's Cut North Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Marginal	Private land on the west side of the crossing location is degraded from oil and gas history, although some potential for conservation exists. Steep slopes, proximity to historic Beale's cut, and potential contamination may make this location less favorable for development.
Wildfire risk to habitat	Marginal	Overburning is very close on both sides of this location, but the small canyon east of the crossing has high quality woodland and montane vegetation and is only experiencing moderate overburning risk.
Climate refuge value	Best-performing	Montane conifer woodlands are directly adjacent to the east and relatively close patches exist to the west compared to Los Piñetos.
Environmental co-benefit lift potential	Best-performing	Restoration of former oil and gas sites to the west presents a major opportunity for environmental lift. High visibility of an overcrossing structure raises conservation awareness. Ideal location for a potential trail crossing to access the adjacent Beale's Cut historical site
Overall Permanence	Good	This and Sierra Over/Under are the best performing site alternative along SR-14 for permanence criteria. See discussion below.

Permanence assessment discussion

On the west side of SR-14 there are favorable slope gradients for construction, but it is immediately adjacent to a privately owned parcel to the west - the same one that threatens the permanence of Los Piñetos. Adjacent montane woodland, riparian habitat along Newhall Creek, and northerly aspect provides the most favorable climate refuge value of the SR-14. Overburning is prevalent nearby, especially on the east side, however the canyon directly adjacent to the east retains high quality oak and montane woodland habitat. Combining remediation of any contamination associated with historic oil and gas operations on the west side with habitat restoration associated with the project may be leveraged here to provide high environmental lift.

5.4.5 Constructability Criteria

Geological and Geotechnical	Average
This location will have similar geological and geotechnical characteristics as Location 5 – Beale's Cut South SR-14 Overcrossing.	

Traffic Impacts	Average
During construction of the overcrossing, short-term traffic disruptions may arise during nighttime closures for falsework erection and removal, but minimal impact is anticipated once falsework is installed. Long-term traffic effects are expected to be minimal overall.	

Approaches and Slopes	Good
A moderate amount of cut/fill required on the eastern edge of the deck landing with fair gradients and good orientation and good habitat potential. On the east side there is a small watershed containing high quality habitat that drains under the embankment of SR-14. Our proposal suggests altering the fire road and embankment to allow for easier passage from that watershed onto the freeway spanning deck. On the west side however, the deck intersects cleanly with existing grade. That grade is sloping down slightly to the north which is a favorable exposure for the resulting deck surface which would also tilt down towards the north side creating a cross slope. Although the west side has a favorable condition to meet grade with little earth movement required, much of the approach is abandoned oil and gas operations rather than quality habitat. Therefore, grading to remove and restore the surface on the west side would be required.	

Utilities	Good
An existing high-voltage overhead electrical transmission line crosses SR-14 approximately 300 feet north of this crossing location and will need to remain in place. There are no major utilities along SR-14.	

Environmental and Remediation Need	Good
Due to the extensive excavation anticipated during the construction phase, careful attention must be paid to cultural sensitivities. However, much of the area to be excavated to the east appears to be fill material from construction of SR-14. The need for cultural sensitivity implies a recognition and respect for potential cultural artifacts, heritage sites, or sacred grounds that may be encountered during the excavation process.	

Regulatory Complexity	**Average**
While the anticipated impacts on SR-14 are expected to be minimal, coordination and road permitting will be necessary with Caltrans to work on the proposed site location.	

Construction Complexity	**Average**
The crossing site comprises a singular overcrossing structure and involves a minor road reconfiguration. Access for construction and staging would be constrained along SR-14 to the west due to steep slopes. Coordination of off-site staging areas is required.	

Cost	**Average**
Item	**Cost**
Bridge Structural Cost	$33,220,000
Roadway Cost/Drainage/Grading	$1,760,000
Mobilization, Construction Management, Design	$12,250,000
Contingency	$8,750,000
Total (rounded)	$56,000,000

Overall Constructability	**Good**

5.5 Beale's Cut South (SR-14 overcrossing)

5.5.1 Description

Beale's Cut South is located at SR-14 PM R25.38. This crossing site involves a cast-in-place concrete arch bridge overcrossing SR-14, which serves as pathway for wildlife.

SR-14 is a 14-lane road in this location with five lanes of traffic and two lanes of ramp in each direction. There are no changes proposed to SR-14. Existing conditions at Beale's Cut South provide an ideal location for a concrete arch bridge due to the "cut" section. The signature arch bridge can span between the two fill/cut tops on either side of SR-14. The ample elevation difference between the top of proposed bridge and the roadway below provides enough room to span a concrete arch over the entire roadway width, while still providing enough vertical clearance during both the final condition and the temporary construction condition (falsework). The proposed reinforced concrete arch combined with a prestressed concrete box girder is an architecturally elegant and structurally sound structure.



Figure 74. Beale's Cut South crossing location of SR-14 from east looking west. Photo credit: Stillwater Sciences.

5.5.2 Design Strategy

The proposed bridge deck structure lands in a saddle where the cut face on the west side of SR-14 is lowest. Restoring and manipulating the slopes all the way down to Sierra Highway and adding an appropriate overcrossing there creates a protected passage into the interior of the 'Y'. Grading of steep slopes to the east is necessary to provide optimal wildlife access to the structure where it meets the primary ridge of the San Gabriel Mountains.

Beale's Cut South lends itself to an arched crossing, which has the advantage of less construction within the freeway itself because not as many lines of column are needed to support the elevated overcrossing. Generally, these arches are considered to be more iconic gateway-type structures and in other locations they have been created for symbolic reasons alone (such as in San Diego). Opting for this type of structure over the more conventional freeway crossing structural technology benefits placemaking efforts.

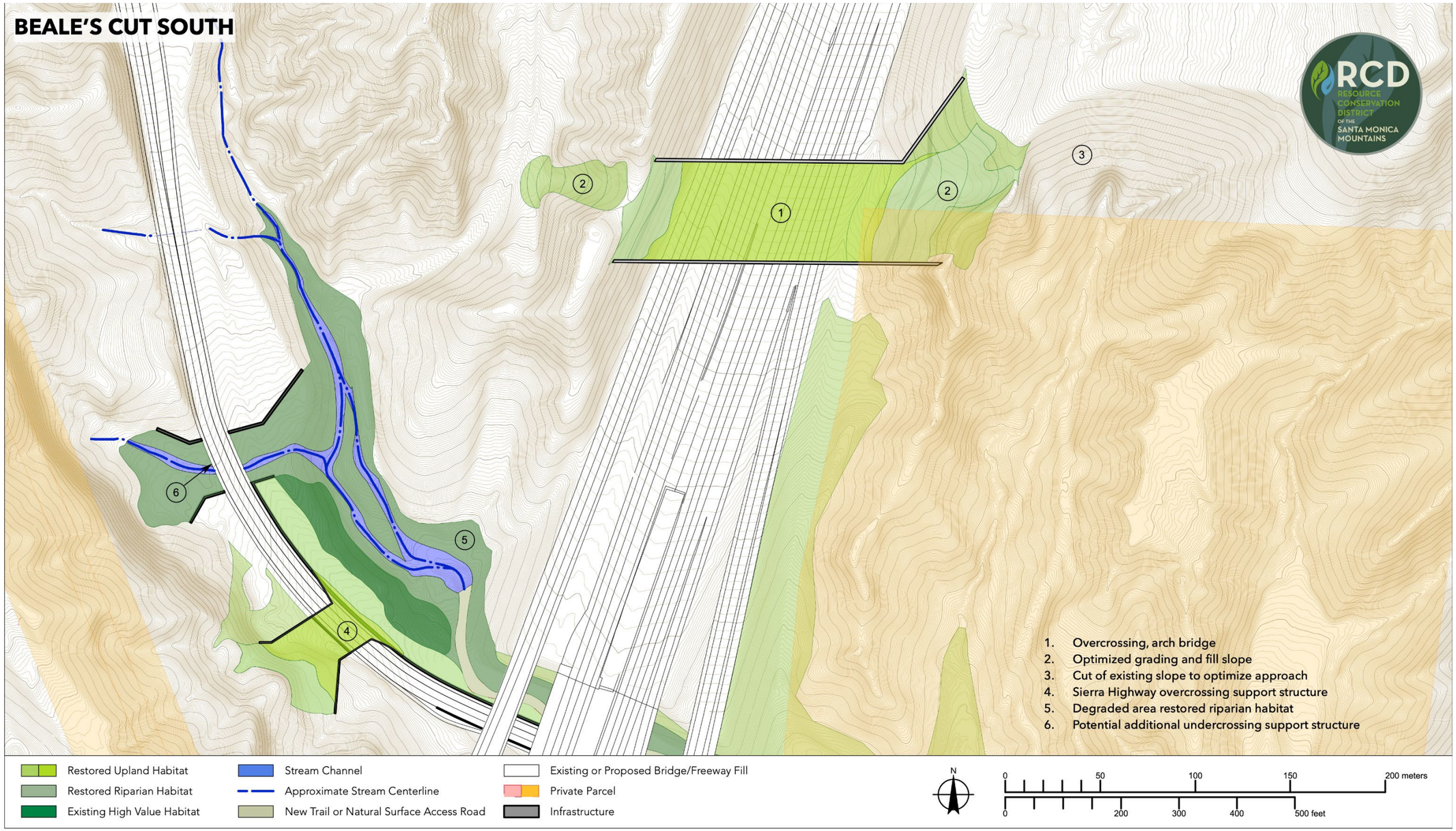


Figure 75. Plan view of Beale's Cut South preliminary crossing design.

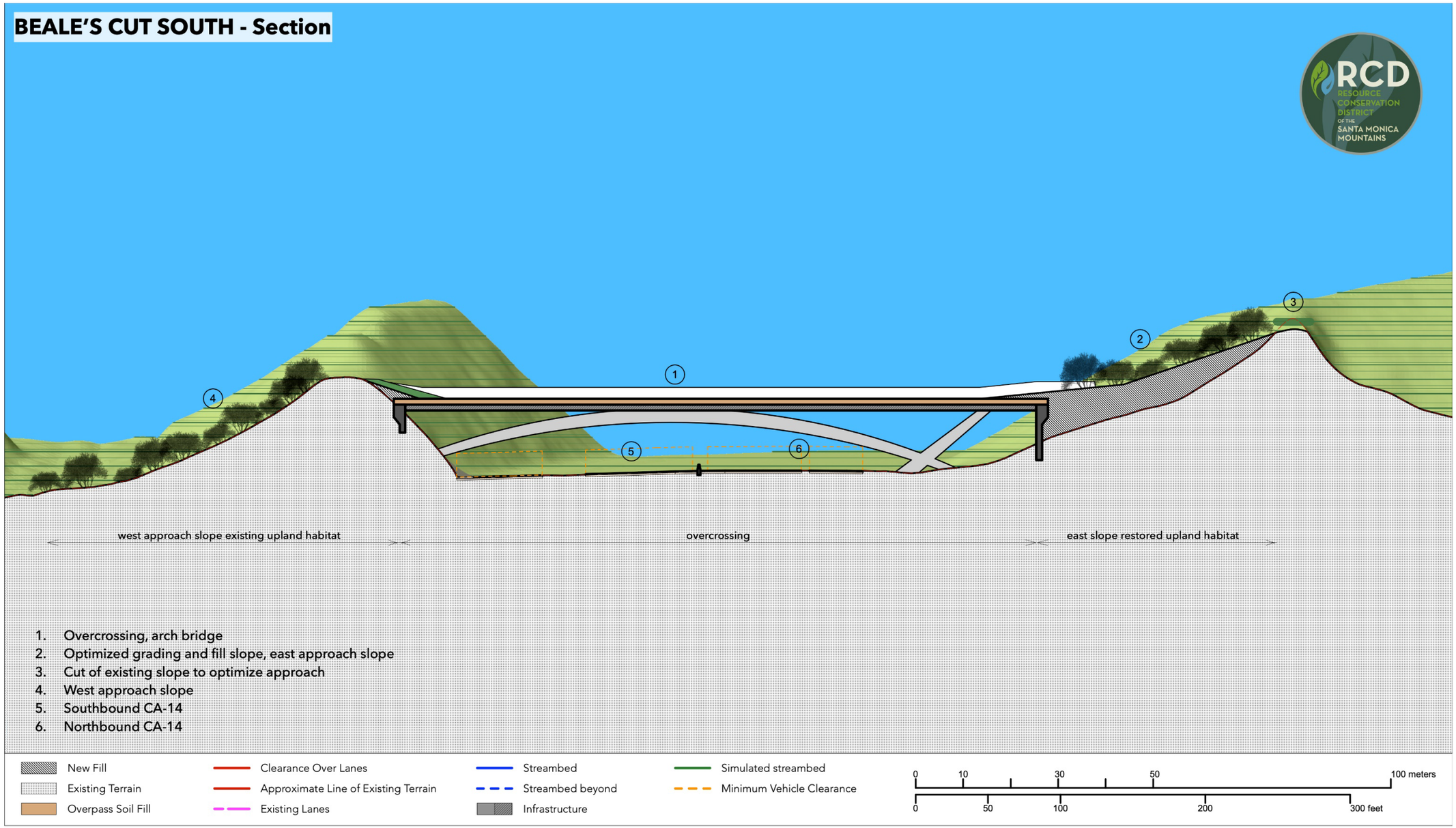


Figure 76. Cross-section of Beale's Cut South preliminary crossing design.

Criteria performance rankings for the alternative are as follows:

5.5.3 Ecological Criteria

Table 9. Ecological criteria for Beale's Cut South crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Beale's Cut South Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Better	Vegetation mapping and Omniscape modeling indicate a lack of good habitat adjacent, likely due to recent wildfire impacts. However, based on field visits, scrub and chapparal vegetation nearby is generally recovering. This site is also close to a mountain lion-vehicle collision cluster and is on the primary ridgeline of the San Gabriels.
Riparian	Marginal	The west end of the crossing lands near degraded riparian habitat of Bull Creek west of SR-14. However, the steep terrain and overcrossing with upland vegetation is not expected to directly benefit riparian species and habitats.
Montane	Marginal	The south aspect is unfavorable for montane species; however, montane conifer and hardwood vegetation occurs in the vicinity.
Oak woodland	Marginal	Modeling indicates poor conditions and potential for oak woodland and woodland species due to the site being mostly surrounded by scrub and grassland and exhibiting a southerly aspect.
Scrub and grasslands	Best	Scrub is highly favored based on modeling results. There are also areas of native perennial grasses near the crossing to the east.
Watershed connectivity	Good	Site is along the primary ridge of the San Gabriel Mountains and just south of the watershed boundary of the Santa Clara and Los Angeles Rivers (in the Los Angeles River watershed). Overpass does not provide a direct riparian connection, but is near Bull Creek.
Wildlife collision records	Best	Site is within mountain lion-vehicle collision cluster.
Overall Ecological	Good	See discussion below.

Ecological assessment discussion

The southerly aspect and associated high solar exposure of Beale's Cut South makes this location naturally suitable for scrub and native grassland habitats. It is experiencing overburning which favors conversion to non-native annual grassland. While remote sensing-based vegetation mapping suggested the prevalence of non-native annual grasslands at the site, field visits revealed that coastal sage scrub and native grasses are recovering and mapping probably reflected recent wildfires around the time of the survey. Regardless, this

location is naturally unfavorable for montane and woodland habitats due to the southerly aspect. Beale's Cut South also sits at the end of the primary ridgeline of the San Gabriel Mountains on the east side of SR-14, suggesting good potential for wildlife movement. A male mountain lion-vehicle collision was recorded at the site and two others are nearby.

5.5.4 Permanence Criteria

Table 10. Permanence criteria for Beale's Cut South crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Beale's Cut South Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Good 	South side lands in a steep area of LADWP land which could be compatible with conservation.
Wildfire risk to habitat	Insufficient 	Overburning is occurring on both sides of the crossing.
Climate refuge value	Marginal 	Site is at a relatively high elevation, but there is low potential for montane habitat adjacent due to southerly aspect and frequent overburning.
Environmental co-benefit lift potential	Average 	Restoration of filled riparian area to the west along Bull Creek would be included, and the visibility of an overcrossing structure encourages conservation awareness.
Overall Permanence	Average 	See discussion below.

Permanence assessment discussion

Land on the east side of SR-14 is owned by the Los Angeles Department of Water and Power (LADWP). A crossing in this location may have minimal disruption to LADWP operations due to the steep topography and location of the crossing site at the up-hill edge of the parcel with limited access. Overburning will continue to be a concern at this site due to the hot, dry aspect, Santa Ana wind corridor, and human influences, such as extensive power line corridors to the east. A high fire frequency and south aspect also suggests a low climate refuge value due to unsuitable microclimate conditions for montane, oak, or riparian woodlands. However, as naturally one of the hottest and driest locations within the study area, climate change may lead to exceeding the temperature and soil moisture demands of native plant species currently present in the higher elevations of the Pass. Improved connectivity of such sites at the warm-dry edge of microclimate gradients may be warranted to facilitate long-term movement and migration of regionally native species not currently present in the nearby surrounding area.

5.5.5 Constructability Criteria

Geological and Geotechnical	Average
Beale's Cut South is situated proximally to the Northridge blind thrust fault zone (~0.4 miles or less) and the Sierra Madre fault zone (~300 feet), indicating a moderate to strong potential for earthquake shaking. The proposed bridge has natural slopes composed of sedimentary bedrock and has a moderate to high probability of landslides in the event of an earthquake. Due to the proposed location site falling within an existing Alquist Priolo fault zone and its proximity to the Northridge blind thrust fault zone and Sierra Madre fault zone, the risk of fault rupture should be considered moderate to high. The likelihood of encountering corrosive soils is moderate to high, while the potential for rippability is moderate to low. The risks associated with liquefaction, expansive soils, and land subsidence are considered low. The low risk of seismic settlement is attributed to the proposed site's predominantly shallow bedrock, allowing for the feasibility of shallow foundation placement.	

Traffic Impacts	Good
During construction of the overcrossing, short-term traffic disruptions may arise during nighttime closures for falsework erection and removal, but minimal impact is anticipated once falsework is installed. Long-term traffic effects are expected to be minimal overall.	

Approaches and Slopes	Average
Beale's Cut south has a complex approach slope on the east requiring a particular combination of cut/fill that is cut from the existing ridge conditions and a fill in some of the drainage zones. The deck intersects a saddle in the cut-face on the west of SR-14. While there is no requirement for manipulation of grade on the west side, the exiting approach slope is steep. A lateral ridge route exists that improves the access gradient to some extent but is less direct. Beale's Cut South requires the same Sierra Highway crossing location as Sierra Over Under alternative (see below).	

Utilities	Most suitable
There are no major utilities along SR-14 at the proposed crossing location.	

Environmental and Remediation Need	Most suitable
The construction phase of the overcrossing may result in scenic and visual impacts, however, the implementation of the project design may fully mitigate any negative visual impacts.	

Regulatory Complexity	**Good** 
While the anticipated impacts on I-5 to be minimal. Coordination and road permitting will be necessary with Caltrans to work on SR-14.	

Construction Complexity	**Marginal** 
The crossing site comprises a single overcrossing structure, necessitating limited construction access and staging along SR-14. Coordination for off-site staging areas will be required.	

Cost	**Least suitable** 
Item	**Cost**
Bridge Structural Cost	$110,050,000
Roadway Cost/Drainage/Grading	$3,860,000
Mobilization, Construction Management, Design	$39,870,000
Contingency	$28,480,000
Total (rounded)	$182,300,000

Overall Constructability	**Good**

5.6 Sierra Over/Under (Sierra Highway overcrossing and SR-14 undercrossing)

5.6.1 Description

Sierra Over/Under is the last opportunity to cross SR-14 before it weaves into the I-5 interchange to the south. It derives its name from its proposed crossing type: a combination of an overcrossing of Sierra Highway and an undercrossing of SR-14.

Sierra Over Under is located at SR-14 PM R25.16. This crossing site involves a prefabricated arch overcrossing at Sierra Highway and a reconfiguration of Sierra Highway and habitat restoration under SR-14. The designated wildlife pathway traverses the prefabricated arch and runs adjacent to Sierra Highway beneath SR-14.

Sierra Highway consists of a four-lane road with two lanes of traffic in each direction and a painted center median. The crossing location begins approximately 0.4 miles north of the I-5/SR-14 interchange along Sierra Highway. It is proposed to change Sierra Highway's lanes to two southbound lanes and one northbound lane.



Figure 77. Sierra Over/Under crossing location from west looking east. Photo credit: Stillwater Sciences.

5.6.2 Design Strategy

From the east, a "road diet" narrows the Sierra Highway to three drive lanes and two bike lanes. Commuter use from north to south in the morning necessitates two lanes in that direction. A proposed sound wall and retaining elements create a broader naturalized passage underneath the spans of SR-14 and the two on- and off-ramps that exist there. Significant buried infrastructure limits the amount of retaining and grading, and does not allow for the daylighting of Bull Creek, which is piped beneath the underpass.

The steep slope of Sierra Highway makes going under the road or constructing a viaduct similar to Old Road's level of difficulty; Sierra Highway descends so steeply from the north that achieving adequate clearance at its intersection with SR-14 is impossible. At the south end of the western ridgeline within the Y, a low and gentle gradient for terrestrial wildlife to move creates a natural opportunity for an overcrossing. The steepest slopes fall below the level of the overcrossing deck and then the riparian connection underneath on the east leads up and over to the primary ridgeline of the San Gabriels on the other side of SR-14. It is possible to drill culverts, but the site's topography poses a limiting factor on the width of passage. Utilities prevent the undercrossing from being excavated significantly; otherwise, a reconnection of buried Bull Creek would be possible (as at Old Road X for the South Fork Santa Clara River). Instead, the proposed crossing would employ a simulated riparian connection with appropriate vegetation but without any flow, seasonal or otherwise. On the west side of Sierra Highway, the created gentle fill slope that extends over the crossing is oriented Northeast which is ideal for an oak woodland habitat extension.

Sierra Over/Under is likely a less costly alternative than the Beale's Cut North and South overcrossing options for SR-14. Criteria performance rankings for the alternative are as follows:

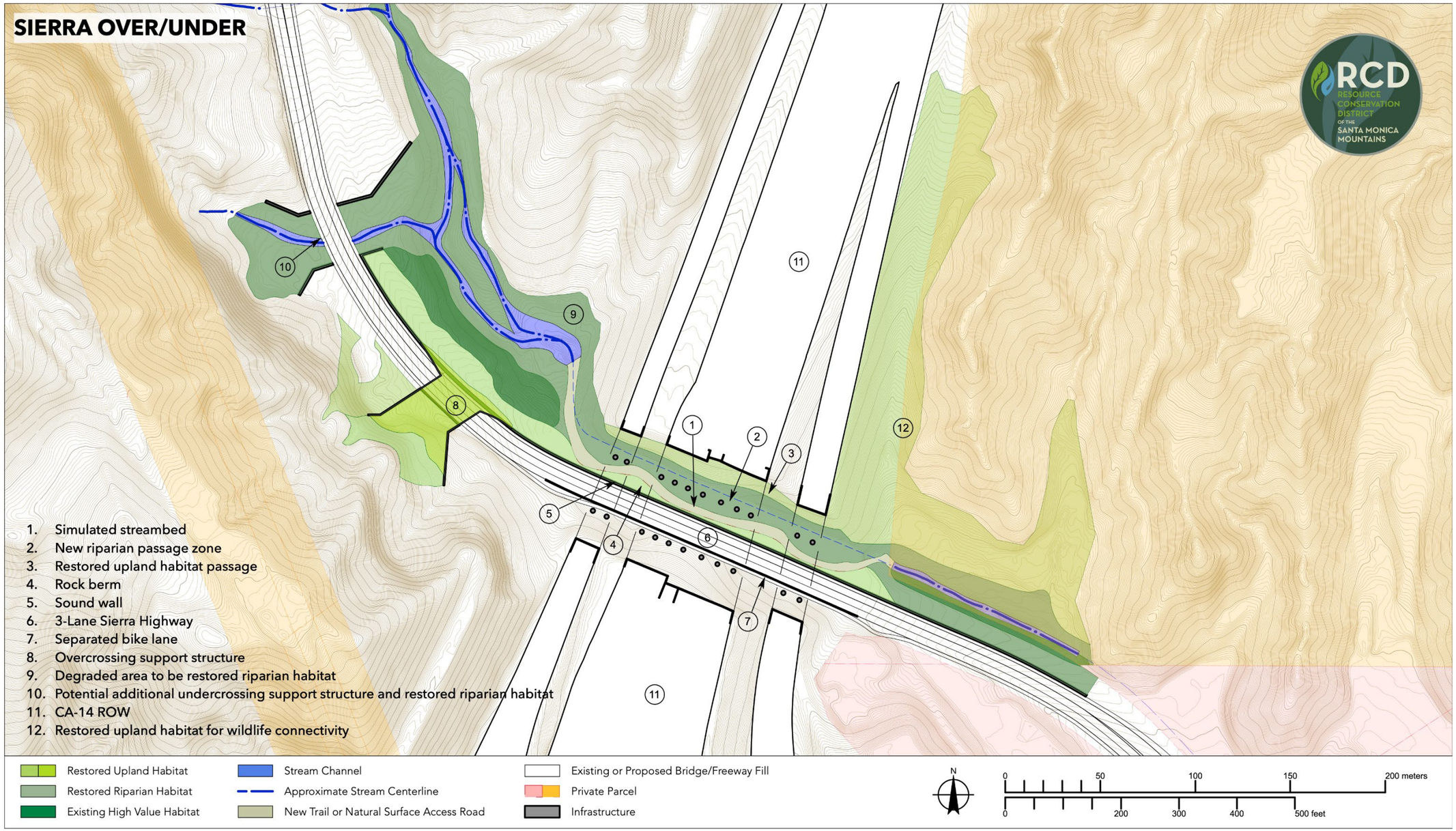


Figure 78. Plan view of Sierra Over/Under preliminary crossing design.

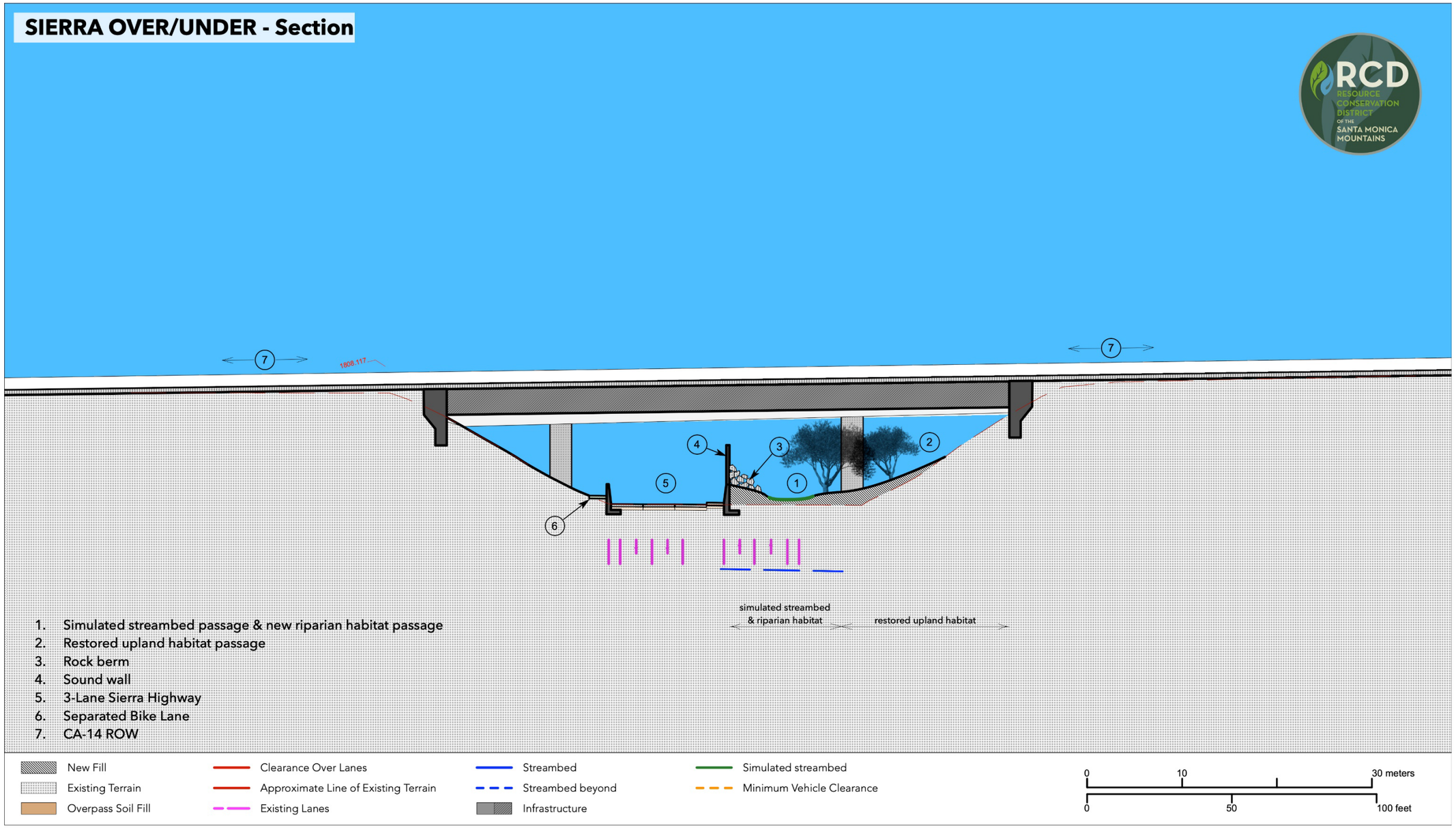


Figure 79. Cross-section of Sierra Over/Under preliminary crossing design.

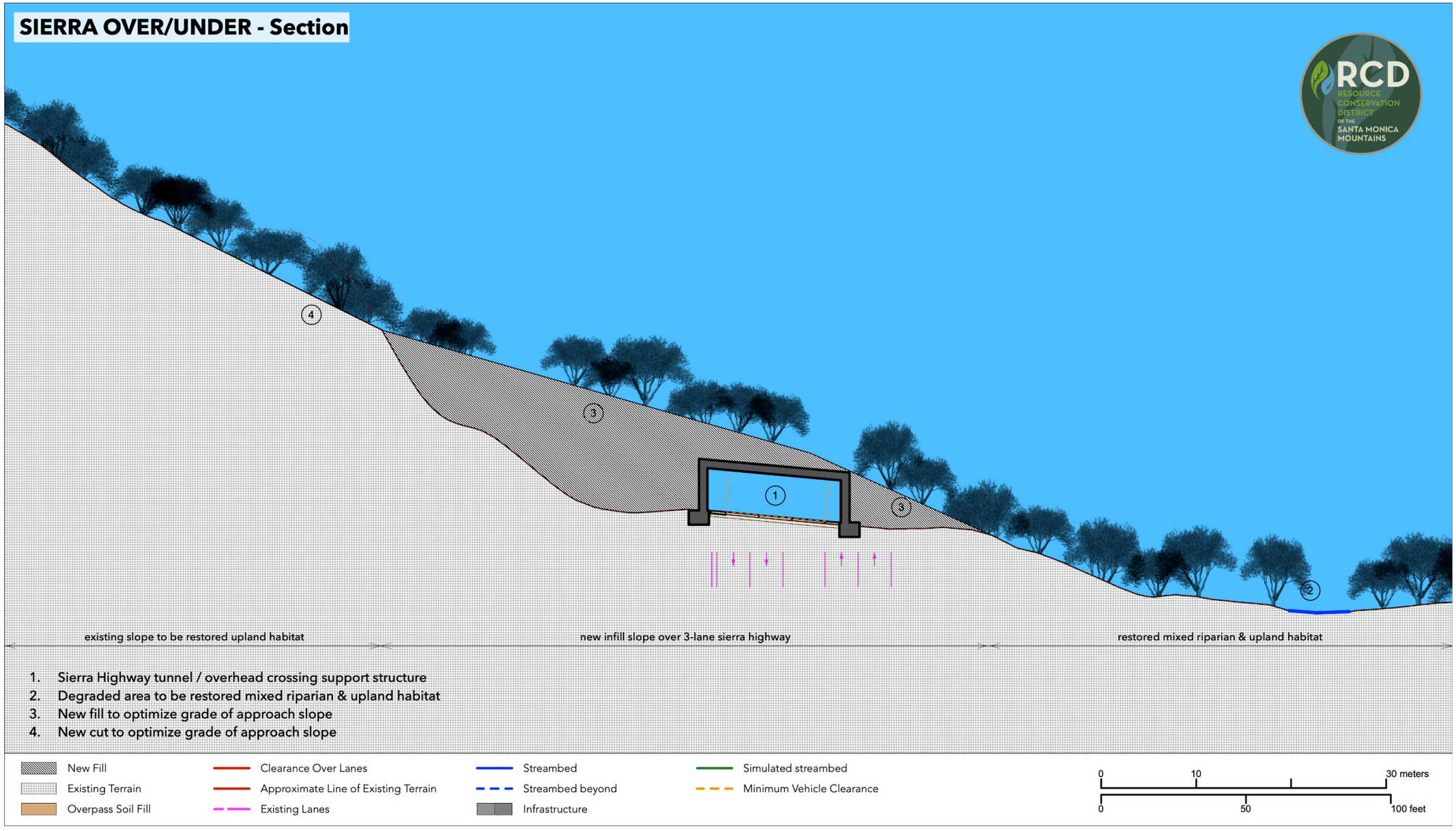


Figure 80. Cross-section of Sierra Over/Under preliminary crossing design.

5.6.3 Ecological Criteria

Table 11. Ecological criteria for Sierra Over/Under crossing alternative. See Figure 44 for a detailed rubric for each assessment criterion.

Sierra Over/Under Ecological Criteria		
Criterion	**Assessment**	**Rationale**
Generalist/ mountain lion	Better	Site is within mountain lion-vehicle collision cluster. Site is near the primary ridge of the San Gabriel Mountains and has relatively high habitat quality adjacent.
Riparian	Better	The alternative will improve connectivity along Bull Creek, but no riparian restoration within the underpass possible due to the depth of culvert under SR-14 and extensive utility infrastructure beneath the site. Restoration of filled areas of Bull Creek to the west are proposed.
Montane	Good	The modeling suggests good connectivity for montane hardwood habitats, but not montane conifer habitat.
Oak woodland	Good	Oak woodland habitat is nearby and modeling supported a "good" ranking.
Scrub and grasslands	Good	Mostly riparian habitat is present in the immediate vicinity and underpasses are not ideal for scrub habitat, but good scrub habitat is nearby.
Watershed connectivity	Better	Although the site is part of a key watershed/creek (Bull Creek) in the LA River watershed, there is no opportunity to daylight creek due to the depth of the culvert and utilities.
Wildlife collision records	Best	Within mountain lion-vehicle collision cluster.
Overall Ecological	Better	Best opportunity to connect Bull Creek. See discussion below.

Ecological assessment discussion

Omniscape connectivity modeling validated observation data by NPS for mountain lions west of I-5 which suggests mountain lions favor moving along primary ridgelines in the Santa Susanas until ridgelines run out. The primary ridgeline of the San Gabriels to the east terminates just uphill of the Sierra Over/Under location. While there is no mountain lion observation data available east of SR-14, this modeling suggests Beale's Cut North, South, and Sierra Over Under have a high likelihood of mountain lion use due to their proximity to the primary ridgeline. Other wildlife species may exhibit similar behavior. Drawbacks of this site are the location along busy Sierra Highway and developed land use on the southeast corner of the undercrossing and further to the east along Sierra Highway. This site is also closest to the I-5/SR-14 interchange with extensive noise, light, and potential for collisions. Fencing strategies will be key to a successful crossing here. Additionally, restoration of Bull Creek and adjacent drainages may help to funnel wildlife to a crossing in this location.

5.6.4 Permanence Criteria

Table 12. Permanence criteria for Sierra Over/Under crossing alternative. See Figure 45 for a detailed rubric for each assessment criterion.

Sierra Over/Under Permanence Criteria		
Criterion	**Assessment**	**Rationale**
Conservation/ Land ownership status	Average	East of the crossing is LADWP land. This portion of the parcel is the most accessible, flattest, and potentially most useful for LADWP. Land west of the crossing is conserved.
Wildfire risk to habitat	Marginal	Overburning is occurring on both sides of the crossing
Climate refuge value	Good	Site is adjacent to riparian habitat and modeling suggests potential connectivity for montane hardwood habitats.
Environmental co-benefit lift potential	Good	Restoration of filled riparian area west of the crossing along Bull Creek is included, and the visibility of an overcrossing structure of Sierra Highway encourages conservation awareness. Restoration of riparian and formerly developed areas east on LADWP property may be beneficial.
Overall Permanence	Good	Slightly lower permanence than Beale's Cut North. See discussion below.

Permanence assessment discussion
Land on the east side of SR-14 is owned by the LADWP. As the most accessible portion of the parcel due to its adjacency to Sierra Highway, this parcel may be less compatible for a crossing if LADWP intends for future development. Detailed discussions with LADWP are needed to determine compatibility. However, there are likely design options to provide connectivity even with some development of the parcel. Drainages on the LADWP site, and further east along Sierra Highway, have also been graded and concrete lined. Construction of an undercrossing may lead to restoration of these features and potential additional environmental lift. Overburning will continue to be a concern at this site.

5.6.5 Constructability Criteria

Geological and Geotechnical	**Marginal**
Sierra Over/Under is situated proximally to the Northridge blind thrust fault zone (~0.5 miles or less) and the Sierra Madre fault zone (~0.5 miles or less), indicating a moderate to strong potential for earthquake shaking. The proposed bridge has natural slopes composed of sedimentary bedrock and has a moderate to high probability of landslides in the event of an earthquake. 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. The depth to bedrock and existing soil conditions may vary significantly along the Sierra Highway creating a potential for differential settlement conditions depending on where the exact location of the bridge crossing is located.

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. Soil conditions at the proposed alternative site should be considered corrosive due to high sulfate concentrations, therefore the potential for corrosive soils should be considered high.

The site is considered to have low probability of expansive soils, ground subsidence, and rippability.

The proposed bridge is within a liquefaction potential zone indicating a risk associated with liquefaction moderate to high. Since liquefaction potential is considered moderate to high, deep foundations are recommended at this location.

Traffic Impacts	**Good** 
Constructing the proposed overcrossing will require staged construction for the completion of a prefabricated arch overcrossing at Sierra Highway and a reconfiguration of Sierra Highway. Traffic will remain on the existing road while the bridge is being constructed. When constructing the concrete arch tunnel over Sierra Highway, traffic will be rerouted through the tunnel. The long-term traffic impacts include a road re-configuration and road diet along Sierra Highway.	

Approaches and Slopes	**Good** 
Sierra Over/Under ranks highly on slope criteria because it is an undercrossing that follows grade and the approaches on the east side are gentle. Approach from the east is essentially directed to this point via existing ridges and draws. The passage under SR-14 and its on- and off-ramps adjacent to the Sierra Highway is at grade; however, grading is required for passage along with narrowing of Sierra Highway to the south. Once under the freeway on the west, the crossing element adds the overcrossing portion which intersects a short but steep section of the primary ridgeline of the 'Y' zone at its southern terminus. This allows fill to be added to reduce the steepness of the existing ridgeface. Short retaining wall sections create gentler cross slopes in the underpass zone. Utilities prevent the undercrossing from being excavated significantly otherwise a reconnection of buried Bull Creek would be possible (as at Old Road X for the South Fork Santa Clara River).	

Utilities	**Marginal** 
An existing 76" LAWP water main that runs along the north side Sierra Highway presents will need to be protected and remain in place during construction.	

Other major utilities in the area include underground gas transmission, oil, communications, electrical, and a fiber optic transcontinental facility along an approximately 8-foot wide utility trench on the north and south roadway edges of Sierra Highway.

Environmental and Remediation Need	**Marginal**

Environmental impacts are associated with the proposed location site. The crossing site will require environmental clearance for the restoration of a creek. This location may also be exposing hazards due to unknown materials that have been used as fill. Further coordination with the Department of Toxic Substance Control may be required.

Regulatory Complexity	**Least suitable**

While the anticipated impacts on I-5 are expected to be minimal, coordination and road permitting will be necessary with Los Angeles County and Caltrans to work on Sierra Highway. CDFW permit, Regional Water Quality Control Board (RWQCB.)

Construction Complexity	**Good**

Construction on Sierra Highway entails constructing an overcrossing and road reconfiguration of Sierra Highway under SR-14, necessitating a lay-down and staging area within the Caltrans right-of-way devoid of I-5 traffic disruption. The primary access point for construction activities will be situated along Sierra Highway

Cost	**Most suitable**

Item	**Cost**
Bridge Structural Cost	$7,150,000
Roadway Cost/Drainage/Grading	$2,500,000
Mobilization, Construction Management, Design	$3,380,000
Contingency	$2,420,000
Total (rounded)	**$15,500,000**

Overall Constructability	**Good**

5.7 Crossings not carried forward

The following crossing locations were removed from consideration during the feasibility study process for the reasons described below (locations are mapped in Figure 23). However, it should be noted that conditions may change in the future, and these locations may become appropriate to consider further. Existing undercrossings/culverts below in particular, while not determined to be suitable for a major crossing structure alternative at this time, may be appropriate for smaller-scale near-term implementation of connectivity enhancements such as those proposed by NPS (2023) for locations along I-5.

La Salle was not carried forward due to unworkable topographical obstructions which would prevent easy access for wildlife from/to the east into the Y. It received initial consideration because of evidence of wildlife use by bobcats next to culverts to the south, good open space connection to the east, and only moderate permanence issues. An additional reason for initial consideration was because it offers opportunities to connect tributary and mainstem Santa Clara River with adjacent restoration. This should still be an overall connectivity priority for the Pass area, but connecting to the mainstem Santa Clara River did not address the central purpose of this Study, which is to connect the Santa Susana and San Gabriel Mountains.

Towsley Canyon was not carried forward due to permanence issues on the west side of I-5 and steep approach slopes to the east and west.

Leaming Canyon was not carried forward as a major crossing site because the costs of constructing a larger tunnel (shell tunnel) proved grossly infeasible. The site stood out initially because wildlife are using the existing culvert according to NPS research (cite NPS study) and good habitat from the east and west channels to that location. Improving this culvert or creating a wider and shorter tunnel under I-5 is a better addition to the Old Road X alternative than a stand-alone alternative.

Crescent Valley was excluded from further analysis because there is no viable topography on public land to the east of I-5, where the decks would need to land. Despite feasible topography and quality habitat to the west of I-5 coming from East Canyon, land acquisition issues presented too great a concern. Weldon North serves the same habitat connection area and has superior permanence.

Gun Club North and South were not carried forward due to poor habitat quality and permanence issues (ownership and land use are not ideal) as compared to Weldon North. Initial studies indicated feasible topography, but the widening project of I-5 rendered any landing geometry of a bridge deck impossible.

Weldon South was not carried forward due to challenging topography to the east, but the west presents a high-quality connection opportunity. Furthermore, unlike Weldon North, it does not present any opportunity to connect habitat to the north to any additional tributaries. It is also unclear whether land on the east is protected or private. CPAD indicates that the land is public, but there is equipment and cut wood (firewood?) being stored on parcels in the landing area. LA County Parcel data was also unclear as to its protection status.

Sunshine Canyon and Y Interchange alternatives were not carried forward because navigating through the "spaghetti" of the I-5 / SR-14 interchange is much more complex and large-scale than other alternatives. The pattern of private, public, and utility-owned land, the structural complexity required to cross over approximately two dozen lanes, and the challenges associated with necessary habitat restoration at these locations proved impractical to pursue further at this time. However, these alternatives showed initial promise because Omniscape modeling and roadkill collision data suggest wildlife coalesce there. The Rim of the Valley corridor area and the CDFW Essential Habitat Connectivity area includes areas south of Sunset Canyon landfill that could be served by these crossing alternatives (see Figures 1 and 2). This is also an area of unique ecosystem and watershed connectivity within the LA River watershed that warrant further connectivity needs evaluation (see Figures 12 and 13). Adequate fencing and habitat restoration are critical near-term recommendations to ensure that wildlife moves safely across the chosen I-5 crossing and is not channeled towards this habitat terminus at the base of the 'Y'. Potential for future crossings in this location is recommended in the medium and longer-term (see Section 6).

Sierra Puma Kill site (north of Los Piñetos) was ruled out due to its proximity to urban development, as well as its lack of opportunity to create permanent habitat buffers.

5.8 Summary

Of the 17 sites originally assessed for their ecological, permanence, and constructability criteria, six were recommended for further analysis. Five of these alternatives are recommended as potential sites of new crossings. Two of these sites are located along I-5 and three are located along SR-14. The other site, Los Piñetos, is an existing under-crossing along SR-14 recommended for short-term enhancement to provide immediate connectivity benefits for surrounding scrub/grassland and oak woodland habitat. Because of challenges with surrounding land ownership, Los Piñetos may not be viable as a long-term crossing site.

To best understand the constructability of each alternative, the six alternatives were taken to a preliminary design phase. The next chapter contains short-, medium-, and long-term program recommendations, including recommendation for the Old Road X and Weldon North alternatives to be taken to the further to the environmental review and Caltrans project document phase.

6 NEWHALL PASS CONNECTIVITY PROGRAM RECOMMENDATIONS

The Newhall Pass sits within a complex convergence of ecological and infrastructure systems. A major crossing structure of I-5 will be a key component for restoring ecological connectivity; however, achieving a level of connectivity within the Pass that will support regional resilience of mountain lion populations and other biodiversity will require a variety of additional actions addressing other barriers and stressors to connectivity. While the scope of this study focuses on options for a single major crossing structure, these broader connectivity needs and opportunities, and the role that an initial crossing structure may play in addressing them, must be considered and anticipated as part of the alternatives evaluation process. In other words, the ideal I-5 crossing structure will maximize the connectivity potential of a broader Pass-wide connectivity program that is yet to be developed. Hence, an overall Pass-wide connectivity plan is recommended as a key next step to ensure long-term success of the I-5 crossing. Many of the following recommendations may be include in such a plan.

The following connectivity program recommendations begin with near-term recommendations that should be completed within the next 6 years for the I-5 crossing alternatives, and then go on to discuss how these alternatives may be further enhanced in the medium- (6–10 years) and long-term (10+ years) with additional crossing structures and management actions that may fully achieve the connectivity goals outlined in Section 1 this Report. The following Table (13) and Figure (81) summarizes the recommendations and anticipated benefits (general benefits – see Section 3 for additional detail) relative to the connectivity goals for different areas of the Pass.

In addition to the action items proposed in Table 13, we recommend developing an adaptive management and monitoring program to track progress against baseline connectivity conditions. This type of program can both shed light on the efficacy of different strategies, and provide valuable species data to local wildlife experts, such as CDWF and USFWS. This type of program is explained in more detail in Section 6.4.

Table 13. Summary of recommendations .

Location	Code	Timeframe	Connectivity Program Recommendations	Purpose/Benefit
I-5	1A	Near-term	Advance I-5 Old Road X and Weldon North to Environmental Document Phase where a single crossing will be advanced to 65% design. Key project components: 65% design for crossing structure; restoration plan for surrounding lands, and wildlife exclusion fencing including jump outs and other measures to prevent wildlife-vehicle collisions;	Provides wildlife and ecological connectivity between the San Gabriel and Santa Susana Mountains (Los Piñetos currently provides connectivity across SR-14, but this may only be a temporary solution; see 2A-2C). May also expand habitat area for species not currently present in the "Y".
	1B	Near-term	Implement NPS I-5 connectivity recommendations from the *LA Metro and Caltrans Recommendations for Improved Wildlife Permeability* document	Provides additional connectivity benefits at culverts and other locations along I-5 north of the Weldon Bridge
	1C	Near-term	Evaluate land acquisition of private parcels near Weldon North crossing west of I-5	Improves permanence of Weldon North crossing location and may inform whether Weldon North is selected over Old Road X
	1D	Near-term	Fencing, restoration, and supporting connectivity enhancement measures study associated with preferred crossing site selected for 65% design.	Success of the selected crossing structure location will depend on additional enhancements on adjacent lands
	1E	Medium-term	Complete construction of initial I-5 crossing at Old Road X or Weldon North	See 1A
	1F	Medium-term	Design to 65% a second crossing of I-5 for an overcrossing at Weldon North (favoring terrestrial and montane habitats and species) or undercrossing at Old Road X (favoring riparian habitats and species), whichever is not carried forward in the current project.	Precedent crossings on SR-101 and I-15 include both upland (overpass) and riparian (underpass) connectivity components – this is a best management practice for key regional connectivity locations. Connectivity measures that support movement of diverse species and natural processes within all major habitat types and ecological contexts are recommended to ensure regional ecological resilience as climate tipping points are approached. Increasing redundancy of connectivity (i.e., more than one crossing) also improves resilience in the event that one crossing fails in the future.
	1G	Long-term	Complete second crossing of I-5 at either Weldon North or Old Road X	See 1F
	1H	Long-term	Evaluate, and construct as appropriate, an underpass at the existing I-5 crossing of South Fork of the Santa Clara River at Calgrove. Restore aquatic and riparian connectivity along concrete-lined reaches of the South Fork through the City of Santa Clarita to the mainstem of the Santa Clara River (Wiley Canyon Rd to Lyons Ave). Maintain connectivity between the South Fork and the large patch of upland habitat east of Wiley Canyon Rd near the transition from soft bottom to concrete-lined stream channel.	Reconnecting the South Fork Santa Clara River to the mainstem Santa Clara River supports ecological resilience of the upper portion of the South Fork Santa Clara River watershed within the Pass, particularly for aquatic and riparian species in the Pass that are relatively disconnected from broader Santa Clara River watershed under current conditions due to concrete lining and channelization of the South Fork through Santa Clarita. Maintaining connectivity of the large patch of upland habitat east of Wiley Canyon Rd supports its resilience and also supports maintaining connectivity of the Continental Scrub zone (see Figures 12 and 13- watersheds and ecosystem map).

Location	Code	Timeframe	Connectivity Program Recommendations	Purpose/Benefit
SR-14	2A	Near-term	Complete Los Piñetos SR-14 underpass enhancement measures and determine whether permanent connectivity to the Los Piñetos underpass through private land on the west end of the underpass (i.e., Forum Engineering Property) can be secured.	Improves connectivity for wildlife to access Los Piñetos and the quality of connectivity beneath SR-14, including the adjacent connection to Newhall Creek to the west. These measures support connectivity to the new I-5 crossing from the San Gabriel Mountains.
	2B	Near-term	If permanent connectivity to Los Piñetos from the west cannot be secured and/or if expected connectivity benefits of other crossing alternatives are confirmed to be superior and worthwhile (as suggested by this suitability analysis), complete 65% design of new crossing site alternative for the SR-14 (i.e., Beale's Cut North and South or Sierra Highway Over/Under).	Securing a high-quality, permanent crossing of SR-14 is critical to maintaining connectivity to the new I-5 crossing and between the Santa Susana and San Gabriel Mountains
	2C	Near-term	Design associated Sierra Highway connectivity enhancements to 65% based on SR-14 crossing location selected in 2A and/or 2B	Wildlife vehicle collisions are frequent on Sierra Highway. Evaluate fencing and other measures along Sierra Highway to reduce collisions and improve connectivity between major crossing structures on I-5 and SR-14.
	2D	Medium-term	Complete construction of a new permanent crossing, or enhanced Los Piñetos crossing, of SR-14 and Sierra Highway and associated stewardship actions on adjacent lands.	See 2A-2C
	2E	Long-term	Evaluate, and construct as appropriate, an underpass crossing structure of SR-14 at Bull Creek favoring riparian, and potentially aquatic, conditions (Sierra Highway Over Under, if not completed as 2D)	Restoring connectivity of streams of major watersheds supports ecological resilience, particularly for riparian and aquatic species and considering expected ecological tipping points in the coming decades.
	2F	Long-term	Evaluate, and construct as appropriate, an overcrossing at the Pass/boundary between the Santa Clara and the Los Angeles River watersheds of SR-14 favoring upland conditions (Beale's Cut North or South, if not completed as 2D)	Restoring upland connectivity at major watershed boundaries supports regional ecological resilience, particularly for long-term movement of species and ecological processes between watersheds as climate change-driven landscape change are expected to accelerate in the coming decades.
	2G	Long-term	Evaluate, and construct as appropriate, an underpass crossing enhancement of SR-14 at Elsmere/Whitney Canyon branch of Newhall Creek.	See 2E
I-5/SR 14 interchange and south of the "Y"	3A	Medium-term	Conduct a feasibility study of crossing enhancements for I-5/SR-14 interchange and south of the Y. Select single crossing location and design to 65%.	Natural lands adjacent to I-5 and SR-14 south of the Y are included in the California Essential Linkages zone and the Rim of the Valley Corridor Area, demonstrating the importance of these areas to connectivity (Figures 1 and 3) Crossings in these locations may be beneficial and should be evaluated further. Several unique ecosystems (Coastal Scrub zone) and watersheds (Bull Creek) are also bisected by freeways in this (see Figures 12 and 13-watersheds and ecosystem map). Restoring connectivity would provide more complete of ecological conditions that may support long-term resilience of species and ecosystems in the Pass, the Santa Susana Mountains, and the San Gabriel Mountains, particularly for species that favor the ecological conditions on the south slope of the Pass.
	3B	Long-term	As appropriate per 3A, design and construct an underpass crossing enhancement and associated riparian and aquatic habitat restoration of Bull Creek within the I-5/SR-14 interchange (Bull Creek South on Figure 81, below).	Connectivity of Bull Creek would provide connectivity emphasizing riparian, aquatic, and low-elevation montane hardwood species, between the Santa Susana Mountains and San Gabriel Mountains within the Los Angeles River watershed, supporting greater regional ecological resilience. This measure would also improve connectivity with aquatic, upland, and riparian habitat areas within Metropolitan Water District facilities downstream of the project area on Bull Creek within the City of Los Angeles.
	3C	Long-Term	As appropriate per 3A, design and construct an overcrossing of the I-5/SR-14 interchange to provide upland connectivity along the south slope of the Pass between the Michael D. Antonovich Open Space in the Santa Susana Mountains and the south slope of San Gabriel Mountains	The south slope of the Pass includes unique subregional microclimates with a stronger maritime influence, differing geology, and biota compared with the northern slope and the crest areas of the Pass. Conservation networks that include a connected network of such unique ecological conditions, or geodiversity, are believed to be best suited for supporting regional ecological resilience to climate change.

Location	Code	Timeframe	Connectivity Program Recommendations	Purpose/Benefit
General (all areas of the Pass)	4A	Near-term	Replicate NPS *LA Metro and Caltrans Recommendations for Improved Wildlife Permeability* study for entire Pass area, including SR-14 and I-5 south of the Weldon Bridge	Will improve connectivity and protect wildlife beyond the benefits provided by major crossing structures that are emphasized here.
	4B	Near-term	Pass-wide wildlife survey and movement study	Wildlife patterns and movement east of I-5 and along SR-14 (NPS has been monitoring areas west of I-5) are not well documented to support future design measures/planning (current understanding of wildlife movement is believed to be sufficient for near-term measures of advancing the Old Road X and Weldon North Crossing design measures; see 1A).
	4C	Near-term	Pass-wide fencing study along SR-14 and I-5 associated with near-term connectivity measures	Fencing will reduce vehicle collisions and funnel wildlife to crossing structures.
	4D	Near-term	Pass-wide wildfire management action plan, or similar	Restoring wildfire regime to natural frequency in over-burned areas, especially east of SR-14, will improve resilience of biodiversity and connectivity strategies.
	4E	Near-term	Pass-wide land acquisition evaluation and strategy	Securing private land for permanent protection, particularly parcels adjacent to crossing locations, will improve function of crossings (see Figure 10: Land Conservation and Ownership Status).
	4F	Near-term	Develop Pass-wide ecological restoration, climate resilience & stewardship plan	Formal study and planning to address restoration needs; specific climate change tipping points, stressors, exposures, and vulnerabilities; and needed stewardship actions and entities will be key for success. The above recommendations can serve as a key component for such a plan.

6.1 Near-term Program Recommendations

Construction of a crossing of I-5 freeway is the most urgent need for addressing connectivity in the Pass to align with the goals of achieving resilience of mountain lion populations and existing biodiversity. **We recommend advancing the Old Road Underpass and the Weldon North Overcrossing forward in the Environmental Documentation Phase of the project, during which a single preferred alternative will be selected and carried through to 65% design.** An I-5 crossing was deemed a higher priority than an SR-14 crossing in the near-term because the Los Piñetos underpass of SR-14 currently provides connectivity between the "Y" and the San Gabriel Mountains, while connectivity across I-5 is currently limited to small culverts, the unvegetated and constrained Old Road underpass, and the future unvegetated new Weldon Bridge. The site selection criteria perform similarly for both sites and we recommend both be carried forward to the environmental document stage and a preferred crossing be determined then.

By adding a high-quality crossing of I-5 as the next major step in sustaining Pass-wide connectivity, a relatively high-quality connection between the Santa Susana and San Gabriel mountains can be achieved. However, importantly, with private land surrounding the west end of the Los Piñetos underpass of SR-14, the permanence of connectivity to the future I-5 crossing from the San Gabriels is uncertain. Therefore, an additional key near-term action is to determine a solution for a permanent crossing of SR-14 by either securing connectivity through private land to Los Piñetos or pursuing a new crossing site.

The unnaturally high level of wildfire along the east side of SR-14 is a significant concern for the permanence of all crossing site alternatives along SR-14, and by extension I-5. Wildfire especially threatens chaparral, montane, riparian, and oak woodland habitats because unnaturally frequent wildfires drive vegetation type conversions to scrub and non-native grasslands. Emerging climate change stressors may exacerbate wildfire and result in an overall reduction in these woodland habitat types that rely on cooler and moister microclimates, as well as a reduced climate refuge value for wildlife within the area.

A study of wildfire stewardship strategies for the Pass, and especially the SR-14 segment, is an important near-term action. Additional-near term program elements are recommended in Table 13 to support Pass-wide connectivity enhancement and should occur within approximately the next six years.

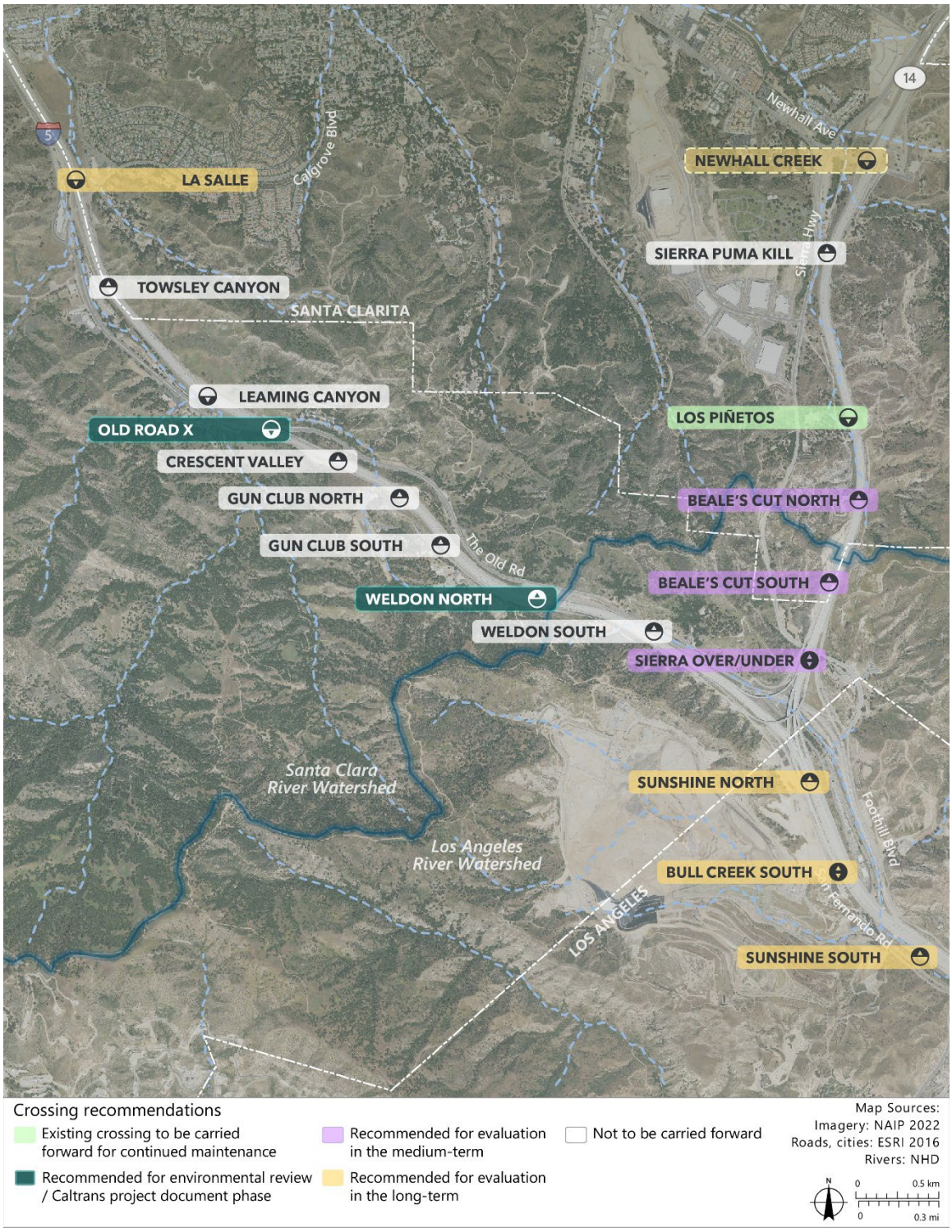


Figure 81. Overview of crossing recommendations broken out by phases.



Figure 82. Near-term primary connectivity benefits. Two crossings, one at I-5 and one at SR-14, connect Santa Susana and San Gabriel Mountains.

6.2 Medium-term Program Recommendations

A medium-term (approximately 6 to 10 years) priority should be to secure permanent connectivity between the new I-5 crossing and the San Gabriel Mountains by either constructing a new crossing of SR-14, or permanently conserving and restoring lands under and around the Los Piñetos underpass. In its current condition, the Los Piñetos crossing of SR-14 cannot be relied upon to provide connectivity between the San Gabriel and Santa Susana mountains because the land surrounding the west end of the existing underpass is privately held and zoned for development. Therefore, it is a risk to the long-term connectivity between the recommended new crossing of I-5 and the San Gabriel Mountains to the east. While connectivity modeling and observation records of the Los Piñetos crossing suggest adequate connectivity, especially for coastal sage scrub habitat and species, mountain lions have not been observed using the crossing. Therefore, extensive surrounding restoration of woodland and chaparral habitats to the east soul also accompany land conversation at Los Piñetos to the west. The somewhat isolated location away from the primary ridgeline of the San Gabriels and steep slopes to the east of Los Piñetos may also be reasons mountain lions are not using the crossing. These factors could not be remedied by restoration activities. A wildlife study east of SR-14, including mountain lion collaring may be beneficial to answer these questions.

Currently, other modeled crossing sites on SR-14 suggest better connectivity opportunities for mountain lions and for montane and riparian habitats. The Beale's Cut South and Sierra Over/Under alternatives are surrounded by conserved or potentially conservable government-owned land on both sides. The Beale's Cut North location was modeled as the best location for overall connectivity for focal habitat types along SR-14 but also includes private land on the west like Los Piñetos. The feasibility of these crossings should also be studied further.

As demonstrated by the two precedent Southern California wildlife crossing projects discussed in Section 3.6, emerging connectivity best management practices suggest that high quality regional corridors should include both riparian and upland connectivity to maximize movement of diverse biota and ecological processes. Dramstad et al. (1996) also suggest the principle of "redundancy" be applied to corridors connecting significant habitat patches, whereby major habitat patches or corridor zones include at least two corridors in case one fails in the future. This principle may be especially important considering accelerating climate change and associated range shifts and disturbance processes. Therefore, as an additional medium-term measure, we suggest that a second crossing be advanced along I-5 at either Weldon North or Old Road X, whichever is not advanced in the current phase of work. By including both crossings, redundancy and diverse lower-elevation riparian and higher-elevation upland/montane woodland-oriented crossings will maximize potential suitability for movement of diverse biota and ecological processes prior to the arrival of expected climate tipping points in the coming decades, as discussed in Section 3.5.

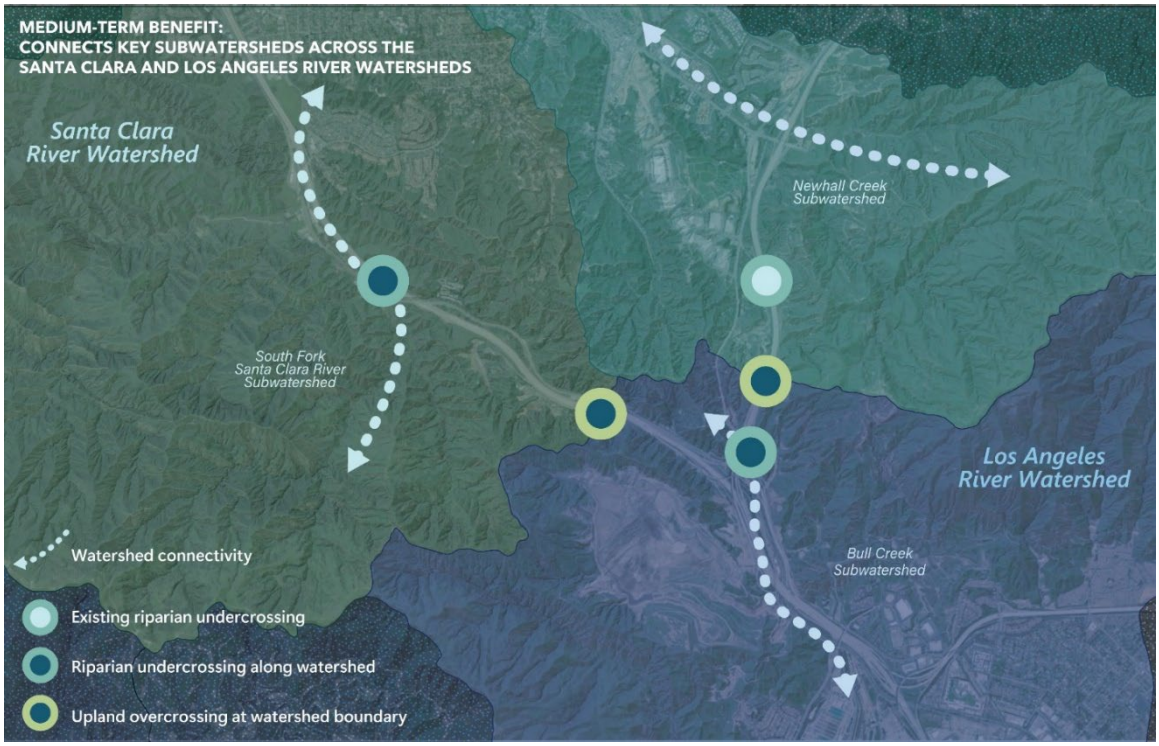


Figure 83. Medium-term benefits. Diverse connectivity for upland and riparian habitats within each major subwatershed of the Santa Clara and Los Angeles Rivers within the Pass. Restores primary ridgelines at major watershed boundaries and supports climate resilience and movement of diverse biota.

6.3 Long-term Program Recommendations

The following long-term recommendations consider a 10-year plus timeline. Given the 75-year design life of major crossing structures (AASHTO 2017), combined with accelerating climate-driven ecological change expected over this period, it is appropriate to consider such a long-term timeframe for the project. With anticipated climate tipping points being reached and exceeded in this time period, over the long term we may see a substantial expansion in conservation and connectivity measures occurring across the region. The Newhall Pass will likely be integral as a regional connectivity and biodiversity hotspot. Therefore, substantial additional connectivity measures in the Pass are recommended for consideration in the long term.

Expanding upon the near- and medium-term recommendations to complete a single permanent crossing of SR-14 and I-5, and a new second crossing of I-5, a key long-term recommendation is to add a second permanent crossing of SR-14. This measure supports the principle of achieving connectivity redundancy by also providing two crossings of the of the regionally significant SR-14 barrier. By providing one crossing that focuses on upland habitat connectivity and one that focuses on riparian habitat connectivity along both I-5 and SR-14 in the long term, both freeways would be aligned with the riparian and upland connectivity provided at precedent Anneberg Crossing and the I-15 crossings presented in Section 3.6.

Additionally, given the confluence of three different subregional-scale watersheds and multiple ecosystem types within the Pass (see Figure 84), additional crossing structures are recommended to create a resilient framework over the long term that reconnects major watershed and ecosystem patterns with the goal of "connecting natures stage" (McCrea et al. 2016). Providing riparian and upland crossings at each of the three primary waterways/watersheds within the Pass, including Newhall Creek, Bull Creek, and the South Fork of the Santa Clara River, would support more complete restoration of watershed connectivity and associated resilience benefits along these waterways. Additionally, each creek ultimately flows into either the Cities of Santa Clarita or Los Angeles, where they are heavily modified, often with concrete lining, before they connect with the mainstem Santa Clara or Los Angeles rivers downstream. Therefore, many riparian and aquatic species are disconnected within these upper watershed areas within the Pass and re-connecting these waterways with the mainstem rivers through these Cities (downstream of the Pass) over the long term is recommended to support watershed and ecosystem resilience. Urban waterway restoration and connectivity efforts are in progress for the Los Angeles River including the Los Angeles River Masterplan (2022), Rim of the Valley Plan (2016) and the Upper Los Angeles River & Tributaries (ULART) Plan (2023).

Finally, the major ecological zones, which are generally oriented east to west along topographic and microclimate gradients, are also increasingly fragmented in lower elevation areas as they approach the Cities. Efforts should be made to maintain and restore connectivity between increasingly fragmented patches of upland vegetation within them to improve resilience of habitat types and regional connectivity along these major ecological gradients. The following diagrams suggest the general locations for all potential crossing structures needed to restore these overarching ecological patterns, also known as "nature's stage".

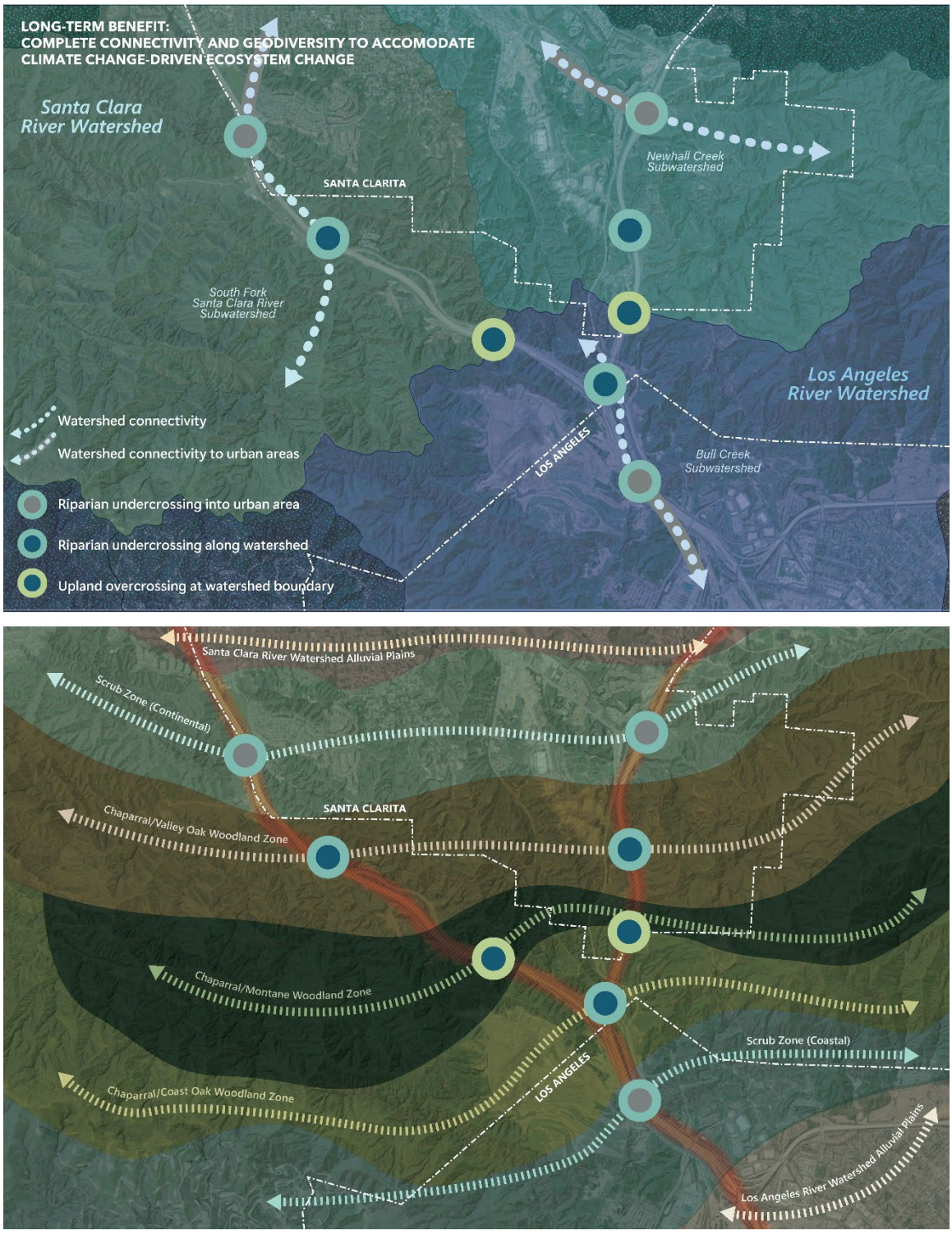


Figure 84. Striving for complete connectivity of subregional watersheds (top) and ecosystems (bottom) over the long term to accommodate long-term climate change-driven ecosystem change and species range shifts (conserving "nature's stage" – see Section 3.5 for more information) (McCrea et al. 2016; Brown 2019; Gordon, Bailey & Larwood 2022).

6.4 Adaptive Management and Monitoring Recommendations

For the project to produce lasting, safe passage for wildlife and other ecological resilience benefits, it is important to address monitoring and adaptive management considerations early in the planning and design process. Much of the work performed to date can serve as a valuable baseline for initiating adaptive management and monitoring programs and to support design refinements in later phases of the project. The ecological characterization, refined vegetation mapping, and associated habitat suitability and connectivity modeling presented in Section 3 can serve as a baseline from which future ecological change can be measured in the Pass to help guide adaptive management decisions. As we have seen during this analysis of existing datasets, landcover in the Newhall Pass is in a constant state of change. Clearly, the drought of the 2010's took a toll on vegetation communities as evidenced by changes in wildfire frequency and vegetation types mapped by the MULC remote sensing study compared to vegetation types that were mapped in the circa 2000 CalVeg dataset (See Appendix A). However, field visits during the spring and summer of 2023 revealed that large areas of vegetation are also recovering well post-fire. Field visits also revealed edge effects such as dumping of fill material in formerly riparian areas along Sierra Highway north of SR-14 and extensive, potentially unauthorized, mountain bike trail networks that may be impacting wildlife behavior.

Focused monitoring of vegetation and additional wildlife studies within the Pass should be completed in the near-term to support decision making around management actions, including additional crossings, restoration activities, and land acquisitions discussed in the above subsections. Additional near-term wildlife monitoring, including radio collar studies of mountain lions and camera trapping along SR-14 and I-5 south of the Y, would be helpful for refining recommendations for future crossings along those segments of Pass freeways and can provide a needed baseline for monitoring change once crossings are constructed. Changes to land conservation status and regulations relevant to wildlife connectivity should also be closely monitored for potential implications for crossing site selection and design. Any changes to these connectivity contextual factors could also be used to update the Omniscape model, which may reveal new insights into optimal crossing locations and ongoing adaptive management needs.

As recommended crossing alternatives are carried forward in this study, and a preferred alternative is selected for 65% design, the following additional adaptive management and monitoring topics should be considered and incorporated into decision making and design documentation as appropriate: wildlife movement success; establishment, health, and long-term sustainability of vegetation on and adjacent to crossing structures; success of adaptation and restoration associated with disturbances over time such as wildfire, drought, or long-term climate change and associated species range shifts; ability of crossing structures and potential design changes to accommodate new emerging regional wildlife movement concerns; and, implications of potentially conflicting uses such as trails, land development, and other human activities and edge effects on crossing structures or in adjacent wildlife movement corridor areas.

Given the highly urban surrounding context and high profile of this project once constructed, adaptive management activities should also consider topics such as community awareness, perceptions and behavior that may benefit or impact connectivity in the Pass. Understanding and perceived value by local communities is key to success of conservation actions within highly urbanized areas (Opdam et al. 2013). Monitoring these community characteristics may help understand and preemptively address any potential future human use-wildlife or ecological conflicts that may arise after implementation.

Discussions around the roles and responsibility for adaptive management and monitoring for the structure to be designed to 65% will be explored and identified during subsequent tasks. Broader, Pass-wide adaptive management and monitoring discussions should also be considered, scoped and applications made supporting funds. CDFW will continue to provide leadership on overarching regional and state-wide connectivity goals and modeling and will be closely engaged. Caltrans will certainly be integral in long-term management of built infrastructure within their right of way. Local conservancies and conservation authorities such as MRCA and the City of Santa Clarita's Open Space Preservation District should also be engaged to explore potential stewardship roles for habitat structures. At the Annenberg Wildlife Crossing of SR-101, the adjacent land manager, MRCA, assumed responsibility for the long-term management of the habitat "surface" of the crossing structure and its approach habitat within the CalTrans ROW, with CalTrans maintaining the structure itself. For most conserved land in the Pass, MRCA is the public land manager west of I-5, with City of Santa Clarita Open Space Protection District managing the lands east of I-5 and both sides of SR-14 ROW. LADWP and MWD are key government landowners, especially near the Y interchange of I-5 and SR-14. The needs and capacities of all land management entities and project partners will be considered in the management and monitoring of the project.

6.5 Toward Implementation

Ultimately, this feasibility study is only the first step toward identifying the best crossings for I-5 and SR-14. The site chosen will be a crossing of I-5 freeway and associated frontage roads, due to its ranking as the most critical regional connectivity need, according to CDFW. Not only does this study validate the CDFW's assessment, but it also emphasizes additional connectivity needs for SR-14. The two I-5 alternatives recommended to be carried forward from this feasibility study, Old Road X and Weldon North, will be first taken through CEQA, during which a preferred alternative will be identified, and then taken to 65% design completion. This will complete the overall Newhall Pass Wildlife Connectivity Design Project (this project).

Making the selected alternative crossing feasible will not only require funding, but also continued engagement with the community to gather input and create co-authorship opportunities. We have begun that process with the most significant community within the study area: Crescent Valley Mobile Home Park. Initial meetings with community representatives have been favorable overall. They have been particularly supportive of the Old Road X crossing alternative, which is at the doorstep of their community and essentially their 'front yard'. We were encouraged enough by the interaction to extend, at a conceptual level, the viaduct design and explore a new access point to the community through a gap in the riparian woodland to an existing roadway within the community.

Fostering public awareness and interest in the crossing structures consistently through the project's planning, design, and implementation presents a prime opportunity to build a perception of value by the public and a visual identity for the project; integrating significant architectural elements within the crossing structure's design rather than surface treatment alone is integral to achieving infrastructure that enriches surrounding communities as a "placemaking" feature and achieving wildlife connectivity. A wildlife crossing structure is a two-way gateway: for wildlife it is a movement passage and for humans it is a portal. In this case, it is a portal into and out of a megacity, Los Angeles, from the north and has always been a key access location for indigenous communities for generations. Coherent iconography within the future structure that reflects this dual nature creates public infrastructure that serves public aspirations beyond transportation. It transcends the status of 'bridge for dirt' and becomes a celebration of a future we want. Importantly, the public process involved in this next phase will inform the iconography of the project.

Ongoing coordination with our California and federal agency partners for advanced planning and fund development is a concurrent next step during the environmental document phase. Some elements of the overall project (phases of habitat restoration, County road and park-related improvements, etc.) may be fundable in part by local agencies (City/County). With each passing year, regulatory incentives and requirements for wildlife habitat connectivity enhancement increase, with California leading the way. Engaging with lawmakers is also a key part of the implementation strategy.

Various NGO and philanthropic organizations include connectivity in their missions. Regardless of the funding source, highlighting the unique characteristics of each site to show what people are donating to and motivate donations of all sizes will be essential to progressing the selected projects. As an example, we heard numerous bear stories from Crescent Valley community members surrounding and in the vicinity of the Old Road X crossing alternative. Emphasizing iconic species ("charismatic megafauna") such as the bear and mountain lion increases awareness and visibility and makes the project personable. Charismatic "minifauna", such as the abundant local Horned Lizard and endangered aquatic Stickleback might also be highlighted to foster approachability within the project.

An individual puma, P-22, came to symbolize the Liberty Canyon/Wallis-Annenberg wildlife crossing and helped to promote the project's identity and implementation. Facts and figures related to the unique scale and opportunity of such projects can also generate intrigue and attention and bolsters positive inertia for projects. For the Weldon North alternative, the bridge deck, if constructed, would be the longest spanning wildlife crossing in the United States, and maybe the world. For the Old Road X alternative, 1,500 feet of surface roadway would be replaced by 1,500 linear feet of restored stream and riparian habitat.
Funding implementation will require a combination of iconic architecture and motivational storying of the project through key fauna and other exceptional features to help donors understand the cause they are supporting, inspire contributions of all sizes, and communicate the importance of wildlife conservation to the public.

6.6 Next Steps

We recommend that the Old Road X and the Weldon North alternatives advance to the Caltrans Project Development Process, starting with the preparation of a PID document—in this case the development of a PSR-PDS document. These locations demonstrate the best balance of ecological, permanence, and constructability potential. These locations will be further studied and evaluated during Caltrans project development and subsequent CEQA and NEPA regulatory pathways when a single alternative will be selected for 65% design. A design firm will be selected to complete 65% design documents.

It is clear that success of a single crossing alone cannot meet ecological resilience needs of such an integral location for regional connectivity and ecosystem functions. Recommendations provided throughout this document pertaining to the broader Pass should be advanced via new project pathways. Efforts to secure a permanent crossing of SR-14 should proceed immediately, as should further baseline wildlife and habitat studies along SR-14 and I-5 south of the Y.

7 REFERENCES

Ackerson, B.K. & Harveson, L.A. (2006) 'Characteristics of a ringtail (Bassariscus astutus) population in Trans Pecos, Texas', Texas Journal of Science, 58, pp. 169-184.

Ager, A. A., Johnson, B. K., Kern, J. W., & Kie, J. G. (2003). Daily and seasonal movements and habitat use by female Rocky Mountain elk and mule deer. Journal of Mammalogy, 84, 1076–1088.

Alexander, J. L., Olimb, S. K., Bly, K. L. S., & Restani, M. (2016). Use of least-cost path analysis to identify potential movement corridors of swift foxes in Montana. Journal of Mammalogy, 97(3), 891–898. https://doi.org/10.1093/jmammal/gyw032

Allen, L.W., M. Carmona-Freeman, D.S. Cooper, J. Feenstra, K.L. Garrett, G. George, M. Loquvam, E. Osgood, T. Ryan, M. San Miguel, and S. Vigallon. 2009. Los Angeles County's Sensitive Bird Species. Western Tanager 75(3). January/February 2009.

American Association of State Highway & Transportation Officials (AASHTO). (2017). LRFD Bridge Design Specifications (8th ed.). Accession Number: 01650633, Record Type: Publication, ISBN: 9781560516545, Report/Paper Numbers: LRFD-8.

Amstrup, S. C., & Beecham, J. (1976). Activity Patterns of Radio-Collared Black Bears in Idaho. The Journal of Wildlife Management, 40(2), 340–348. https://doi.org/10.2307/3800435

Bard, S. M., & Cain, J. W. (2020). Investigation of bed and den site selection by American black bears (Ursus americanus) in a landscape impacted by forest restoration treatments and wildfires. Forest Ecology and Management, 460, 117904. https://doi.org/10.1016/j.foreco.2020.117904.

Barnum, D. A. (1975). Ecology of the Western Gray Squirrel. Washington State University.

Barrett, K., & Price, S. J. (2014). Urbanization and stream salamanders: a review, conservation options, and research needs. Freshwater Science, 33(3), 927-940. University of Chicago Press.

Barja, I., & List, R. (2006). Faecal marking behaviour in ringtails (Bassariscus astutus) during the non-breeding period: spatial characteristics of latrines and single faeces. Chemoecology, 16, 219–222.

Barnes B.V., Pregitzer K., Sipes T., Spooner V. (1982) Ecological forest site classification. Journal of Forestry.493-498.

Bartelt, P. E., Peterson, C. R., & Klaver, R. W. (2004). Sexual differences in the postbreeding movements and habitats selected by Western toads (Anaxyrus boreas) in southeastern Idaho. Herpetologica, 60, 455–467.

Bell, M. C. (Ed.). (1991). Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Behrends, P., Daly, M., & Wilson, M. I. (1986). Range use patterns and spatial relationships of Merriam's kangaroo rats (Dipodomys merriami). Behaviour, 96(3/4), 187-209. Brill. Retrieved from http://www.jstor.org/stable/4534505

Beier, P. (1995). Dispersal of Juvenile Cougars in Fragmented Habitat. The Journal of Wildlife Management, 59(2), 228–237. https://doi.org/10.2307/3808935

Beier, P., Hunter, M. L., & Anderson, M. (2015). Special Section: Conserving Nature's Stage. Conservation Biology, 29(3), 613-617.

Beier, P., Riley, S. P. D., & Sauvajot, R. M. (2010). Mountain lions (Puma concolor). In S. D. Gehrt, S. P. D. Riley, & B. L. Cypher (Eds.), Urban Carnivores: Ecology, Conflict, and Conservation (pp. 141–156). The Johns Hopkins University Press, Baltimore, USA.

Benson, J. F., Mahoney, P. J., Sikich, J. A., Serieys, L. E. K., Pollinger, J. P., Ernest, H. B., et al. (2016). Interactions between demography, genetics, and landscape connectivity increase extinction probability for a small population of large carnivores in a major metropolitan area. Proceedings of the Royal Society B: Biological Sciences, 283, 20160957. https://doi.org/10.1098/rspb.2016.0957

Best, T., & Granai, N. (1994). Tamias merriami. Mammalian Species, 476, 1-9.

Blakey, R. V., Sikich, J. A., Blumstein, D. T., Riley, S. P. D., et al. (2022). Mountain lions avoid burned areas and increase risky behavior after wildfire in a fragmented urban landscape. Current Biology, 32, 4762–4768. Elsevier Inc. https://doi.org/10.1016/j.cub.2022.08.082

Block, W. M., & Morrison, M. L. (1998). Habitat relationships of amphibians and reptiles in California oak woodlands. Journal of Herpetology, 32(1), 51–60. https://doi.org/10.2307/1565478

Borchert, M. I., & DeFalco, L. A. (2016). Yucca brevifolia fruit production, predispersal seed predation, and fruit removal by rodents during two years of contrasting reproduction. American Journal of Botany, 103, 830-836. https://doi.org/10.3732/ajb.1500516

Brattstrom, B. (2013). Distribution of the coast horned lizard, Phrynosoma coronatum, in Southern California. Bulletin, Southern California Academy of Sciences, 112, 206-216. https://doi.org/10.3160/0038-3872-112.3.206

Brehme, C. S., Barnes, S., Ewing, B., Gould, P., Vaughan, C., Hobbs, M., Tornaci, C., Holm, S., Sheldon, H., Fiutak, J., & Fisher, R. N. (2023). Elevated road segment (ERS) passage design may provide enhanced connectivity for amphibians, reptiles, and small mammals. Frontiers in Ecology and Evolution, 11. https://doi.org/10.3389/fevo.2023.1145322

Brennan, M. M., Whitmee, S., Braneon, C. V., Meinsma, N., & Green, R. (2022). Sea level rise and city-level climate action. European Journal of Environmental and Public Health, 6(2), em0111. https://doi.org/10.21601/ejeph/12046

Brown, I. T. (2019). Managing Cities as Urban Ecosystems: Analysis Tools for Biodiversity Stewardship in Los Angeles. *UCLA*. ProQuest ID: Brown_ucla_0031D_18469. Merritt ID: ark:/13030/m53r60sg. Retrieved from https://escholarship.org/uc/item/4c81w4nr

Brunk, K. M., Gutiérrez, R. J., Peery, M. Z., et al. (2023). Quail on fire: changing fire regimes may benefit mountain quail in fire-adapted forests. Fire Ecology, 19, 19. https://doi.org/10.1186/s42408-023-00180-9

Bryant, H. C. (1916). Habits And Food Of The Roadrunner In California. Kessinger Publishing. ISBN-10: 1166560600

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., & Laake, J. L. (1993). Distance sampling: Estimating abundance of biological populations. Biometrics, 50(3). https://doi.org/10.2307/2532812

Harestad, A. S., & Bunnell, F. L. (1983). Dispersal of a yearling male black-tailed deer. Northwest Science, 57(1). https://hdl.handle.net/2376/1904

Calder, W. A. (1968). The Diurnal Activity of the Roadrunner, Geococcyx Californianus. The Condor, 70(1), 84-85. [Available at: https://sora.unm.edu/sites/default/files/journals/condor/v070n01/p0084-p0085.pdf]

Calder, W., & Schmidt-Nielsen, K. (1967). Temperature regulation and evaporation in the pigeon and the roadrunner. American Journal of Physiology, 213, 883-889.

California Department of Fish and Game. (1998). Black bear management plan. California Department of Fish and Game, Sacramento. Retrieved from http://www.dfg.ca.gov/wildlife/hunting/bear/.

California Department of Fish and Wildlife. (2020). Wildlife Movement Barrier Priorities – CDFW – 2020 [ds2867] – California Open Data. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=178511

California Department of Fish and Wildlife. (2022). Science: Habitat Connectivity. Available at: https://wildlife.ca.gov/Science-Institute/Habitat-Connectivity

California Energy Commission (2021). Cal-Adapt. Available at: https://cal-adapt.org/

California Natural Resources Agency (2022). 30x30. Available at: https://www.californianature.ca.gov/pages/30x30

California, State of. (2024). California Climate Adaptation Strategy. Available at: https://climateresilience.ca.gov/ (Accessed March 19, 2024).

Caldwell, P. M., Terai, C. R., Hillman, B., Keen, N. D., Bogenschutz, P., Lin, W., et al. (2021). Convection-permitting simulations with the E3SM global atmosphere model. Journal of Advances in Modeling Earth Systems, 13, e2021MS002544. https://doi.org/10.1029/2021MS002544

Carroll, K. A., Hansen, A. J., Inman, R. M., Lawrence, R. L., & Hoegh, A. B. (2020). Testing landscape resistance layers and modeling connectivity for wolverines in the western United States. Global Ecology and Conservation, 23, e01125. https://doi.org/10.1016/j.gecco.2020.e01125.

Clark, J. D., Dunn, J. E., & Smith, K. G. (1993). A multivariate model of female black bear habitat use for a Geographic Information System. The Journal of Wildlife Management, 57, 519–526.

Cooper, D. S. (2008). Ecological assessment of open space remnants in northeastern Los Angeles. Prepared for Mountains Recreation and Conservation Authority.

Cooper, D.S. (2014). Wildlife of Fern Dell, Griffith Park, Los Angeles, California. Prepared for Friends of Griffith Park, March 10, 2014.

Cooper, D. S., & Muchlinski, A. E. (2015). Recent decline of lowland populations of the Western Gray Squirrel in the Los Angeles area of Southern California. Bulletin of the Southern California Academy of Sciences, 114(1), 42–53. https://doi.org/10.3160/0038-3872-114.1.42

Cooper, D.S. and P. Mathewson. (2009). Griffith Park wildlife management plan (Final). Report submitted to the Los Angeles Dept. of Recreation and Parks by Cooper Ecological Monitoring, Inc., Contract No. 2930. Jan. 22, 2009. 94 Pp, incl. appendices. Available at www.griffithparkwildlife.org.

Corlatti, L., Hackländer, K., & Frey-Roos, F. (2009). Ability of wildlife overpasses to provide connectivity and prevent genetic isolation. Conservation Biology, 23, 548-556. https://doi.org/10.1111/j.1523-1739.2008.01162.x

Correa Ayram, C., Mendoza, M., Pérez-Salicrup, D., & Granados, E. (2014). Identifying potential conservation areas in the Cuitzeo Lake basin, Mexico by multitemporal analysis of landscape connectivity. Journal for Nature Conservation, 22, 424-435. https://doi.org/10.1016/j.jnc.2014.03.010.

Costello, C. M. (2010). Estimates of dispersal and home-range fidelity in American black bears. Journal of Mammalogy, 91(1), 116–121. https://doi.org/10.1644/09-MAMM-A-015R1.1

Connell, J. H. (1954). Home range and mobility of brush rabbits in California chaparral. Journal of Mammalogy, 35(3), 392–405. https://doi.org/10.2307/1375964
Cramer, P. (2013). Design recommendations from five years of wildlife crossing research across Utah. Technical report, Proceedings of the 2013 International Conference on Ecology and Transportation.

Crooks, K. R., Suarez, A. V., Bolger, D. T., & Soule, M. E. (2001). Extinction and recolonization of birds on habitat islands. Conservation Biology, 15, 159-172.

Dalke, P. D., & Sime, P. R. (1938). Home and seasonal ranges of the eastern cottontail in Connecticut. Transactions of the Third North American Wildlife Conference, 659-669.

Deguise, I., & Richardson, J. S. (2009). Movement behaviour of adult western toads in a fragmented, forest landscape. Canadian Journal of Zoology, 87(12), 1184-1194. https://doi.org/10.1139/Z09-109

Delaney, K. S., Riley, S. P. D., & Fisher, R. N. (2010). A Rapid, Strong, and Convergent Genetic Response to Urban Habitat Fragmentation in Four Divergent and Widespread Vertebrates. PLoS ONE, 1(9), e12767.

deMaynadier, P. G., & Hunter, M. L. J. (1995). The relationship between forest management and amphibian ecology: A review of the North American literature. Environmental Reviews, 3, 230-261. https://doi.org/10.1139/a95-012

Delaney, K., Busteed, G., Fisher, R., & Riley, S. (2021). Reptile and amphibian diversity and abundance in an urban landscape: Impacts of Fragmentation and the Conservation Value of Small Patches. Ichthyology & Herpetology, 109. https://doi.org/10.1643/h2019261

Dramstad, W. E., Olson, J. D., & Forman, R. T. T. (1996). Landscape Ecology Principles in Landscape Architecture and Land-Use Planning.

Dunagan, S. P., Karels, T. J., Moriarty, J. G., Brown, J. L., & Riley, S. P. (2019). Bobcat and rabbit habitat use in an urban landscape. Journal of Mammalogy, 100(2), 401-409.

Dunford, C. E., Marks, N. J., Wilmers, C. C., et al. (2020). Surviving in steep terrain: a lab-to-field assessment of locomotor costs for wild mountain lions (Puma concolor). Movement Ecology, 8, 34. https://doi.org/10.1186/s40462-020-00215-9

Dusek, G. L., Mackie, R. J., Herriges, J. D. Jr., & Compton, B. B. (1989). Population ecology of white-tailed deer along the lower Yellowstone River. Wildlife Monographs, 104, 1-68.

Ernest HB, Vickers TW, Morrison SA, Buchalski MR, Boyce WM (2014) Fractured Genetic Connectivity Threatens a Southern California Puma (*Puma concolor*) Population. PLoS ONE 9(10): e107985. https://doi.org/10.1371/journal.pone.0107985

Elowe, K. D., & Dodge, W. E. (1989). Factors affecting black bear reproductive success and cub survival. The Journal of Wildlife Management, 53(4), 962–968. https://doi.org/10.2307/3809596

Fair, Wm. Scott, & Henke, S. E. (1999). Movements, Home Ranges, and Survival of Texas Horned Lizards (Phrynosoma cornutum). Journal of Herpetology, 33(4), 517–525. https://doi.org/10.2307/1565567

Farías González, V., Fuller, T., & Sauvajot, R. (2012). Activity and Distribution of Gray Foxes (Urocyon cinereoargenteus) in Southern California. The Southwestern Naturalist, 57, 176-181. https://doi.org/10.2307/23258044.

Fernandeño Tataviam Band of Mission Indians. https://www.tataviam-nsn.us/. Accessed: 12/20/2023

Folse, L. J., Jr. (1974). Population ecology of roadrunners (Geococcyx californianus) in South Texas. Master's thesis, Texas A&M University, College Station, TX.

Foster, M. L., & Humphrey, S. R. (1995). Use of Highway Underpasses by Florida Panthers and Other Wildlife. Wildlife Society Bulletin, 23(1), 95–100. http://www.jstor.org/stable/3783202

Freidin, R., Schreck, D., Scruggs, B., Shulman, E., Swauger, A., Tashnek, A., Longcore, T., & Boydston, E. (2011). Wildlife use of the Los Piñetos Underpass Santa Clarita, California. UCLA Institute of the Environment and Sustainability Environment 180 – Senior Practicum in Environmental Science. Client: Mountains Recreation and Conservation Authority.

Gagnon, J. (2005). Use of video surveillance to assess wildlife behavior and use of wildlife underpasses in Arizona. In: Proceedings of the 2005 International Conference on Ecology and Transportation. Raleigh, NC: Center for Transportation and the Environment, North Carolina State University.

Ganz, T. R., DeVivo, M. T., Kertson, B. N., Roussin, T., Satterfield, L., Wirsing, A. J., & Prugh, L. R. (2022). Interactive effects of wildfires, season and predator activity shape mule deer movements. Journal of Animal Ecology, 91, 2273–2288. https://doi.org/10.1111/1365-2656.13810

Garrett, K. L. (2016). Birds of the Baldwin Hills. Ornithology, Natural History Museum of Los Angeles County. Retrieved from https://bhc.ca.gov/webmaster/arc/documents/Biota_of_the_Baldwin_Hills_-_Birds.pdf

Gordon, J. E, Bailey, J. J, & Larwood, J. G. (2022). Conserving nature's stage provides a foundation for safeguarding both geodiversity and biodiversity in protected and conserved

areas. *Parks Stewardship Forum*, 38(1). http://dx.doi.org/10.5070/P538156118 Retrieved from https://escholarship.org/uc/item/8fp8v4wk

Gordon, K. M., McKinstry, M. C., & Anderson, S. H. (2004). Motorist response to a deer-sensing warning system. Wildlife Society Bulletin, 32, 565-573. https://doi.org/10.2193/0091-7648(2004)32[565:MRTADW]2.0.CO;2

Grigione, M. M., Beier, P., Hopkins, R. A., Neal, D., Padley, W. D., Schonewald, C. M., & Johnson, M. L. (2002). Ecological and allometric determinants of home-range size for mountain lions (Puma concolor). Animal Conservation, 5(4), 317-324. https://doi.org/10.1017/S1367943002004079

Gustafson, K. D., Gagne, R. B., Vickers, T. W., Riley, S. P., Wilmers, C. C., Bleich, V. C., & Ernest, H. B. (2019). Genetic source–sink dynamics among naturally structured and anthropogenically fragmented puma populations. *Conservation Genetics*, 20(2), 215–227. https://doi.org/10.1007/s10592-018-1125-0

Hall, H. M., & Grinnell, J. (1919). Life-zone indicators in California. Proceedings of the California Academy of Sciences, 9, 37-67. Retrieved from https://www.biodiversitylibrary.org/page/26463140#page/75/mode/1up

Hamlin, K. L., & Mackie, R. J. (1989). Mule deer in the Missouri River Breaks, Montana: A study of population dynamics in a fluctuating environment. Montana Department of Fish, Wildlife & Parks.

Harvey, T. "Life history account for Western Gray Squirrel" in Zeiner, D.C., W.F.Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1988-1990. California's Wildlife. Vol. I-III. California Depart. of Fish and Game, Sacramento, California.

Hult, S. M. (2014). Ecology and Demography of the Blainville's Horned Lizard (Phrynosoma blainvillii) in the Southern San Joaquin Valley of California. Master's thesis, California State University, Bakersfield. Retrieved from https://scholarworks.calstate.edu/downloads/mk61rm52t

Harrington, J. L., & Conover, M. R. (2006). Characteristics of Ungulate Behavior and Mortality Associated with Wire Fences. Wildlife Society Bulletin, 34, 1295-1305. https://doi.org/10.2193/0091-7648(2006)34[1295:COUBAM]2.0.CO;2

Heller, N. E., and E. S. Zavaleta. (2009) Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation 142:14–32.a

Harrison, R. L. (1997). A comparison of gray fox ecology between residential and undeveloped rural landscapes. The Journal of Wildlife Management, 61(1), 112–122. https://doi.org/10.2307/3802420

Hawkins, R. E., Klimstra, W. D., & Autry, D. C. (1971). Dispersal of deer from Crab Orchard National Wildlife Refuge. Journal of Wildlife Management, 35, 216-220.

Hemker, Thomas & Lindzey, Frederick & Ackerman, Bruce. (1984). Population Characteristics and Movement Patterns of Cougars in Southern Utah. Journal of Wildlife Management. 48. 1275-1284. 10.2307/3801788.

Howard, R., & Moore, A. (1991). A complete checklist of the birds of the world (2nd ed.). London: Academic Press Ltd.

Hygnstrom, S. E., Groepper, S. R., VerCauteren, K. C., Frost, C. J., Boner, J. R., Kinsell, T. C., & Clements, G. M. (2008). Literature review of mule deer and white-tailed deer movements in western and midwestern landscapes. Great Plains Research: A Journal of Natural and Social Sciences, 18(2), 219-231. https://digitalcommons.unl.edu/greatplainsresearch/962

IPCC. (2023). Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (H. Lee & J. Romero, Eds.). IPCC, Geneva, Switzerland, 184 pp. doi: 10.59327/IPCC/AR6-9789291691647.
Jones, W. T. (1989). Dispersal Distance and the Range of Nightly Movements in Merriam's Kangaroo Rats. Journal of Mammalogy, 70(1), 27–34. https://doi.org/10.2307/1381666

Jensen, M. P., Allen, C. D., Eguchi, T., Bell, I. P., LaCasella, E. L., Hilton, W. A., Hof, C. A. M., & Dutton, P. H. (2018). Environmental warming and feminization of one of the largest sea turtle populations in the world. Current Biology, 28(1), 154-159.e4. https://doi.org/10.1016/j.cub.2017.11.057.

Johnson, W. E., Onorato, D. P., Roelke, M. E., Land, E. D., Cunningham, M., Belden, R. C., McBride, R., Jansen, D., Lotz, M., Shindle, D., Howard, J., Wildt, D. E., Penfold, L. M., Hostetler, J. A., Oli, M. K., & O'Brien, S. J. (2010). Genetic restoration of the Florida panther. Science, 329(5999), 1641-1645. https://doi.org/10.1126/science.1192891.

Kammermeyer, K. E., & Marchington, R. L. (1976). Notes on dispersal of male white-tailed deer. Journal of Mammalogy, 57(4), 776-778.

Karasov-Olson, A., & Kelt, D. A. (2020). Small mammal assemblage composition and habitat associations across an elevational gradient in southern California. Journal of Mammalogy, 101(1), 92-106. https://doi.org/10.1093/jmammal/gyz178.

Karelus, D. L., Geary, B. W., Harveson, L. A., & Harveson, P. M. (2021). Movement ecology and space-use by mountain lions in West Texas. Global Ecology and Conservation, 31, e01859. https://doi.org/10.1016/j.gecco.2021.e01859.

Kie, J. G., Bowyer, R. T., Nicholson, M. C., Boroski, B. B., & Loft, E. R. (2002). Landscape Heterogeneity at Differing Scales: Effects on Spatial Distribution of Mule Deer. Ecology, 83(2), 530–544. https://doi.org/10.2307/2680033.

Kilbride, K. M., Crawford, J. A., Blakely, K. L., & Williams, B. A. (1992). Habitat Use by Breeding Female California Quail in Western Oregon. The Journal of Wildlife Management, 56(1), 85–90. https://doi.org/10.2307/3808794.

King, J. L. (2004). The current distribution of the introduced fox squirrel (Sciurus niger) in the greater Los Angeles metropolitan area and its behavioral interaction with the native western gray squirrel (Sciurus griseus). M.S. thesis, California State Univ., Los Angeles, CA. 112 pp.

Knapp, R. A., Preisler, H. K., Matthews, K. R., & Jellison, R. (2003). Developing probabilistic models to predict amphibian site occupancy in a patchy landscape. Ecological Applications, 13, 1069–1082.

Kofron, C., & Villablanca, F. (2016). Decline of the Endangered Morro Bay Kangaroo Rat in California. Journal of Fish and Wildlife Management, 7. https://doi.org/10.3996/102014-JFWM-078

Koehler, G. M., & Hornocker, M. G. (1989). Influences of Seasons on Bobcats in Idaho. The Journal of Wildlife Management, 53(1), 197–202. https://doi.org/10.2307/3801331

Kozakiewicz, C. P., Burridge, C. P., Funk, W. C., et al. (2019) Urbanization reduces genetic connectivity in bobcats (Lynx rufus) at both intra– and interpopulation spatial scales. Molecular Ecology, 28, 5068–5085. https://doi.org/10.1111/mec.15274

Lacy, R. C., & Sherman, P. W. (1983). Kin recognition by phenotype matching. The American Naturalist, 121(4), 489-512. https://doi.org/10.1086/284078

Laurie, A., & Seidensticker, J. (1977). Behavioural ecology of the sloth bear (Melursus ursinus). Journal of Zoology, 182, 187–204.

Lawhead, D. N. (1984). Bobcat Lynx rufus home range, density and habitat preference in south-central Arizona. The Southwestern Naturalist, 29(1), 105–113. https://doi.org/10.2307/3670775

Lendrum, P. E., Anderson, C. R., Jr., Long, R. A., Kie, J. G., & Bowyer, R. T. (2012). Habitat selection by mule deer during migration: Effects of landscape structure and natural-gas development. Ecosphere, 3(9), 82. http://dx.doi.org/10.1890/ES12-00165.1

Lenton, T. M., Armstrong McKay, D. I., Loriani, S., Abrams, J. F., Lade, S. J., Donges, J. F., Milkoreit, M., Powell, T., Smith, S. R., Zimm, C., Buxton, J. E., Bailey, E., Laybourn, L., Ghadiali, A., & Dyke, J. G. (Eds.). (2023). The Global Tipping Points Report 2023. University of Exeter, Exeter, UK. https://global-tipping-points.org/download/4608/

Lewis, J. S., Rachlow, J. L., Horne, J. S., Garton, E. O., Wakkinen, W. L., Hayden, J., Zager, P. (2011). Identifying habitat characteristics to predict highway crossing areas for black bears within a human-modified landscape. Landscape and Urban Planning, 101(2), 99-107. https://doi.org/10.1016/j.landurbplan.2011.01.008.

Litvaitis, J. A., Sherburne, J. A., & Bissonette, J. A. (1986). Bobcat Habitat Use and Home Range Size in Relation to Prey Density. The Journal of Wildlife Management, 50(1), 110–117. https://doi.org/10.2307/3801498

Loft, E. R., Menke, J. W., Kie, J. G., & Bertram, R. C. (1987). Influence of Cattle Stocking Rate on the Structural Profile of Deer Hiding Cover. The Journal of Wildlife Management, 51(3), 655–664. https://doi.org/10.2307/3801285

Logan, K. A., Irwin, L. I., & Skinner, R. (1986). Characteristics of a hunted mountain lion population in Wyoming. Journal of Wildlife Management, 50, 648-654.

Longcore, T. (2019). iNaturalist observation: [https://www.inaturalist.org/observations/33101863]. Accessed May 1 2024].

Los Angeles County. (2022). LA River Master Plan. https://pw.lacounty.gov/uploads/swp/LARiverMasterPlan-FINAL-DIGITAL-COMPRESSED.pdf

Los Angeles, C. of (2022). Wildlife Pilot Study | Draft Ordinance | Los Angeles City Planning. https://planning.lacity.org/node/133059 [Accessed August 1, 2022].

LA Sanitation & Environment (LASAN) (2020). 2020 City of Los Angeles Biodiversity Report. City of Los Angeles, California. Available online at: https://www.lacitysan.org/san/sandocview?docname=cnt052553

Lyren, L. M. (2001). Movement patterns of coyotes and bobcats relative to roads and underpasses in the Chino Hills area of southern California. Master's Thesis, California State Polytechnic University. Retrieved from http://www.werc.usgs.gov/sandiego/lyrenthesis.html

Lyles, D., Rosenstock, T. S., Hastings, A., & Brown, P. H. (2009). The role of large environmental noise in masting: General model and example from pistachio trees. Journal of Theoretical Biology, 259(4), 701-713.

Madin, J. S., & Lyons, S. K. (2005). Incomplete sampling of geographic ranges weakens or reverses the positive relationship between an animal species' geographic range size and its body size. Evolutionary Ecology Research, 7(4), 607-617. https://doi.org/10.1086/429699

Marchinton, R. L., & Hirth, D. H. (1984). Behavior. In L. K. Halls (Ed.), White-tailed deer ecology and management (pp. 129-168). Stackpole Books.

Marshal, J. P., Bleich, V. C., Andrew, N. G., & Krausman, P. R. (2004). Seasonal forage use by desert mule deer in southeastern California. Southwestern Naturalist, 49, 501–505.

McCoy, J. E., Hewitt, D. G., & Bryant, F. C. (2005). Dispersal by yearling male white-tailed deer and implications for management. The Journal of Wildlife Management, 69, 366-376. https://doi.org/10.2193/0022-541X(2005)069

McNab W.H., Cleland D., Freeouf J., Keys, J. Jr., Nowacki G., Carpenter C. (2007) Description of ecological subregions: sections of the conterminous United States [CD-ROM]. Gen. Tech. Report WO-76B. Washington, DC: U.S. Department of Agriculture, Forest Service.

McRae, B. H., Popper, K., Jones, A., Schindel, M., Buttrick, S., Hall, K., Unnasch, R. S., & Platt, J. (2016). Conserving nature's stage: Mapping omnidirectional connectivity for resilient terrestrial landscapes in the Pacific Northwest. The Nature Conservancy, Portland, Oregon, 47 pp. Available online at: http://nature.org/resilienceNW.

Miller, A. H., & Stebbins, R. C. (1964). The Lives of Desert Animals in Joshua Tree National Monument. (R. C. Stebbins, Ed.). University of California Press.

Montalvo, A., Jr, D., & Lopez, R. (2014). Greater Roadrunner (Geococcyx californianus) Home Range and Habitat Selection in West Texas. Western North American Naturalist, 74, 201-207. https://doi.org/10.3398/064.074.0205.

Muths, E. (2003). Home Range and Movements of Boreal Toads in Undisturbed Habitat. Copeia, 2003(1), 160-165. https://doi.org/10.1643/0045-8511(2003)003[0160:HRAMOB]2.0.CO;2

Myers, A. (2020). Toadal Isolation: Genetic Connectivity of the Western Toad (Anaxyrus boreas) along I-90 in the Snoqualmie Pass Area of Washington State (Master's thesis). Retrieved from https://digitalcommons.cwu.edu/etd/1371

National Park Service. (2016). Park planning—Rim of the Valley Corridor Special Resource Study. National Park Service Planning, Environment & Public Comment. https://parkplanning.nps.gov/projectHome.cfm?parkID=422&projectID=31945

National Park Service. (2023). DRAFT LA Metro and Caltrans Recommendations for Improved Wildlife Permeability. Prepared for LA Metro and Caltrans.

Newby, J. R. (2011). Puma dispersal ecology in the Central Rocky Mountains. Wildlife Biology, University of Montana, Missoula, Montana, i-104.

Newsom, G. (2020). Executive Order N-82-20.

Nicholson, W. S., Hill, E. P., & Briggs, D. (1985). Denning, Pup-Rearing, and Dispersal in the Gray Fox in East-Central Alabama. The Journal of Wildlife Management, 49(1), 33–37. https://doi.org/10.2307/3801836

Ng, S. J., Dole, J. W., Sauvajot, R. M., Riley, S. P. D., & Valone, T. J. (2004). Use of highway undercrossings by wildlife in southern California. Biological Conservation, 115(3), 499-507. https://doi.org/10.1016/S0006-3207(03)00166-6.

Opdam, P., Nassauer, J.I., Wang, Z., Albert, C., Bentrup, G., Castella, J-C., McAlpine, C., Liu, J., Sheppard, S., Swaffield, S. Science for action at the local landscape scale. Landscape Ecology (2013) 28:1439–1445

Ortiz, J. L. (2022). Temporal and spatial overlap in the behaviors of a native and invasive tree squirrel in southern California. Ethology Ecology & Evolution, 34(2), 148–164. https://doi.org/10.1080/03949370.2021.1936651

Ozoga, J. J., & Verme, L. J. (1986). Initial and subsequent maternal success of white-tailed deer. The Journal of Wildlife Management, 50(1), 122–124. https://doi.org/10.2307/3801500.

Pease, K. M., Freedman, A. H., Pollinger, J. P., McCormack, J. E., Buermann, W., Rodzen, J., Banks, J., Meredith, E., Bleich, V. C., Schaefer, R. J., Jones, K., & Wayne, R. K. (2009). Landscape genetics of California mule deer (Odocoileus hemionus): The roles of ecological and historical factors in generating differentiation. Molecular Ecology, 18, 1848–1862. https://doi.org/10.1111/j.1365-294X.2009.04112.x

Phillips, J., Phillips, R., Srinivasan, N., Aso, D., Lao, W., & Cornely, P. (2012). Wildlife Linkage for the Highway 101 Corridor: A User's Guide to Developing Protective Highway Crossings for Wildlife While Connecting California's Students with Science and Nature. De Anza College, Environmental Studies Department. https://www.deanza.edu/es/documents/safe%20passages_2012.pdf

Peterson, C. J., Mitchell, M. S., DeCesare, N. J., Bishop, C. J., & Sells, S. S. (2021). Habitat selection by wolves and mountain lions during summer in western Montana. PLoS ONE, 16(7), e0254827. https://doi.org/10.1371/journal.pone.0254827

Phillips, S. (2022). Updated habitat suitability mapping for riparian brush rabbits in the northern San Joaquin Valley and Sacramento/San Joaquin River Delta. Prepared for U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge Complex, Agreement Number F21AC02336-00. California State University, Stanislaus, Endangered Species Recovery Program, 1 University Circle, Turlock, CA 95382. Retrieved from https://esrp.csustan.edu/publications/pdf/Phillips_2022_RBR_Habitat.pdf

Price, M. V., Goldingay, R. L., Szychowski, L. S., & Waser, N. M. (1994). Managing habitat for the endangered Stephens' kangaroo rat (Dipodomys stephensi): Effects of shrub removal. The American Midland Naturalist, 131(1), 9–16. https://doi.org/10.2307/2426603

Quinn, R. D. (1990). Habitat preferences and distribution of mammals in California chaparral (Research paper PSW, Vol. 202). U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Rahm, N. M. (1938). Quail range extension in the San Bernardino National Forest. California Fish and Game, 24, 133-158.

Riley, S. P., Serieys, L. E., Pollinger, J. P., Sikich, J. A., Dalbeck, L., Wayne, R. K., & Ernest, H. B. (2014a). Individual behaviors dominate the dynamics of an urban mountain lion population isolated by roads. Current Biology, 24. https://doi.org/10.1016/j.cub.2014.07.029

Riley, S. P., Brown, J. L., Sikich, J. A., Schoonmaker, C. M., & Boydston, E. E. (2014b). Wildlife-friendly roads: The impacts of roads on wildlife in urban areas and potential remedies. In Urban Wildlife Conservation: Theory and Practice (pp. 323-360). https://doi.org/10.1007/978-1-4899-7500-3_15

Riley, S. P., Sikich, J. A., & Benson, J. F. (2021). Big Cats in the Big City: Spatial Ecology of Mountain Lions in Greater Los Angeles. The Journal of Wildlife Management, 85. https://doi.org/10.1002/jwmg.22127

Rogers, L. L. (n.d.). Factors Influencing Dispersal in the Black Bear. In B. D. Chepko-Sade & Z. T. Halpin (Eds.), Mammalian Dispersal Patterns: The Effects of Social Structure on Population Genetics (pp. 75–84). University of Chicago Press. Retrieved from https://www.bearstudy.org/images/stories/Publications/Factors_Influencing_Dispersal_in_the_Black_Bear.pdf

Rubalcava-Castillo, F. A., Sosa-Ramírez, J., Luna-Ruíz, J. J., Valdivia-Flores, A. G., & Íñiguez-Dávalos, L. I. (2021). Seed dispersal by carnivores in temperate and tropical dry forests. Ecology and Evolution, 11, 3794–3807. https://doi.org/10.1002/ece3.7201

Santa Monica Mountains Conservancy. (2020). Upper Los Angeles River and Tributaries Revitalization Plan. https://upperlariver.konveio.com/volume-i-english

Sawyer, H., Rodgers, P. A., & Hart, T. (2016). Pronghorn and mule deer use of underpasses and overpasses along U.S. Highway 191. Wildlife Society Bulletin, 40, 211–216. https://doi.org/10.1002/wsb.650

Sawyer, H., & Kauffman, M. J. (2011). Stopover ecology of a migratory ungulate. Journal of Animal Ecology, 80, 1078–1087. https://doi.org/10.1111/j.1365-2656.2011.01845.x

Schwartz, C. C., & Franzmann, A. W. (1992). Dispersal and survival of subadult black bears from the Kenai Peninsula, Alaska. The Journal of Wildlife Management, 56(3), 426–431. https://doi.org/10.2307/3808854

Smith, J. G., Jennings, M. K., Boydston, E. E., Crooks, K. R., Ernest, H. B., Riley, S. P. D., Serieys, L. E. K., Sleater-Squires, S., & Lewison, R. L. (2020). Carnivore population structure across an urbanization gradient: a regional genetic analysis of bobcats in southern California. Landscape Ecology, 35, 659-674.

Soule, M. E., Bolger, D. T., Alberts, A. C., Wright, J., Sorice, M., & Hill, S. (1988). Reconstructed Dynamics of Rapid Extinctions of Chaparral-Requiring Birds in Urban Habitat Islands. Conservation Biology, 2(1), 75–92. http://www.jstor.org/stable/2386274

Sparks, J. L. Jr., & Gates, J. E. (2017). Seasonal and regional animal use of drainage structures to cross under roadways. Human–Wildlife Interactions, 11(2), 182–191. University of Maryland Center for Environmental Science, Appalachian Laboratory. Retrieved from https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1425&context=hwi

Shields, P. W. (1960). Movement Patterns of Brush Rabbits in Northwestern California. The Journal of Wildlife Management, 24(4), 381–386. https://doi.org/10.2307/3796515

Spencer, W. D., Beier, P., Penrod, K., Winters, K., Paulman, C., Rustigian-Romsos, H., Strittholt, J., Parisi, M., & Pettler, A. (2010). California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

Stark, R. C., Fox, S. F., & Leslie, D. M. (2005). Male Texas Horned Lizards Increase Daily Movements and Area Covered in Spring: A Mate Searching Strategy? Journal of Herpetology, 39(1), 169–173. https://doi.org/10.1670/0022-1511(2005)039[0168:MTHLID]2.0.CO;2

Stuart, S. N., Chanson, J. S., Cox, N. A., Young, B. E., Rodrigues, A. S., Fischman, D. L., & Waller, R. W. (2004). Status and trends of amphibian declines and extinctions worldwide. Science (New York, N.Y.), 306(5702), 1783–1786. https://doi.org/10.1126/science.1103538

Sweanor, L. L., Logan, K. A., & Hornocker, M. G. (2000). Cougar Dispersal Patterns, Metapopulation Dynamics, and Conservation. Conservation Biology, 14(3), 798–808. http://www.jstor.org/stable/2641439
Stoner, D.C., Rieth, W.R., Wolfe, M.L., Mecham, M.B., & Neville, A. (2008). Long-Distance Dispersal of a Female Cougar in a Basin and Range Landscape. The Journal of Wildlife Management, 72, 933–939. https://doi.org/10.2193/2007-219

Tiedt, A. R. (2011). Den site selection of Ringtails (Bassariscus astutus) in west central Texas. Animal Science, Angelo State University, San Angelo, Texas.
Thompson, R.C.A., Lymbery, A.J., & Smith, A. (2010). Parasites, emerging disease and wildlife conservation. International Journal for Parasitology, 40(10), 1163–1170. https://doi.org/10.1016/j.ijpara.2010.04.009

Thorne, J.H., Cameron, D., & Quinn, J.F. (2006). A conservation design for the central coast of California and the evaluation of mountain lions as an umbrella species. Natural Areas Journal, 26, 137-148.

Tiersen, W., Mattfeld, G.E., Sage, R.W., & Behrend, D.E. (1985). Seasonal movements and home ranges of white-tailed deer in the Adirondacks. Journal of Wildlife Management, 49, 760-769.

Toweill, D.E., & Teer, J.G. (1980). Home range and den habits of Texas ringtails (Bassariscus astutus flavus). In J.A. Chapman & D. Pursley (Eds.), Proceedings of the Worldwide Rir-bearer Conference (pp. 1103-1120). Frostburg, MD, 3-11 August 1980. R.R. Donnelley & Sons.

Trapp, G.R. (1978). Comparative behavioral ecology of the ringtail and gray fox. Carnivore, 1, 3-31.
U.S. Fish and Wildlife Service. (2020). Habitat Characteristics of the Houston Toad (Anaxyrus Bufo Houstonensis). September 2020 (Version 1.0). U.S. Fish and Wildlife Service, Region 2. Albuquerque, New Mexico, 1-6. [Available at: https://www.fws.gov/sites/default/files/documents/Habitat_Characteristics_of_the_Houston_Toad.pdf]

Unitt, P., & Hargrove, L. (2018). Southward and downslope extensions of breeding ranges of birds in southern California. In W. D. Shuford, R. E. Gill Jr., & C. M. Handel (Eds.), Trends and traditions: Avifaunal change in western North America (pp. 85–115). Studies of Western Birds 3. Western Field Ornithologists, Camarillo, CA. doi: 10.21199/SWB3.4.

Wakeling, B.F., Gagnon, J.W., Olson, D.D., Lutz, D.W., Keegan, T.W., Shannon, J.M., Holland, A., Lindbloom, A., & Schroeder, C. (2015). Mule Deer and Movement Barriers. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, U.S.A.

Wenner, S.M., Murphy, M.A., Delaney, K.S., Pauly, G.B., Richmond, J.Q., Fisher, R.N., & Robertson, J.M. (2022). Natural and anthropogenic landscape factors shape functional connectivity of an ecological specialist in urban Southern California. Molecular Ecology. https://doi.org/10.1111/mec.16656

Whitford, W.G., & Bryant, M. (1979). Behavior of a Predator and its Prey: The Horned Lizard (Phrynosoma Cornutum) and Harvester Ants (Pogonomyrmex Spp.). Ecology, 60(4), 686–694. https://doi.org/10.2307/1936605

Whittaker, D.G., & Lindzey, F.G. (2004). Habitat use patterns of sympatric deer species on Rocky Mountain Arsenal, Colorado. Wildlife Society Bulletin, 32(4), 1114-1123. http://www.jstor.org/stable/3784749

Wood, C.M. (1989). The Physiological Problems of Fish in Acid Waters. In W. Momis, D.J.A. Brown, E.W. Taylor, & J.A. Brown (Eds.), Acid Toxicity and Aquatic Animals, Society for Experimental Biology Seminar Series (pp. 125-152). Cambridge University Press.

Solari, S., & Baker, R.J. (2007). Mammal Species of the World: A Taxonomic and Geographic Reference by D.E. Wilson; D.M. Reeder. Journal of Mammalogy, 88(3), 824-830. https://doi.org/10.1644/06-MAMM-R-422.1

Yarchin, J.C., 1994. Home Range Use by Ringtails in a Southwestern Riparian Area. Pages 156-164 in P.R. Krausman and N.S. Smith (Eds.), Proceedings of the Managing Wildlife in the Southwest Symposium, October 1990. Southwest Section of The Wildlife Society, Tucson, AZ.

Wyatt, D.T. (1993) Home range size, habitat use, and food habits of ringtails (Bassariscus astutus) in Central Valley riparian forest, Sutter Co., California, Unpublished M.S. thesis, California State University, Sacramento, CA, 100 pp.

van der Ree, R., Jaeger, J., van der Grift, E., & Clevenger, A. (2011). Effects of roads and traffic on wildlife populations and landscape function: Road ecology is moving toward larger scales. Ecology and Society, 16. https://doi.org/10.5751/ES-03982-160148

Vander Haegen, W. M., Orth, G. R., & Aker, L. M. (2005). Ecology of the western gray squirrel in south-central Washington: Progress report. Washington Department of Fish and Wildlife, Olympia, 41 pp.