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September 27, 2023

Via email

Reid Miller
California Department of Housing &
Community Development
2020 West El Camino Avenue
Sacramento, CA 95833
E-Mail: HousingElements@hcd.ca.gov

Re: Comments on County of Orange Housing Element Resubmittal

Dear Mr. Miller:

Hills For Everyone has reviewed the Housing Element submitted to the Housing and Community Development Department ("HCD") and has found significant discrepancies that must be corrected to provide an accurate picture of housing opportunities in Orange County. In short, we do not believe the "Brea Canyon Parcels (Aera)" property (the "Brea Canyon Site") is suitable for the number of units proposed. The number should be revised dramatically or the property eliminated from consideration altogether.

I. The Brea Canyon Site Does Not Meet the Statutory Criteria for Inclusion on the Land Inventory.

The County's July 2023 Draft Housing Element (the "July Draft") includes in its Land Inventory a site it calls "Brea Canyon Parcels (Aera)," with 1,857 project units across all affordability levels. July Draft, page B-10. As explained in the July Draft, this "Brea Canyon Site" is part of a larger ownership of Aera Energy's lands on approximately 2,906 acres of the unincorporated areas of both Orange County and Los Angeles County. Roughly 90% of Aera Energy's ownership is in Los Angeles County, and 10% is in Orange County. *See* Attachment 1.

The text description of the site, however, is factually incorrect and provide a false sense of the likelihood of development on this site. The July Draft states, "In 2002,

planning applications were submitted to the County of Orange and the County of Los Angeles for development of a 2,906 gross acre master planned residential community."

This is technically correct. But the draft fails to state that Aera Energy's development application was formally withdrawn by the landowner in the summer of 2020. Because the applicant had failed to advance the project after nearly 20 years, the Los Angeles County Regional Planning Commission was poised to deny the application, but the landowner chose to withdraw the application instead of having a denial on the books. As the July Draft does acknowledge, applications on the Orange County portion of the property are presently "on hold." July Draft, page B-20. There is no current evidence that the landowner intends to develop the property. The Housing Element's characterization for the two-decade-old application as "recent" (*id.*) is plainly false. This land is not "suitable and available for residential development" because it has no "realistic and demonstrated potential for redevelopment"; it therefore has no place on the Housing Element's inventory. Gov. Code § 65583(a)(3).

II. The Brea Canyon Site Cannot Provide the Number of Units Assigned in the July Draft of the Housing Element.

Further, the County of Los Angeles has proposed rezoning the land on its side of county line to one unit per 40 acres, through its pending East San Gabriel Valley Area Plan. This rezone would ultimately allow for around 65 units on the Los Angeles County portion of the property. This Area Plan has been unanimously recommended by the Los Angeles County Regional Planning Commission. *See* Attachment 3. This Area Plan will be heard before the Los Angeles County Board of Supervisors in Fall 2023.

Additionally, the Brea Canyon Site is within a Very High Fire Hazard Severity Zone for both counties as designated by the California Department of Forestry and Fire Protection. *See* Attachments 4 and 5. The County of Los Angeles has proposed a Wildfire Protection Ordinance for all of its lands in such zones. *See* Attachment 6. The Ordinance, presently working its way through the legislative process, outlines constraints on the land including ingress/egress and hillside slope constraints. Such ordinances and slope evaluations do not exist in Orange County's plans, but much of the Aera Energy land in Los Angeles County is shown as 25-50% slope and/or 50%+ slope. This slope is greater on the south facing slopes in Orange County's territory due to the proximity of the Whittier/Elsinore Fault. *See* Attachment 7. Using Google Earth, we were able to spot analyze six locations on the property. The lowest slope percentage was 45% and the highest was more than 66%. *See* Attachment 8.

The County, however, acts as if the property is flat and has no constraints and hence is proposing 1,857 units (or six units per acre). The hills would need to be leveled

to accommodate this level of growth. By claiming so many essentially imaginary units on this severely constrained site, the County plainly fails in its duty to "specify . . . the number of units that can *realistically* be accommodated." Gov. Code § 65583.2(c) (emphasis added).

Orange County's treatment of the recent widening proposal for Brea Canyon Road reflects the unlikelihood of extensive development on the Brea Canyon Site. Citing strong opposition to the proposed road expansion from governmental agencies and non-profits, along with the fact that the County of Los Angeles had no intention of widening its portion of the roadway, the County stopped its environmental review of the project and formally withdrew the application. In June 2023, the County Board of Supervisors removed the project from the Capital Improvement Program. *See* Attachment 9. This road expansion would have facilitated development of the Brea Canyon Site. Without this road expansion, the Housing Element's projected density on the site becomes even more unlikely.

III. Removing the Brea Canyon Site from the Housing Element's Land Inventory Advances Important Conservation Goals.

Scientists have found that the Brea Canyon Site and the surrounding landscapes are of considerable importance to the preservation of global biodiversity. *See* Attachment 10. Numerous sensitive, threatened, and endangered plants and animals exist on and near this property. For the last 25 years conservation groups have aimed to protect the Brea Canyon land so that these 3,000 acres connect the Puente Hills Preserve (4,000 acres) on the west side and the Chino Hills State Park landscape (15,000 acres) to the east. *See* Attachment X. The property has been identified in the state's effort to protect 30% of California's lands and coastal waters by 2030, a goal that may soon be codified if Governor Newsom signs SB 337. It has additionally been nominated for acquisition funding under the Orange County Transportation Authority's Measure M-2 Environmental Mitigation Program due to its sensitive habitats and species diversity, as well as its significant wildlife connectivity value, and is part of an acquisition plan approved by the California Department of Fish and Wildlife.

The Housing Element itself shows that there is precedent for recognizing the error of including the Brea Canyon Site on the inventory. Since the prior draft, the County has removed one potential housing site (Banning Ranch) from the Land Inventory due to longstanding efforts to conserve the land: As the County notes in Appendix C – Public Participation Summary (July Draft, page C-4), there have been recent efforts to conserve the land as open space and past efforts to develop it have been unsuccessful. Moreover, the land contains wildlife habitat and hosts endangered or threatened species it is not

reflected in the July Draft's site inventory. These same considerations should lead to moving the Brea Canyon Site off the inventory.

The Brea Canyon Site will better serve the County and the state as conservation land, rather than its current status of being perpetually under threat by sprawling residential development that never actually materializes. It has great potential for environmental protection and very limited potential for housing. Keeping it on the Land Inventory is a very bad trade. HCD should recognize this reality and direct Orange County to remove the Brea Canyon Site from the Housing Element's Land Inventory.

Very truly yours,

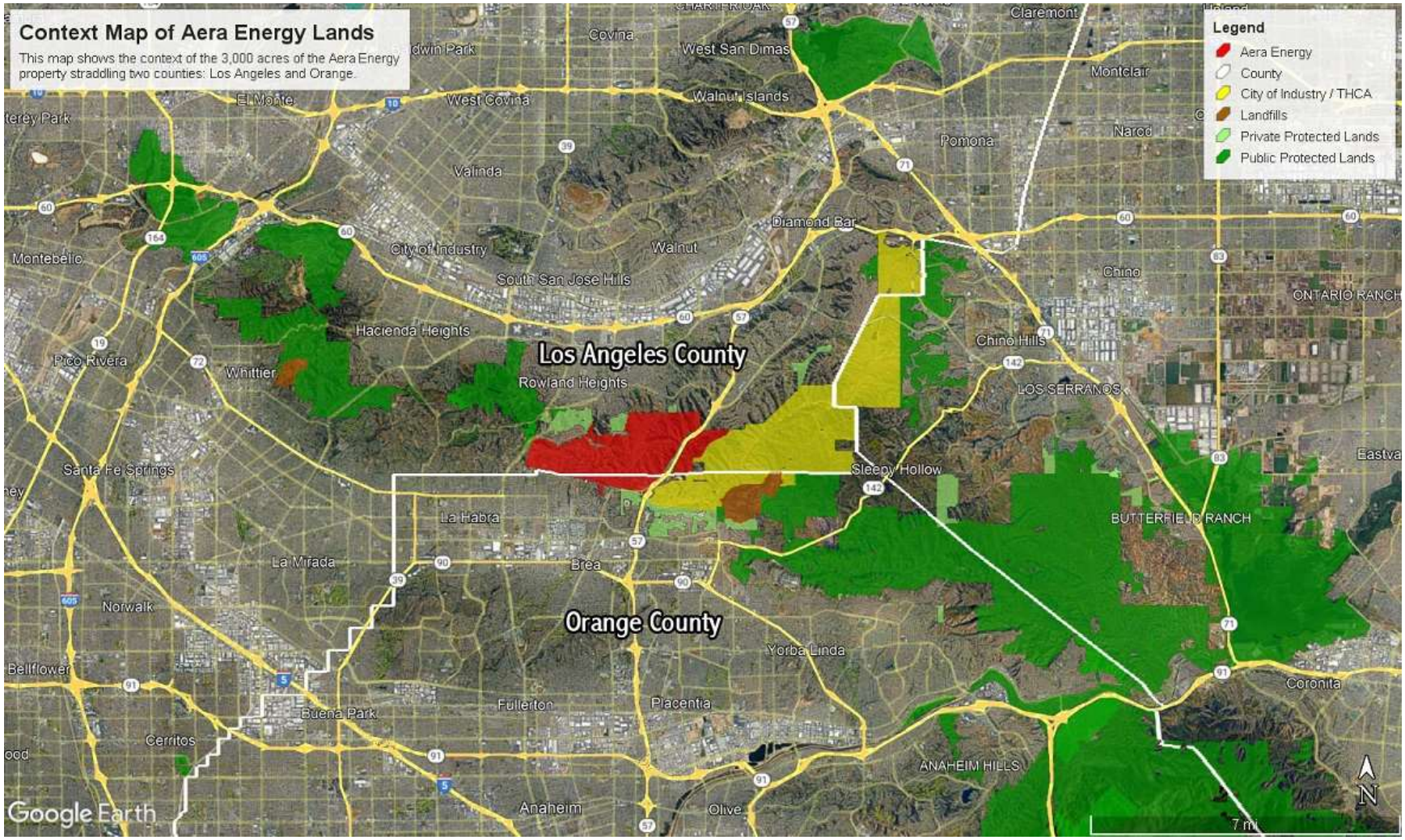
SHUTE, MIHALY & WEINBERGER LLP

Gabriel M.B. Ross

cc: City of Brea
County of Orange
County of Los Angeles

Attachments:

1	Context Map of Aera Energy's Holdings
2	Intentionally omitted
3	Los Angeles County Regional Planning Commission Meeting Minutes (8/9/23)
4	Portion of Cal Fire Very High Fire Hazard Severity Zones map for LA County
5	Excerpt from Orange County General Plan Safety Element
6	Draft Los Angeles County Community Wildfire Protection Ordinance
7	U.S. Geological Survey Quaternary Faults
8	Brea Canyon Slope Analyses
9	Excerpts from Orange County 2016 and 2023 Capital Improvement Plans
10	Evaluation of the Coal Canyon Biological Corridor (Noss et al.)
11	Maintaining Ecological Connectivity Across the Missing Middle of the Puente-Chino Hills Wildlife Corridor. (Spencer 2005)


Context Map of Aera Energy Lands
This map shows the context of the 3,000 acres of the Aera Energy property straddling two counties: Los Angeles and Orange.
Legend
Aera Energy
County
City of Industry / THCA
Landfills
Private Protected Lands
Public Protected Lands
Los Angeles County
Orange County
Claremont
Covina
West San Dimas
Montclair
El Monte
West Covina
Walnut Islands
Pomona
Valinda
Diamond Bar
City of Industry
Walnut
Montebello
South San Jose Hills
Chino
ONTARIO RANCH
Hacienda Heights
Chino Hills
Pico Rivera
Whittier
Rowland Heights
LOS SERRANOS
Santa Fe Springs
Sleepy Hollow
La Habra
BUTTERFIELD RANCH
La Mirada
Brea
Norwalk
Yorba Linda
Bellflower
Coronita
Fullerton
Placentia
Buena Park
Cerritos
ANAHEIM HILLS
Anaheim
Olive
Google Earth
7 mi
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MINUTES

Meeting Place: In-Person: 320 W. Temple Street, Room 150, Los Angeles, CA 90012 Virtual (Online): https://events.gcc.teams.microsoft.com/event/59deba50-ab3d-4873-bdc7-a9b1d9ef6d98@07597248-ea38-451b-8abe-a638eddbac81 or call +1 323-776-6996,577296386# United States, LA

Meeting Date: August 9, 2023 - Wednesday Time: 9:00 a.m.

Present: Commissioners Duarte-White, Louie, O'Connor, Moon, Hastings

Ex Officio Members:

Director of Public Works: Ms. Phoenix Khoury, Senior Civil Engineer

County Counsel: Ms. Elaine Lemke, Assistant County Counsel

Planning Director: Ms. Connie Chung, Deputy Director, Advance Planning Division

Forester and Fire Warden: Mr. Juan Padilla, Supervising Fire Prevention Engineer

LAND ACKNOWLEDGMENT STATEMENT

1. The Land Acknowledgment Statement was led by Commissioner O' representing the First Supervisorial District.

The County of Los Angeles recognizes that we occupy land originally and still inhabited and cared for by the Tongva, Tataviam, Serrano, Kizh, and Chumash Peoples. We honor and pay respect to their elders and descendants -- past, present, and emerging -- as they continue their stewardship of these lands and waters. We acknowledge that settler colonization resulted in land seizure, disease, subjugation, slavery, relocation, broken promises, genocide, and multigenerational trauma. This acknowledgment demonstrates our responsibility and commitment to truth, healing, and reconciliation and to elevating the stories, culture, and community of the original inhabitants of Los Angeles County. We are grateful to have the opportunity to live and work on these ancestral lands. We are dedicated to growing and sustaining relationships with Native peoples and local tribal governments, including (in no particular order) the: Fernandeño Tataviam Band of Mission Indians, Gabrielino Tongva Indians of California Tribal Council, Gabrieleno/Tongva San Gabriel Band of Mission Indians, Gabrieleño Band of Mission Indians - Kizh Nation, San Manuel Band of Mission Indians, San Fernando Band of Mission Indians. To learn more about the First Peoples of Los Angeles County, please visit the Los Angeles City/County Native American Indian Commission website at Los Angeles City/County Native American Indian Commission – government organization (lacounty.gov).

PLEDGE OF ALLEGIANCE

2. The Pledge of Allegiance was led by Commissioner Moon representing the Fourth Supervisorial District.

APPROVAL OF AGENDA

3. Motion/seconded by Commissioners Moon/O'Connor – That the agenda for August 9, 2023 be approved.

At the direction of the Chair, the agenda was approved unanimously.

COUNTY COUNSEL REPORT

4. County Counsel stated for the record that while this is an online meeting, it is a public meeting the same as if it were held in person in the Commission's hearing room and rules that allow for an orderly meeting shall apply. As such, when speaking on an agendized item, comments should address the item on the agenda and no other issues.

Similarly, if speaking during public comment, comments should be limited to issues related to the business of the Regional Planning Commission.

If speakers do not remain on topic, they may be reminded by the Chair or myself to do so. Failure to discuss issues not related to the agendized item, may result in the loss of the right to speak on the item or other items, if directed by the Chair. In addition, speakers should refrain from conduct that is disruptive of the meeting. Doing so also could result in the loss of the right to speak on the agenda item or any other items.

Disruptive conduct can include, but is not limited to, threats made against other speakers, the Commission or its members, or any others participating in the meeting, profane comments not related to the agenda item, or disorderly or contemptuous behavior leading to a disruption of the orderly progression and holding of the meeting.

In such cases, the Chair will advise that the behavior is disruptive and direct that the speaker's microphone be disabled. That person may, however, continue to observe the meeting. Further, disruptive behavior communicated to the panelists of the meeting, which include the Commission and County staff, may result in the removal of that person from the meeting by disconnecting them from the online connection.

DIRECTOR/DEPUTY DIRECTOR

5. Ms. Chung reported that the Board adopted County Code, Title 22 Planning and Zoning Amendment Ordinance amending Title 22 Tune Up "Series 002" Ordinance, to make modifications where necessary to correct discrepancies, typographical errors, and outdated and redundant provisions. The Board also adopted the County Code, Title 22 Planning and Zoning, Amendment to correct the Zoned District map errors and find that adoption of the ordinance is exempt from the California Environmental Quality Act.

DIRECTOR/DEPUTY DIRECTOR (Cont.)

Mr. Thomas Dearborn, presented the 100th Anniversary, *Did You Know Series*. Catalina Island, originally known as Pimu or Pimugna, boasts a rich history that dates back over 7,000 years, with its first inhabitants being the Gabrielino/Tongva tribe. In 1542, the island came under the claim of Spanish settlers, but it changed hands several times before eventually becoming part of Los Angeles County through the California State Constitution in 1850.

Throughout the centuries, Catalina Island has seen a variety of land uses, each leaving its mark on the island's landscape and culture. One remarkable testament to this history is the presence of various historic landmarks and the thriving bison population that still roam freely. Catalina Island covers approximately 75 square miles, the majority falling under unincorporated Los Angeles County, while a smaller portion belongs to the city of Avalon, which was incorporated in 1913. Catalina remains largely undeveloped, due to the efforts of the Catalina Island Conservancy, founded in 1972. This organization works tirelessly to protect and manage nearly 88% of the island, dedicated to conservation, education, and recreation.

The island's natural wonders continue to captivate visitors, as Catalina is home to unique and rare species. The Catalina Island fox, found nowhere else in the world, thrives in this environment. The surrounding marine life is equally impressive, featuring dolphins, sea lions, and the iconic bright-orange Garibaldi fish. With its clear waters and abundant marine biodiversity, Catalina is a haven for snorkeling, scuba diving, and underwater exploration.

The commitment to conservation is evident once on the island. The island's primary transportation is achieved through golf carts, electric cars, or exploring by foot, ensuring that visitors can experience Catalina's allure while preserving its ecological balance for generations to come. Catalina Island is a true hidden gem, boasting a captivating history, an array of diverse wildlife, and an abundance of recreational opportunities. Catalina Island has something to offer every visitor.

MINUTES FOR APPROVAL

6. Motion/seconded by Commissioners Louie/Moon – That the minutes for July 19, 2023 be approved.

At the direction of the Chair, the minutes were approved with Commissioners Louie, Moon, Hastings, O'Connor in favor and Commissioner Duarte-White being recorded as abstaining.

ADMISSION PROCEDURES

Staff announced if you are joining us via telephone and want to provide comment on any of the agenda items, please send an email to comment@planning.lacounty.gov and provide the agenda item number, your first name, your last name, your email address, your phone number, and indicate if you are the applicant or not the applicant.

All participants' microphones will be muted during the meeting unless you have signed up to provide comment. If you have signed up to provide comment, your microphone will be unmuted when it is time for you to speak, and staff will call your name.

PUBLIC HEARING

Community Studies East Area

Project Approved

7. East San Gabriel Valley Area Plan. Project No. 2020-000612-(1, 5). Advance Planning Case No. RPPL2021013047. General Plan Amendment No. RPPL2022003554. Ordinance No. RPPL2022014158. Zone Change No. RPPL2022003557. Environmental Assessment No. RPPL2022003550. State Clearinghouse No. 2022040512. Planner: James Drevno PROJECT LOCATION: Unincorporated communities of Avocado Heights, Charter Oak, Covina Islands, East Azusa, East Irwindale, East San Dimas, Glendora Islands, Hacienda Heights, North Claremont, North Pomona, North Whittier, Northeast La Verne, Northeast San Dimas, Pellissier Village, Rowland Heights, South Diamond Bar, South El Monte, South San Jose Hills, South Walnut, Valinda, Walnut Islands, West Claremont, West Puente Valley, West San Dimas. PROJECT DESCRIPTION: The proposed East San Gabriel Valley Area Plan (Area Plan or Project) is a component of the General Plan focused on the unique needs and characteristics of 24 unincorporated communities within the East San Gabriel Valley Planning Area. The purpose of the Area Plan is to enhance, guide, and support the long-term growth, development, and maintenance of these communities. The Area Plan consists of areawide goals and policies on land use, economic development, community character and design, conservation and natural resources, mobility, and parks and recreation. The Area Plan also includes community specific goals and policies for each community or grouping of communities. Zoning and land use policy map changes are also proposed as part of the Project to bring zoning and land use policy into conformance; to direct growth near major transit stops, along major corridors, and away from hazard areas; to conserve natural resources; and to implement the Housing Element Rezoning Program. In addition, zoning map changes are proposed for designated properties to clarify the applicability of the adopted Green Zones Ordinance. The Project also includes ordinance amendments to implement the goals and policies of the Area Plan and consists of new areawide regulations and updates to existing standards. ENVIRONMENTAL DOCUMENTATION: As the lead agency, pursuant to the California Environmental Quality Act ("CEQA"), the County Regional Planning Commission will consider the certification of the Environmental Impact Report ("EIR"), which includes the Final EIR ("FEIR") and Draft EIR ("DEIR"). The Commission will also consider the adoption of the County Mitigation Monitoring and Reporting Program ("MMRP"), the CEQA Findings of Fact, and a Statement of Overriding Considerations. The FEIR will be available for review at least 10 days prior to the public hearing date (Cal. Code of Reg. Title 14 Chap. 3 ss 15089(b)).

Staff presented the amendment to the General Plan and Title 22 of the Los Angeles County Code to establish the East San Gabriel Valley Area Plan and the East San Gabriel Valley Planning Area Standards District for the 24 unincorporated communities. The unincorporated communities total about 51.3 square miles, with a diverse population of 242,000. Land uses are mostly residential, with limited industrial and commercial areas. In addition, some residential areas include active equestrian and small-scale agricultural uses. The Project aims to conserve the character of the East San Gabriel Valley communities, while growing sustainably into a dynamic regional hub that provides diverse options for housing, goods and services, recreation, and mobility for its residents, workers, and visitors.

PUBLIC HEARING (Cont.)

For further action and discussion visit:
http://lacdrp.granicus.com/ViewPublisher.php?view_id=1

Motion/seconded by Commissioners Duarte-White/Moon – That the Regional Planning Commission close the public hearing and recommend certification of the Final Environmental Impact Report along with the required findings of fact and statement of overriding considerations and adopt the Mitigation Monitoring and reporting program for the East San Gabriel Valley Area Plan pursuant to state and local CEQA Guidelines.

Motion/seconded by Commissioners Duarte-White/Moon – That the Regional Planning Commission adopt the resolution recommending approval to the County of Los Angeles Board of Supervisors the East San Gabriel Valley Area Plan, Project No. 2020-000612-(1,5), Advance Planning Case No. RPPL2021013047, General Plan Amendment No. RPPL2022003554, Zone Change No. RPPL2022003557, Ordinance No. RPPL2022014158, Environmental Assessment No. RPPL2022003550 with the revisions as recommended by staff.

At the direction of the Chair, the item passed unanimously.

PUBLIC COMMENT

8. Public comment pursuant to Section 54954.3 of the Government Code.

There were no requests by members of the public to address the Commission.

CONTINUATION OF REPORTS

9. Possible Call for Review of Decisions by Hearing Officer, pursuant to Section 22.240.010.B of the Los Angeles County Code.

There were no items Called up for Review by the Commission.

10. Commission/Counsel/Director Reports

There were no reports given by Commission/Counsel/Director.

ADJOURNMENT

A recording of the testimony received and the discussions held at this meeting and a copy of all findings and resolutions acted upon by the Commission are on file in the Department of Regional Planning.

The Commission adjourned at 10:44 a.m. to Wednesday, August 16, 2023.

Elida Luna, Commission Secretary

ATTEST

Michael R. Hastings, Chair

APPROVE

Connie Chung, Deputy Director
Advance Planning Division

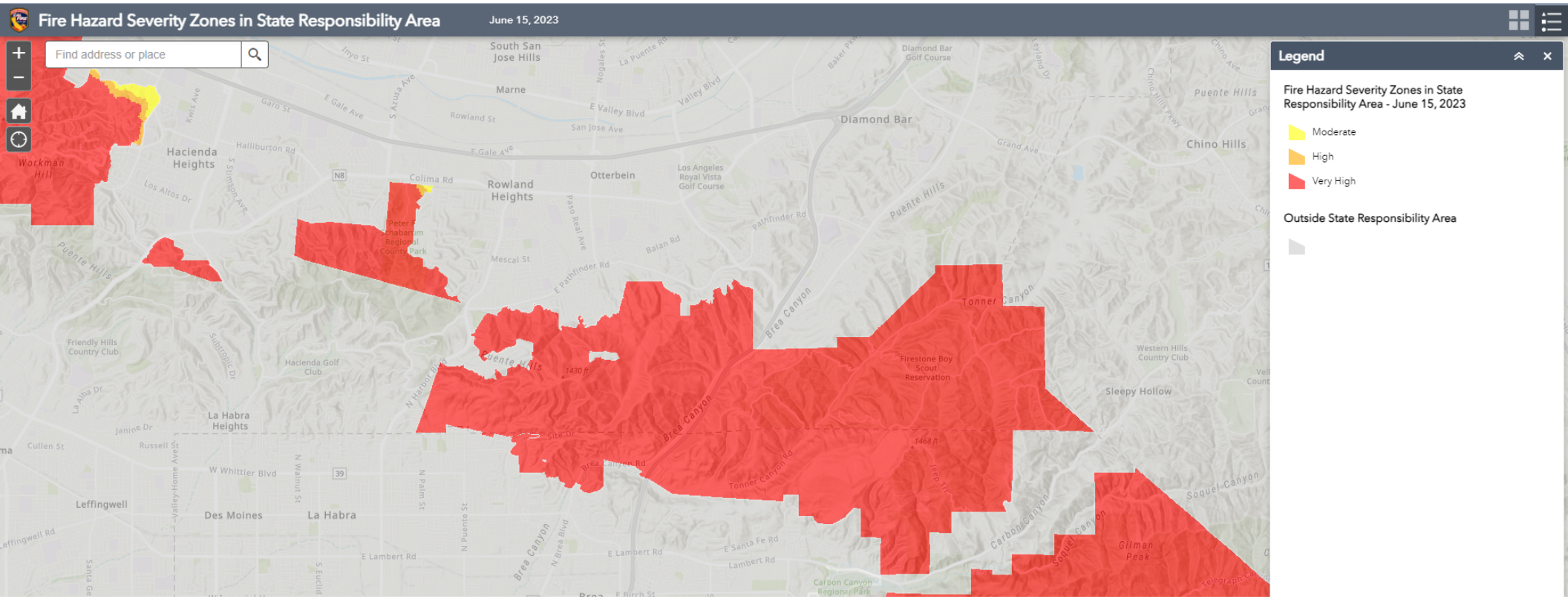
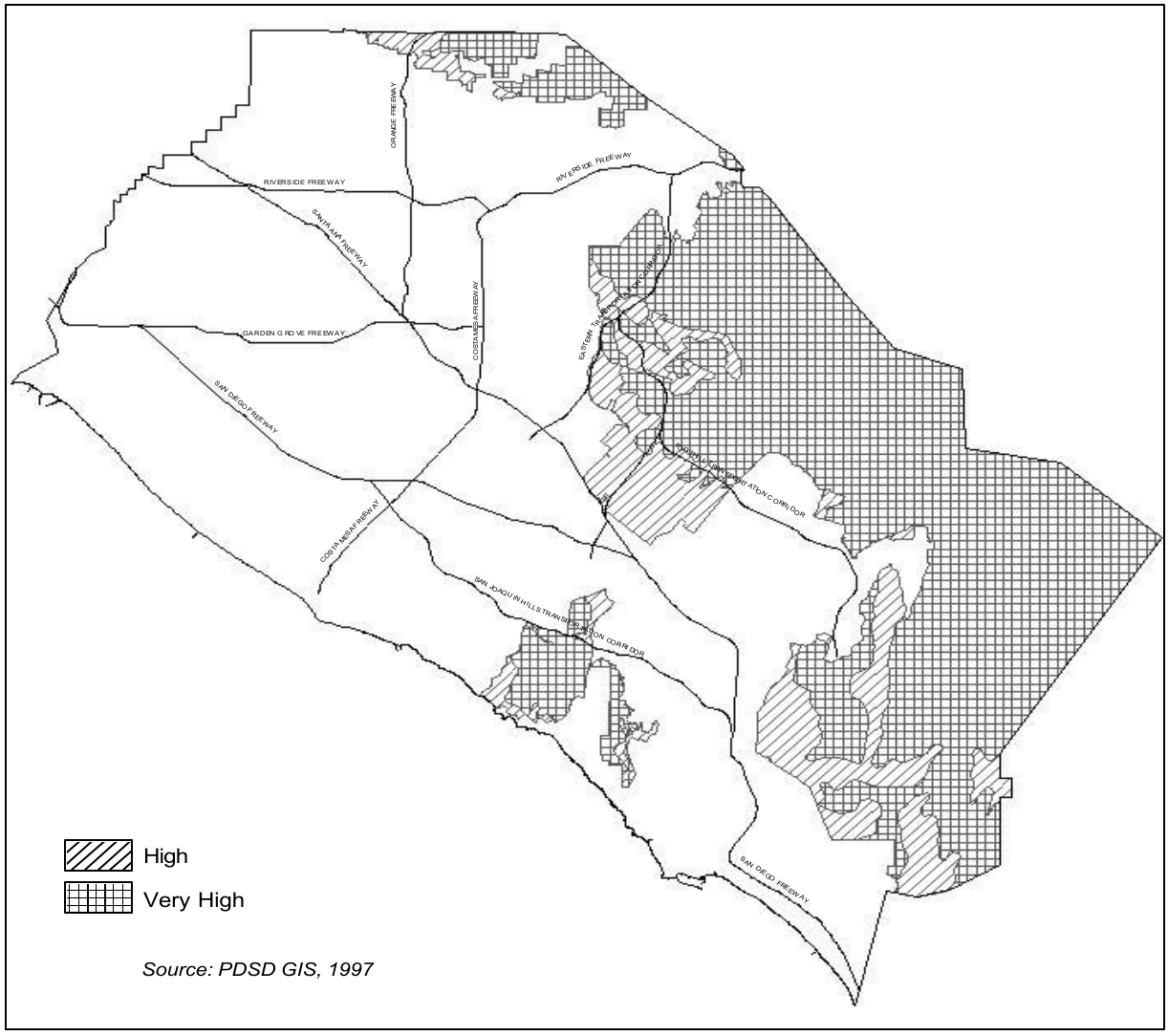

Fire Hazard Severity Zones in State Responsibility Area
June 15, 2023
Find address or place
Legend
Fire Hazard Severity Zones in State Responsibility Area - June 15, 2023
Moderate
High
Very High
Outside State Responsibility Area
South San Jose Hills
Marne
Diamond Bar
Diamond Bar Golf Course
Chino Hills
Puente Hills
Hacienda Heights
Workman Hill
Rowland Heights
Otterbein
Los Angeles Royal Vista Golf Course
Peter F. Schabarum Regional County Park
Tonner Canyon
Brea Canyon
Firestone Boy Scout Reservation
Sleepy Hollow
Western Hills Country Club
Friendly Hills Country Club
Hacienda Golf Club
La Habra Heights
Leffingwell
Des Moines
La Habra
Carbon Canyon
Soquel Canyon
Gilman Peak
Carbon Canyon Regional Park
1430 ft
1468 ft

Figure IX-1



FIRE HAZARD SEVERITY ZONES

DRAFT COMMUNITY WILDFIRE PROTECTION ORDINANCE (PREVIOUSLY NAMED THE REDUCE DAMAGE FROM WILDFIRE ORDINANCE)

ORDINANCE NO. _____

An ordinance amending Title 21 (Subdivision) and Title 22 (Planning and Zoning) of the Los Angeles County Code to reduce and manage risks to people and property located in the Very High Fire Hazard Severity Zone (VHFHSZ) and Hillside Management Area (HMA). The ordinance amends Title 21 and 22 to address adequate evacuation egress during wildfire events, to improve public safety, and to reduce risks to development and environmental resources located within the VHFHSZ and HMA.

SECTION 1. Section 21.12.020 is hereby amended to read as follows:

21.12.020 - ~~Time of meetings.~~ Responsibility.

~~The Subdivision Committee shall meet regularly to consider tentative maps and exhibit maps.~~ The Subdivision Committee shall review maps and reports submitted by applicants.

SECTION 2. Section 21.12.030 is hereby deleted in its entirety

SECTION 3. Section 21.12.040 is hereby amended to read as follows:

21.12.~~040~~ 030 - Report of recommendations to advisory agency.

The subdivision committee shall report in writing its recommendations to the advisory agency.

SECTION 4. Section 21.16.015 is hereby amended to read as follows:

Section 21.16.015 - Building Location and Access Restrictions—Exhibit Map

…

A. The exhibit map shall be submitted to the satisfaction of the Director of Regional Planning and shall depict, but shall not be limited to, the location and dimensions of all structures, buildings, yards, walls, fences, vehicle and bicycle parking and loading facilities, the vehicular, bicycle, and pedestrian access to the proposed structures, buildings, and parking and loading facilities, ~~and~~ the location and design of pedestrian roadway crossings (i.e., crosswalks), emergency vehicle access and turnarounds, and fuel modification zones.

…

SECTION 5. Section 21.24.010 is hereby amended to read as follows:

Section 21.24.010 - General requirements – determination of adequacy

…

B. In determining the adequacy of a route of access, the advisory agency shall consider the potential for blockage of the route ~~by flood, fire or landslide~~ and the effect of such blockage on the safe evacuation of future users and occupants of the division and on the deployment of fire equipment or other services under emergency conditions. Each route of access to a highway from or through a VHFHSZ shall have adequate capacity, safety, and viability to accommodate emergency egress and access by fire-fighting apparatus and other emergency equipment, as defined by Title 32 (Fire Code) of the County Code.

C. The advisory agency may disapprove a design which makes use of a residential street as a route of access to industrial, commercial or other divisions of land generating traffic which would conflict with the residential ~~character~~ use of the street.

~~C. Each route of access to a highway from or through a VHFHSZ shall have adequate capacity, safety, and viability to accommodate emergency egress and access by fire-fighting apparatus and other emergency equipment, as defined by Title 32 (Fire Code) of the County Code, and shall be assessed in conjunction with Section B above.~~

SECTION 6. Section 21.24.020 is hereby amended to read as follows:

Section 21.24.020 - Restricted residential access

A. If a street or street system is restricted to a single access route to a highway shown on the Highway Plan (except for a limited secondary highway), which is maintained and open to public travel, whether at the point of intersection with the highway or at some point distant from the highway, the street or street system shall serve not more than:

1. 150 dwelling units or 50 residential lots, whichever is less, where ~~the restriction is designed to be permanent, and~~ the street or street system ~~does not traverse a wildland area which is subject to hazard from brush or forest fire~~ is not located in and does not pass through a VHFHSZ.

2. 75 dwelling units or 25 residential lots, whichever is less, where ~~the restriction is designed to be permanent, and~~ the street or street system ~~traverses a wildland area which is subject to hazard from brush or forest fire~~ is located in or passes through a VHFHSZ.

~~3. 300 dwelling units or 100 residential lots, whichever is less, where the restriction is subject to removal through future development.~~

B. If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units

shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and is not located in and does not pass through a VHFHSZ, ~~and the restriction is subject to removal through future development,~~ the permitted number of dwelling units may be increased to ~~600~~ 300, or the permitted number of residential lots may be increased to 150, whichever is less. In no event shall the pavement width be less than 20 feet. The provisions of this section shall not apply to divisions of land referred to in Section 21.32.040 to divisions of land approved pursuant to Section 21.32.080, or to minor land divisions.

SECTION 7. Section 21.24.030 is hereby amended to read as follows:

Section 21.24.030 – Adequate ~~W~~wildland access

A. Notwithstanding the provisions of Sections 21.24.020 and 21.24.190, the advisory agency ~~may~~ shall disapprove a design of a division of land which utilizes a cul-de-sac or branching street system or other single-access street or street system as the sole or principal means of access to lots within the division, where the forester and fire warden advises:

~~A~~1. That the street or street system ~~will traverse a wildland area which is subject to extreme hazard from brush or forest fires~~ is located in or passes through a VHFHSZ; and

~~B~~2. That the lack of a second route of access would unduly hinder public evacuation and the deployment of fire-fighting apparatus and other emergency equipment in the event of a ~~brush or forest~~ wildfire, or other type of natural or manmade disaster.

B. Streets shall not be gated, unless recommended otherwise by the County Sheriff, or unless the advisory agency determines that the street may be gated and closed to public use for safety reasons.

SECTION 8. Section 21.24.0040 is hereby amended to read as follows:

Section 21.24.040 - Modifications to access and frontage requirements

A. The advisory agency may modify the requirements of Sections 21.24.010, 21.24.020, 21.24.190 and 21.24.290 where it finds that topographic conditions, title limitations, or the pattern of ownership or the state of development of parcels in the immediate vicinity of a division of land make the strict application of the provisions of these sections impossible or impractical and that the public health, safety and general welfare will not be adversely affected thereby.

B. This Section shall not apply to access or frontage requirements in a VHFHSZ, unless explicitly authorized by the Board of Supervisors.

SECTION 9. Section 21.24.090 is hereby amended to read as follows:

Section 21.24.090 - Right-of-way and roadway width requirements—cross-section diagrams

…

C. The cross-sections designated as "alternate" in the diagrams following this section shall apply to existing improved streets only if the advisory agency finds that:

…

4. The alternate cross-section will not impact either existing or proposed bicycle facilities that are required by and/or consistent with, the County Bicycle Master Plan; ~~and~~

5. That the use of such alternate cross-section would be in keeping with the design and improvement of adjoining highways or streets~~.~~; and

6. The alternate cross-section shall not be located in or pass through a VHFHSZ.

…

SECTION 10. Section 21.24.100 is hereby amended to read as follows:

Section 21.24.100 - Street grades

No highway or street shall have a grade of more than six percent, except for short stretches where the topography makes it impracticable to keep within such grade, and in no event shall the grade of a highway or street that is located in or passes through a VHFHSZ exceed eight percent, except where evidence, which is deemed satisfactory to the advisory agency is given that a lower grade is not possible.~~, and in~~ In no event shall the grade of a highway or street exceed 10 percent except where evidence, which is deemed satisfactory to the advisory agency, is given that a lower grade is not possible.

SECTION 11. Section 21.24.220 is hereby amended to read as follows:

Section 21.24.220 Fire-fighting access easements.

In areas where, in the opinion of the forester and fire warden, there will be fire hazard to the watershed or any other properties, unobstructed fire-protection access easements, not less than ~~15~~ 20 feet wide, shall be dedicated from the public highway to the boundary of the division of land. Where the design of a division of land will cause an existing fire road or fire break to be severed, and the forester and fire warden advises that this condition will impair the provision of adequate fire protection, ~~the advisory agency may require that~~ the subdivider shall either revise the design of the division of land so that

the fire road or fire break will not be severed or provide an alternate easement. The forester and fire warden shall recommend to the advisory agency regarding the location, design and grading of easements required pursuant to the provisions of this section. Such location, design and grading shall be as found necessary by the advisory agency.

SECTION 12. Section 21.24.250 is hereby amended to read as follows:

Section 21.24.250 - Area and width—Sloping terrain

A. In lieu of compliance with subsection A of Section 21.24.240, the plan of subdivision may comply with the requirements of Section 21.24.260 if the advisory agency determines:

…

3. That the lots having a reduced area will be compatible in design to adjacent facing and siding lots of abutting development; and

4. That all lots which are not reduced in area shall comply with subsection A of Section 21.24.240.

…

SECTION 13. Section 21.24.320 is hereby amended to read as follows:

Section 21.24.320 - Flag lots

A. The advisory agency may disapprove the platting of flag lots where this design is not justified by topographic conditions or the size and shape of the division of land, ~~- or~~ where this design is in conflict with the pattern of neighborhood development, or where any portion of the proposed flag lot is located in a VHFHSZ. If flag lots are approved, the access strip shall be provided as follows, unless the subdivision

committee recommends the approval of lesser widths because of topographic conditions or the size and shape of a division of land:

…

B. Each vehicular access strip shall be located so that, when improved as a driveway, the finished grade will not exceed ~~20~~15 percent. Additional grade may be allowed only where permitted by Title 32 (Fire Code) of the County Code. The advisory agency may require that easements for ingress and egress be provided over common driveways for the benefit of the lots served.

SECTION 14. Section 21.24.350 is hereby amended to read as follows:

Section 21.24.350 - Residential subdivisions—Provision of local park sites

…

E. ~~1.~~ Each park site shall be physically suited for the use intended. ~~Land which is made a part of a park site for subdivision design purposes, but which is physically unsuited for park use, shall be discounted when calculating the area of the park site provided pursuant to this section. The park space provided shall be calculated from the road right-of-way line and not from the centerline of an abutting street.~~

1. Land which is made a part of a park site for subdivision design purposes, but which is physically unsuited for park use, shall be discounted when calculating the area of the park site provided pursuant to this section. The park space provided shall be calculated from the road right-of-way line and not from the centerline of an abutting street.

…

4. If located in a VHFHSZ, park sites shall be located between development and wildlands to serve as a fuel break, where feasible. Continuous routine vegetation

management and long-term maintenance of both publicly and privately owned park sites shall be provided by the owner, in a manner prescribed by and acceptable to the County, and secured in a form acceptable to the County.

SECTION 15. Section 21.24.370 is hereby amended to read as follows:

Section 21.24.370 - Divisions of land for purpose of lease only

A. The advisory agency may approve a tentative map of a division of land which does not comply in all respects with the requirements of Parts 1, 2 and 3 of this Title 21 if:

1. The advisory agency finds:

a. The division of land is for lease only~~,~~;

b. Because the lots are to be leased only and because of the situation and development or proposed development of the division of land and surrounding property, approval of the tentative map would not be detrimental to the public welfare or property of other persons in the vicinity thereof; and

c. The proposed design and access to the proposed development provides at least the same level of protection against disaster risk as Parts 1, 2, and 3 of this chapter.

…

SECTION 16. Section 21.24.390 is hereby amended to read as follows:

Section 21.24.390 – Mobile home divisions of land

A. The advisory agency may approve a tentative map of a division of land which does not comply in all respects with the requirements of Parts 1, 2 and 3 of this chapter if:

1. The advisory agency finds:

…

b. The units of space proposed on the tentative map are for mobile homes and related facilities only and the development of a mobilehome park on the property included within the division of land is in conformance with the Zoning Ordinance set out at Title 22; and

c. The mobilehome division of land is not located within the VHFHSZ;

d. If located outside the VHFHSZ, the proposed design and access to the proposed development provides at least the same level of protection against wildfire and other disaster risks as if the application complied with Parts 1, 2, and 3 of this Chapter.

2. On such tentative map and on the final map or parcel map, there appear, in letters no less than one-fourth-inch in height, the words: "DIVISION OF LAND FOR MOBILE HOME PURPOSES ONLY."

…

SECTION 17. Section 21.24.400 is hereby amended to read as follows:

Section 21.24.400 - Division of land adjacent to existing roads

A. If the advisory agency finds that the proposed division of land abuts an existing road which has improvements insufficient for the general use of the lot owners in the division of land and local neighborhood and drainage needs, it may disapprove the design of the division unless the subdivider improves or agrees to improve such road to the same standards required of roads within all divisions of land by Chapter 21.32. If the advisory agency finds that the proposed division of land is located in a VHFHSZ, it shall

deny the proposed subdivision, unless the subdivider improves such road to the same standards required of roads within all divisions of land by Chapter 21.32.

B. Where a subdivider proposes to connect to an existing dead-end or cul-de-sac street in which a turnaround has been installed, the advisory agency may require the reconstruction of existing street improvements as a condition of such connection. If the subdivider makes or agrees to make the required improvements, all of the provisions of this Title 21 which apply to improvements and agreements to improve within a division of land shall apply.

SECTION 18. Section 21.28.060 is hereby amended to read as follows:

Section 21.28.060 - Private and future streets

Except as set out hereinafter, all parcels of land intended for public use in a division of land shown on the final map or parcel map thereof, shall be offered for dedication for public use. However, with the approval of the advisory agency, any road which is intended to be kept physically closed to public travel or posted as a private street at all times may be shown as a private and future street; but in any such case, the final map or parcel map shall contain a conditional offer of dedication, or the map may be accompanied by a conditional offer of dedication by separate instrument, either of which may be accepted by the ~~board of supervisors~~ Board of Supervisors. Any such private and future street shall be shown on such map by heavy dashed lines. Sufficient data shall be shown on each private and future street to define its boundaries, as is required for a public street, and also sufficient mathematical data to show clearly the portion of each lot within such street. The design and improvement of any such private and future street shall be subject to all of the requirements prescribed by this Title 21 for public streets.

SECTION 19. Section 21.32.040 is hereby amended to read as follows:

Section 21.32.040 - Lot sizes in excess of 10 acres—Requirements

…

B. Where each parcel resulting from a division of land has a minimum gross area of 10 acres or is a quarter-quarter-quarter section, resulting from the normal division of an undersized section of land and having a minimum gross area of nine acres, and the entire division of land is zoned A-1, A-2 or D-2 by Title 22 of this code, streets or highways which traverse sloping terrain shall be graded in accordance with engineering plans approved by the road commissioner, and ~~approved by~~ reviewed in consultation with the fire warden if the property or access to the lot is located in or passes through a VHFHSZ, unless all lots abutting any such street or highway are within an area zoned to have a required area of 10 acres or more by the Zoning Ordinance as set out at Title 22 of this code. No other improvements shall be required.

…

SECTION 20. Section 21.32.050 is hereby amended to read as follows:

Section 21.32.050 - Minor land divisions—Requirements

Improvements shall not be required as a condition precedent to filing a parcel map on a minor land division where the advisory agency finds that the existing systems and improvements adequately serve adjacent developed parcels, unless such improvements are necessary for the development of parcels within the division of land, are necessary for the prevention of increased wildfire risk to the subject property or neighboring properties, or are necessary to be consistent with the general plan.

SECTION 21. Section 21.32.060 is hereby amended to read as follows:

Section 21.32.060 - Minor land divisions—Five-acre minimum lot size requirement

…

C. On all parcel maps of five-acre lot size or more, the following note shall be placed: "Further division of this property to lot sizes below five acres will require standard improvements be completed as a condition of approval. The improvements will include but not be limited to providing access sufficient for fire-fighting apparatus and other public safety equipment, installation of water mains, appurtenances and fire hydrants, and conformance to standard Los Angeles County development standards."

SECTION 22. Section 21.32.160 is hereby amended to read as follows:

Section 21.32.160 - Street tree planting

Except as otherwise provided in this section, a subdivider shall plant trees along the frontage of all lots shown on a final map or parcel map. The number, species, and location of such trees shall be as specified by the Director of Public Works, or if the property is located in a VHFHSZ, then by the Director of Public Works in consultation with the ~~Fire Marshal~~ forester and fire warden. Tree planting is not required unless it is determined by the advisory agency to be in the public interest:

…

SECTION 23. Section 21.32.195 is hereby amended to read as follows:

Section 21.32.195 - On-site trees

A. Planting Requirement. In addition to the requirements of Section 21.32.160 (Street Tree Planting), the subdivider shall plant or cause to be planted within the front yard one tree for each 25 feet of street frontage for each parcel created by a residential

division of land, as a condition of approval, except that: ~~a compact lot subdivision and the development of single-family residences therein shall be subject to the on-site tree planting requirements set forth in~~ Section 22.140.585 ~~(Single-Family Residences on Compact Lots).~~

1. A compact lot subdivision and the development of single-family residences therein shall be subject to the on-site tree planting requirements set forth in Section 22.140.585 (Single-Family Residences on Compact Lots); and

2. For lots located in the VHFHSZ, tree type, location, and quantity shall be subject to review by the advisory agency in consultation with the forester and fire warden.

…

SECTION 24. Section 21.40.040 is hereby amended to read as follows:

Section 21.40.040 - Contents—Information and documents required

A. The tentative map shall show and contain, or be accompanied by, the following as an aid to the advisory agency in its consideration of the design of the division of land:

…

26. A cross-section or sections shown to scale with dimensions for all existing and proposed highways, parkways, streets, drives, fire lanes, alleys, and ways, within and adjoining the subdivision. This cross-section or sections shall depict, at a minimum, the existing and proposed pedestrian, bicycle, vehicle, and transit improvements, and other proposed and/or required features such as street trees, street lights, bicycle lanes, traffic-calming devices, signs and utility poles, walls, fences, and adjacent building facades. Additional cross-sections shall be required to depict any

proposed variation from the standard street design described in this Title 21, including a variation in approaches to, and/or departures from, intersections; ~~and~~

27. A vicinity map showing the location of the division in relating to the nearest Fire Hazard Severity Zones (FHSZ);

28. If located in a VHFHSZ, a Fuel Modification Plan identifying proposed defensible space, ~~fuel breaks,~~ and fuel modification areas ~~activities~~;

29. If located in a VHFHSZ, an evacuation analysis shall be provided for review by the County that includes, but may not be limited to, the following:

i. Roadway plan demonstrating adequate emergency vehicle access to and from the proposed division, on public and private roads, consistent with Chapter 21.24 (Design Standards) and Chapter 503.1.2 of Title 32 (Fire Code);

ii. Mapped evacuation routes from the proposed division to nearest highway shown on the Highway Plan, consistent with Section 21.24.010;

iii. Evaluations of mapped evacuation routes for traffic access or flow limitations, including but not limited to weight or vertical clearance limitations, dead-end, one-way, gated, or single lane conditions in a range of emergency scenarios as determined by the County; and

~~27~~30. Such other information as the Director of Regional Planning determines is necessary.

SECTION 25. Section 21.40.120 is hereby amended to read as follows:

21.40.120 - Access to property

The advisory agency may require as a condition of approval of a tentative map that the subdivider produce evidence that the property as divided will have access to a public

street or highway, including adequate access for fire-fighting apparatus and other emergency equipment.

SECTION 26. Section 21.44.320 is hereby amended to read as follows:

Section 21.44.320 - Land subject to flood hazard, inundation, ~~or~~ geological hazard, or wildfire hazard.

A. If any portion of the land within the boundaries shown on a tentative map of a division of land is subject to flood hazard, inundation, ~~or~~ geological hazard, or is located within a VHFHSZ, and the probable use of the property will require structures thereon, the advisory agency may disapprove the map or that portion of the map so affected and require protective improvements to be constructed as a condition precedent to approval of the map.

…

C. If any portion of a lot or parcel of a division of land is subject to flood hazard, inundation, ~~or~~ geological hazard, or is located within a VHFHSZ, such fact and portion shall be clearly shown on the final map or parcel map by a prominent note on each sheet of such map whereon any such portion is shown. A dedication of building restriction rights over the flood hazard, inundation, geological hazard area, or VHFHSZ may be required.

…

SECTION 27. Section 21.48.040 is hereby amended to read as follows:

Section 21.48.040 - Information required — format

…

Q. The project location relative to the nearest VHFHSZ.

~~Q~~R. Such other information as the Director of the Regional Planning determines is necessary.

SECTION 28. Section 21.48.100 is hereby amended to read as follows:

Section 21.48.100 - Access to property

The advisory agency may require as a condition of approval of a tentative minor land division map that the subdivider produce evidence that the property as divided will have access to a public street or highway, including but not limited to adequate access for fire-fighting apparatus and other emergency equipment.

SECTION 29. Section 21.48.140 is hereby amended to read as follows:

Section 21.48.140 - Eligibility for waiver—Certain uses or conditions of property

A. The following minor land divisions shall be eligible for waiver of the requirement that a parcel map be filed:

1. Those in which each resultant parcel is a part of one or more lots shown on a final map, parcel map or approved record of survey map, and the area of each resultant parcel is more than 20 percent of the total area of the lot or lots of which it is a part, except where the tentative map of any such division, the conditions of approval thereof or the requirements of the Subdivision Map Act or of this Title 21 provide for or require the delineation of flood or geological hazard, VHFHSZ areas, or building restrictions;

…

3. Those of a lease-project, except where the tentative map of any such division, the conditions of approval thereof or the requirements of the Subdivision Map

Act or of this title provide for or require the delineation of flood or geological hazards, VHFHSZ areas, or building restrictions;

…

SECTION 30. Section 21.48.170 is hereby amended to read as follows:

Section 21.48.170 - Procedures—Action by advisory agency

A. Within 20 days after acceptance of a request for waiver, or within such additional time as may be necessary, the advisory agency shall waive the requirement that a parcel map be filed as provided in Sections 21.48.130ard and 21.48.140, if it finds:

…

3. That the proposed minor land division complies with all applicable requirements as to area, improvement and design, flood and water drainage control, appropriate improved public roads, sanitary disposal facilities, water supply availability, environmental protection, avoidance or mitigation of wildfire risk, and other requirements of the Subdivision Map Act and of this Title 21.

…

SECTION 31. Section 21.52.010 is hereby amended to read as follows:

Section 21.52.010 - Modification or waiver of provisions authorized when.

…

E. Notwithstanding any contrary provisions of this Section:

…

3. In no event shall provisions of Title 21 regulating development in VHFHSZ be modified or waived unless explicitly authorized by the Board of Supervisors.

SECTION 32. Section 21.60.030 is hereby amended to read as follows:

Section 21.60.030 - Certificate of Compliance—For Undersized Parcels

…

A. A review by the director, pursuant to Chapter 22.226 (Type I Review—Ministerial) of this Code, to determine satisfaction of the following criteria:

…

6. The parcel of land has sufficient access for fire-fighting apparatus and other emergency equipment and adequate fire flow and hydrant spacing as required by Section 20.16.060; and

…

SECTION 33. Chapter 22.14.060 is hereby amended to read as follows:

22.14.060 - F.

…

Fire Department. References to Fire Department shall mean the County of Los Angeles Fire Department, unless otherwise specified.

Fire Hazard. The potential fire behavior or fire intensity in an area, given the type(s) of fuel present (including both the natural and built environment) and their combustibility.

Fire Risk. The intensity and likelihood of a fire event to occur as well as the chance, whether high or low, that a hazard such as a wildfire will cause harm. Fire risk can be determined by identifying the susceptibility of a value or asset to the potential direct or indirect impacts of wildfire hazard events.

…

SECTION 34. Chapter 22.14.080 is hereby amended to read as follows:

22.14.080 - H.

Hillside Management Areas (HMAs). The following terms are defined solely for Chapter 22.104 (Hillside Management Areas):

Development. On-site or off-site activity as follows:

1. Construction or expansion of any structure or impervious surface, such as hardscape;

2. Construction or expansion of any street, highway, or other access road;

3. Construction or expansion of any infrastructure, such as water and sewerage lines, drainage facilities, telephone lines, and electrical power transmission and distribution lines;

4. Grading, such as cut, fill, or combination thereof, including off-site grading;

5. Removal of any vegetation, including fuel modification;

6. A subdivision; or

7. A lot line adjustment.

Hazardous terrain. Topographic features with slopes 50 percent and steeper, and includes features that exacerbate fire risks such as chimneys, saddles, draws, and cliffs.

…

SECTION 35. Chapter 22.14.130 is hereby amended to read as follows:

22.14.130 - M.

…

Microwave station. A building that houses equipment necessary for the receiving, amplifying, or transmitting of microwave signals, including necessary

antenna systems, along a communications route or system which employs microwave frequencies assigned by the Federal Communications Commission.

Mid-Slope. A location on a sloped hillside that is situated between the bottom (foot) and top (ridge) of a contiguous slope.

…

SECTION 36. Chapter 22.14.230 is hereby amended to read as follows:

22.14.230 - W.

…

Wild animal. An animal as defined by Section 10.08.250 (Wild Animal) of Title 10 (Animals) of the County Code.

Wildfire. Any unplanned fire in a wildland area or in the wildland-urban interface (WUI).

Wildland. Undeveloped areas covered wholly or in part by trees, shrubs, grass, or other flammable vegetation.

Wildland-urban interface (WUI). The geographical intersection of developed land and undeveloped wildland.

Interface ~~WUI~~. Areas where development is adjacent to wildland, in which there is clear demarcation or hard edge between developed and undeveloped areas.

Intermix ~~WUI~~. Areas where development is sparsely mixed with wildland areas and vegetation, in which there is no clear demarcation between developed and undeveloped areas.

…

SECTION 37. Chapter 22.14.220 is hereby amended to read as follows:

Chapter 22.14.220 - V.

…

Vertical access. A recorded dedication or easement granting to the public the privilege and right to pass and repass over the dedicator's real property from a public road or dedicated trail to the mean high tide line.

Very High Fire Hazard Severity Zone (VHFHSZ). Geographical areas designated pursuant to California Public Resources Code Sections 4201 through 4204 and classified as Very High in State Responsibility Areas or as Local Responsibility Area ~~Agency~~ Very High Fire Hazard Severity Zones designated pursuant to California Government Code Sections 51175 through 51189.

…

SECTION 38. Chapter 22.104 is hereby amended to read as follows:

Chapter 22.104 HILLSIDE MANAGEMENT AREAS

22.104.010 - Purpose.

A. This Chapter is established to ensure that development preserves and enhances the physical integrity and scenic value of Hillside Management Areas ("HMAs"), to provide open space, reduce wildfire and landslide risks, and to be compatible with and enhance community character. These goals are to be accomplished by:

…

2. Locating development in the portions of HMAs with the fewest hillside constraints; ~~and~~

3. Using sensitive hillside design techniques tailored to the unique site characteristics~~.~~; and

4. Locating development away from portions of the HMAs with the highest wildfire and landslide risks.

…

SECTION 39. Chapter 22.104.030 is hereby amended to read as follows:

22.104.030 - Permit Required.

A Conditional Use Permit (Chapter 22.158) application is required for any development located wholly or partially in an HMA, except for:

A. Development on a single lot, provided that grading in connection with the development does not exceed 15,000 cubic yards of total cut plus total fill material. Notwithstanding the foregoing, a Community Standards District may require a Conditional Use Permit for a lesser amount of total cut plus fill material. This exception shall not apply when: ~~two or more lots or parcels of land are developed in a coordinated effort, regardless of the ownership of the involved lots or parcels of land and regardless of whether the developments are applied for concurrently or through multiple successive applications.~~

1. Two or more lots are developed in a coordinated effort, regardless of the ownership of the involved lots and regardless of whether the developments are applied for concurrently or through multiple successive applications; or

2. A new primary use structure is proposed on a natural or manufactured slope 50 percent or steeper, where located in a VHFHSZ. This provision does not apply to development on terrain with slopes 50 percent or steeper that is one-half acre or less

in size and not contiguous with any other terrain with a natural slope gradient of 50 percent or steeper.

…

D. Development in one contiguous HMA, provided that the HMA is:

1. Within a rural land use designation, one-half acre or less in size (as measured from base of slopes to slopes 25 percent or ~~greater~~ steeper) and not contiguous with any other terrain with a natural slope gradient of 25 percent or steeper; or

…

SECTION 40. Chapter 22.104.060 is hereby amended to read as follows:

22.104.060 - Findings

…

E. That, the proposed development reduces potential hazards on the project site, by:

1. Incorporating fire mitigation and resilience measures through project design, siting, structure hardening, and other methods when located in a Very High Fire Hazard Severity Zone (VHFHSZ);

2. Incorporating strategies to reduce slope instability, landslide, and flooding risks; and

F. That the proposed development is in substantial compliance with the Hillside Design Guidelines.

SECTION 41. APPENDIX I is hereby amended to read as follows:

APPENDIX I - HILLSIDE DESIGN GUIDELINES

I. PURPOSE AND OVERVIEW

The policies of the General Plan, and area and community plans, where applicable, seek to preserve significant natural features in hillside areas and protect the public against natural and man-made hazards. These Hillside Design Guidelines (Guidelines) are intended to implement those policies by ensuring that hillside development projects use sensitive and creative engineering, architectural, and landscaping site design techniques. The Guidelines also help ensure that hillside development projects are designed in a manner that allows the project to meet the findings of the Hillside Management Areas Ordinance (Ordinance), and to protect public health and safety by reducing and mitigating hazards such as wildfire and landslides within the HMAs and VHFHSZ. To accomplish ~~this~~these goals, the~~se~~ Guidelines include specific and measurable design techniques that can be applied to residential, commercial, industrial, and other types of projects.

…

II. SUBSTANTIAL COMPLIANCE

…

Due to the variety, size, geology, hydrology, and complexity of development projects, there is no set number of design measures required in a project to ensure that it, as stated in Section 22.104.010 (Purpose), preserves and enhances the physical integrity and scenic values of HMAs, provides open space, protects public health and safety, and is compatible with and enhances community character. Staff and project applicants are advised that four design

measures per category (Site Planning, Grading and Facilities, Road Circulation, Building Design, and Landscaping) is typically the appropriate number of design measures to be included in a project to allow the findings required by Chapter 22.104 to be made for that project.

Staff and applicants are also advised that these numbers are general recommendations, and not absolute requirements. Because projects are tailored to the individual site requirements and conditions, it is possible that more or less measures may be appropriate. When considering whether to support a request for a lower number of measures from an applicant, factors that staff may consider include density, the size of the project, existing hazards on site, or whether the project is able to meet several partial credit design measures.

…

IV. FACTORS AFFECTING RESIDENTIAL DENSITY

Sensitive hillside design techniques can be used to achieve a better project design while still maintaining a desired number of dwelling units. The General Plan land use designation ("plan category") establishes the appropriate residential density range for a project, including the density maximum. However, there are a number of other factors that can affect the project's density, such as:

- Land division standards (minimum lot size, lot width, street frontage and access)
- Zoning designation (minimum lot size/lot area per dwelling unit)
- Zoning standards (building setbacks, maximum lot coverage)
- Biological constraints (such as woodlands and wildlife habitats and

corridors)

- Natural environmental hazards (such as geologic, seismic, fire, flood)
- Open space, road access, and parking requirements
- Emergency ingress and egress
- Public easements and dedications (such as for utilities)
- Community compatibility and neighbor concerns

…

VI. SENSITIVE HILLSIDE DESIGN MEASURES

1. Site Planning

Conserve land area and form, link open spaces, reduce wildfire and landslide hazards, and promote a more attractive pattern of development that complements the hillside terrain.

…

1.18. Locate development of buildings away from mid-slope locations. Provide a minimum 15-foot setback from terrain with slopes between 25 percent to 49 percent.

1.19. Locate development away from slopes 50% or steeper. Provide a minimum 30-foot setback between buildings and any terrain feature with a natural or graded slope 50 percent or steeper.

1.20. Cluster all buildings on site to consolidate Fuel Modification Zones A and B. This provision applies to structures subject to Section 4908.1 of Title 32 (Fire Code) and ~~exempt if in~~ does not apply where there are conflicts with applicable Community Standards District requirements. Development may also comply through: (1)

shared Fuel Modification Zone B with structures on adjacent parcels, or by (2) locating the structures within 100 feet of public road access.

1.21. Provide 200-foot minimum setback from structures and designated open space or public parkland areas to ensure that all required fuel modification is located within the project site boundaries and no brush clearance is required within the public parkland, to prevent impacts to the habitat and recreational resources.

~~1.18~~ 1.22. Use any other site planning techniques not listed in this Section that either through innovation or in consideration of specific site constraints or other specific project factors, are tailored to allow the project to meet the findings required by Section 22.104.060 (Findings).

…

3. Road Circulation

Preserve the physical shape of the hillside, maintain good connectivity, and provide scenic roadway views.

3.1. Provide at least two points of paved roadway access[6] to a County highway (major or secondary) for any project (or portion of development) greater than ~~50~~ 75 dwelling units or 25 lots, whichever is less. ~~and 10 acres in size. *(Note: This practice should only be considered when the second road connection will not require a substantial amount of additional grading; special consideration may be given when connecting to an adjacent community or providing access to community services such as schools and parks.)*~~

[6] Roadway access may consist of private or future streets, and shall be un-gated, accessible by the public, and must offer an equivalent level of access and evacuation capacity as a public street. ~~*May be a private roadway or fire lane but shall be un-gated, accessible by the public, and of sufficient width to meet Fire Department requirements.*~~

3.2. Locate and design new roadways to follow the existing natural slope contours, avoiding mass landform alteration and excessive grading.[7]

~~3.3. Utilize private drives instead of public streets on 50 percent or more of the project road circulation system to allow slightly higher gradients (up to 15 percent) that result in less grading and better conformance to natural slope contours, taking into account hydrology design and any sewer, water, and storm drain infrastructure.~~

~~3.4~~ 3.3. Use undulating patterns and varying grades[8] for roadway segments exceeding 1,000 feet in length.

~~3.5~~ 3.4. Connect roadways to form blocks wherever feasible (2,000 square feet or less block perimeter), such that at least 75 percent of the development footprint (to include public facilities) is contained within blocks. (Note: The purpose of this is to provide good access and connectivity for safety reasons, and to use roadways to buffer development from natural vegetated areas.)

~~3.6~~ 3.5. Use cul-de-sacs in limited instances, such as where road connections would require grading into 50 percent or greater slopes or grading into 25 percent or greater slopes for a distance of more than 500 feet.

~~3.7~~ 3.6. Provide unpaved trail or paved pedestrian path thru-connections (e.g., pedestrian paseos) for all cul-de-sacs. *(Note: Fee-dedicated strips are recommended instead of easements on private Jots.)*

[7] Subject to the sight distance, signing, striping, and marking requirements of Los Angeles County Department of Public Works.
[8] Subject to the maximum allowed street grade requirements of Los Angeles County Department of Public Works.

~~3.8~~ 3.7. Utilize "edge" (single-loaded) roads along at least 50 percent of the development perimeter, in areas with steep hillside terrain, and to buffer development from undisturbed open space.

~~3.9~~ 3.8. Place all new roadways and paved driveways at least 100 feet below the crest of the tallest hilltop or ridgeline located onsite, or offsite within 500 feet of the project boundary. Avoid mid-slope locations wherever possible.

~~3.10~~ 3.9. Design "split" roadways or landscaped medians to preserve unique or important natural features (such as oak trees or rock outcroppings).

~~3.11~~ 3.10. Use bridge design techniques that are attractive, maximize the preservation of natural watercourses, and allow easy wildlife migration beneath the bridge (minimum six feet of vertical and horizontal clearance recommended).

~~3.12 Use private drives instead of public roadways when it will result in narrower roadway widths that create less grading. *(Note: Private drives should conform to the Los Angeles County Private Drives and Traffic Calming Manual, and should not eliminate sidewalks or reduce sidewalk connections throughout the development.)*~~

~~3.13~~ 3.11. Use any other roadway circulation design techniques not listed in this Section that either through innovation or in consideration of specific site constraints or other specific project factors, are tailored to the site and allow it to meet the findings required by Section 22.104.060 (Findings).

…

5. Landscaping

…

5.4 Utilize native, ~~and~~ drought-tolerant trees, shrubs and ground cover over all exposed graded areas.

…

5.11. Plant native oaks near existing oak woodlands and in strategic locations to protect developments from wildfires, as well as to lessen fire risk associated with development.

5.12. Provide a slope-adjusted minimum clearance between mature vegetation canopies within the required fuel modification zone to maintain adequate horizontal clearance between vegetation (Table 1).

Table 1: Minimum Horizontal Clearance (Slope Adjusted)		
% Slope	Trees	Shrubs
< 25%	10 feet	2x average shrub height
25-50%	20 feet	4x average shrub height
> 50%	30 feet or more	6x average shrub height

~~5.11~~ 5.13. Use any other landscaping design techniques not listed in this Section that either through innovation or in consideration of specific site constraints or other specific project factors, are tailored to the site and allow it to meet the findings required by Section 22.104.060 (Findings).

VII. LIST OF DESIGN EXHIBITS.

…

- Fuel Modification Plan - A specific type of landscape plan that shows all fuel modification zone boundaries, distances between boundaries, and types of

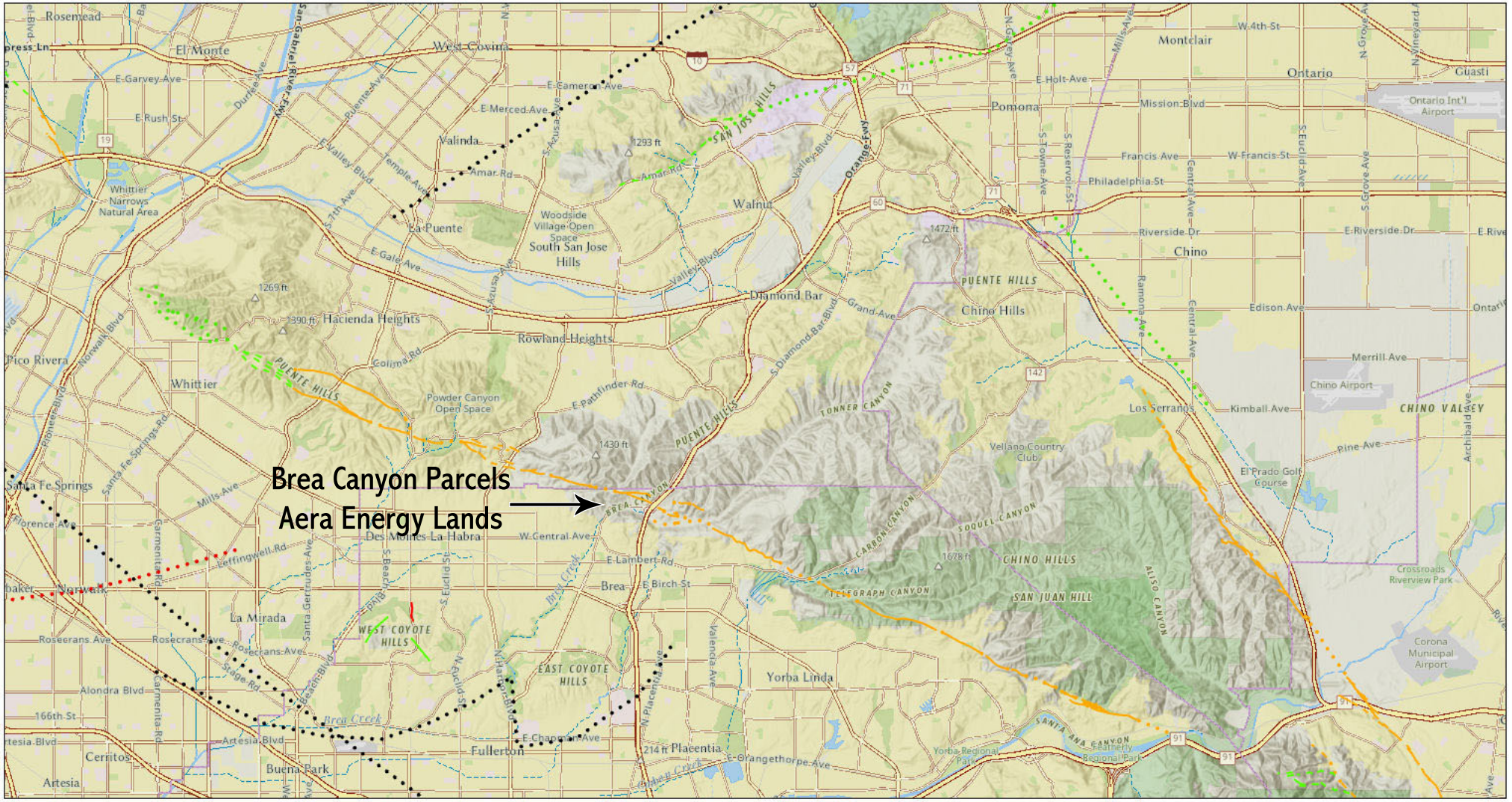
vegetation, as required by the Los Angeles County Fire Department. (Please refer to the Fire Department's separate guidelines when creating this plan.) If the full fuel modification radius cannot be located completely within the project lot, the Fuel Modification Plan shall indicate any off-site defensible space located on adjacent lots.

…

- Buildout Simulation - A color exhibit that shows how new development would impact existing hillside views. It typically depicts a "before" and "after" perspective view of the hillside(s), and includes realistic or semi-realistic photos or renderings of the actual buildings and landscaping that will be used in the development, showing how they will affect the hillside views. If located in a VHFHSZ, the buildout simulation shall include and call out fire risk reduction strategies such as fuel modification zones and ‘structure hardening’ features.

…

U.S. Geological Survey Quaternary Faults



9/28/2023, 9:27:04 AM

1:144,448

0 1.5 3 6 mi

0 2.25 4.5 9 km

Fault Areas
- Class B
- historic
- late Quaternary
- latest Quaternary
- middle and late Quaternary

National Database
- Historic (< 150 years), well constrained location
- Historic (< 150 years), moderately constrained location
- Historic (< 150 years), inferred location
- Latest Quaternary (<15,000 years), well constrained location
- Latest Quaternary (<15,000 years), moderately constrained location
- Latest Quaternary (<15,000 years), inferred location
- Late Quaternary (< 130,000 years), well constrained location
- Late Quaternary (< 130,000 years), moderately contrained location
- Late Quaternary (< 130,000 years), inferred location
- Middle and late Quaternary (< 750,000 years), well constrained location
- Middle and late Quaternary (< 750,000 years), moderately constrained location
- Middle and late Quaternary (< 750,000 years), inferred location
- Undifferentiated Quaternary (< 1.6 million years), well constrained location
- Undifferentiated Quaternary (< 1.6 million years), moderately constrained location
- Undifferentiated Quaternary (< 1.6 million years), inferred location

County of Los Angeles, California State Parks, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS

USGS

Sources: Esri, USGS | Esri, NASA, NGA, USGS | County of Los Angeles, California State Parks, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA | USGS |

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.17 Miles

☑ Show Elevation Profile

☐ Mouse Navigation | Save | Clear

Brea Canyon Parcels
Aera Energy Lands

492 ft
0 ft 0.0%

1985

Imagery Date: 4/2/2021 33°56'48.97" N 117°52'51.56" W elev 854 ft eye alt 4123 ft

Google Earth

Graph: Min, Avg, Max Elevation: 492, 626, 776 ft

Range Totals: Distance: 1077 ft | Elev Gain/Loss: 308 ft, -23.6 ft | Max Slope: 65.3%, -19.0% | Avg Slope: 26.4%, -13.1%

Average Slope: 26.4%

776 ft
700 ft
650 ft
600 ft
550 ft
492 ft

492 ft
0.0%

0 ft 75 ft 150 ft 225 ft 300 ft 375 ft 450 ft 525 ft 600 ft 675 ft 750 ft 825 ft 900 ft 975 ft 1077 ft


Ruler
Line
Path
Polygon
Circle
3D path
3D polygon
Measure the distance between multiple points on the ground
Length:
0.35
Miles
Show Elevation Profile
Mouse Navigation
Save
Clear
686 ft
1751 ft
6.3%
Brea Canyon Parcels
Aera Energy Lands
Brea Blvd
Brea Blvd
S Brea Canyon Rd
Brea Canyon Rd
Orange Fwy
Google Earth
1985
Imagery Date: 4/2/2021 33°56'51.03" N 117°53'22.35" W elev 987 ft eye alt 4101 ft


Graph: Min, Avg, Max Elevation: 464, 614, 748 ft
Range Totals: Distance: 1944 ft
Elev Gain/Loss: 307 ft, -23.2 ft
Max Slope: 45.5%, -17.0%
Avg Slope: 17.4%, -3.2%
748 ft
700 ft
650 ft
600 ft
550 ft
500 ft
464 ft
Average Slope: 17.4%
686 ft
6.3%
250 ft
500 ft
750 ft
1000 ft
1250 ft
1500 ft
1751 ft
1944 ft

Brea Canyon Parcels
Aera Energy Lands

562 ft
833 ft 18.2%

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.34 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

Brea Blvd
Brea Blvd
Brea Blvd
S Brea Canyon Rd

Google Earth

1985

Imagery Date: 4/2/2021 33°56'36.38" N 117°53'01.26" W elev 575 ft eye alt 4055 ft

Graph: Min, Avg, Max Elevation: 443, 576, 738 ft

Range Totals: Distance: 1883 ft | Elev Gain/Loss: 324 ft, -29.6 ft | Max Slope: 52.8%, -30.2% | Avg Slope: 18.4%, -13.2%

738 ft
700 ft
650 ft
600 ft
550 ft
500 ft
443 ft

Average Slope: 18.4%

18.2%

250 ft 500 ft 750 ft 833 ft 1000 ft 1250 ft 1500 ft 1750 ft 1883 ft

729 ft
1577 ft 9.8%

Brea Canyon Parcels
Aera Energy Lands

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.27 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

Site Dr

1985

Imagery Date: 4/2/2021 33°56'38.53" N 117°53'24.41" W elev 665 ft eye alt 4145 ft

Google Earth

Graph: Min, Avg, Max Elevation: 469, 645, 766 ft

Range Totals: Distance: 1578 ft | Elev Gain/Loss: 320 ft, -59.5 ft | Max Slope: 59.5%, -34.3% | Avg Slope: 24.1%, -12.4%

Average Slope: 24.1%

766 ft
700 ft
650 ft
600 ft
550 ft
500 ft
469 ft

729 ft

9.8%

250 ft 500 ft 750 ft 1000 ft 1250 ft 1577 ft

680 ft
2554 ft -9.7%

Brea Canyon Parcels
Aera Energy Lands

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.45 Miles

Show Elevation Profile

Mouse Navigation | Save | Clear

Brea Blvd

Google Earth

1985

Imagery Date: 4/2/2021 33°56'21.32" N 117°53'31.96" W elev 427 ft eye alt 4611 ft

Graph: Min, Avg, Max Elevation: 485, 663, 795 ft

Range Totals: Distance: 2556 ft | Elev Gain/Loss: 421 ft, -257 ft | Max Slope: 66.1%, -60.2% | Avg Slope: 26.9%, -22.8%

Average Slope: 26.9%

795 ft
750 ft
700 ft
650 ft
600 ft
550 ft
485 ft

680 ft

-9.7%

250 ft 500 ft 750 ft 1000 ft 1250 ft 1500 ft 1750 ft 2000 ft 2250 ft 2554 ft

Brea Canyon Parcels
Aera Energy Lands

583 ft
447 ft 0.0%

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.09 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

Oakcrest Ave
N Dorothy Dr
Northwood Ave
Oak Knoll St

Google Earth

1985

Imagery Date: 4/2/2021 33°56'35.44" N 117°54'06.65" W elev 601 ft eye alt 4083 ft

Graph: Min, Avg, Max Elevation: 581, 626, 679 ft

Range Totals: Distance: 566 ft | Elev Gain/Loss: 44.8 ft, -97.9 ft | Max Slope: 66.2%, -78.8% | Avg Slope: 5.6%, -54.0%

679 ft
650 ft
625 ft
600 ft
581 ft

Average Slope: 5.6%

583 ft

0.0%

50 ft 100 ft 150 ft 200 ft 250 ft 300 ft 350 ft 400 ft 447 ft 500 ft 566 ft

Brea Canyon Parcels
Aera Energy Lands

492 ft
0 ft 0.0%

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.17 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

1985

Imagery Date: 4/2/2021 33°56'48.97" N 117°52'51.56" W elev 854 ft eye alt 4123 ft

Google Earth

Graph: Min, Avg, Max Elevation: 492, 626, 776 ft

Range Totals: Distance: 1077 ft | Elev Gain/Loss: 308 ft, -23.6 ft | Max Slope: 65.3%, -19.0% | Avg Slope: 26.4%, -13.1%

Max Slope: 65.3%

776 ft
700 ft
650 ft
600 ft
550 ft
492 ft

492 ft
0.0%

0 ft 75 ft 150 ft 225 ft 300 ft 375 ft 450 ft 525 ft 600 ft 675 ft 750 ft 825 ft 900 ft 975 ft 1077 ft

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.35 Miles

☑ Show Elevation Profile

☐ Mouse Navigation | Save | Clear

686 ft
1751 ft 6.3%

Brea Canyon Parcels
Aera Energy Lands

Brea Blvd
Brea Blvd
S Brea Canyon Rd
Brea Canyon Rd
Orange Fwy

Google Earth

1985

Imagery Date: 4/2/2021 33°56'51.03" N 117°53'22.35" W elev 987 ft eye alt 4101 ft

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Max Slope: 45.5%

748 ft
700 ft
650 ft
600 ft
550 ft
500 ft
464 ft

686 ft

6.3%

250 ft 500 ft 750 ft 1000 ft 1250 ft 1500 ft 1751 ft 1944 ft

Brea Canyon Parcels
Aera Energy Lands

562 ft
833 ft 18.2%

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.34 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

Brea Blvd
Brea Blvd
Brea Blvd
S Brea Canyon Rd

Google Earth

1985

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738 ft
700 ft
650 ft
600 ft
550 ft
500 ft
443 ft

Max Slope: 52.8%

18.2%

250 ft 500 ft 750 ft 833 ft 1000 ft 1250 ft 1500 ft 1750 ft 1883 ft

729 ft
1577 ft 9.8%

Brea Canyon Parcels
Aera Energy Lands

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.27 Miles

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☐ Mouse Navigation Save Clear

Google Earth

1985

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Max Slope: 59.5%

766 ft
700 ft
650 ft
600 ft
550 ft
500 ft
469 ft

729 ft

9.8%

250 ft 500 ft 750 ft 1000 ft 1250 ft 1577 ft

680 ft
2554 ft -9.7%

Brea Canyon Parcels
Aera Energy Lands

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.45 Miles

Show Elevation Profile

Mouse Navigation | Save | Clear

Brea Blvd

Google Earth

1985

Imagery Date: 4/2/2021 33°56'21.32" N 117°53'31.96" W elev 427 ft eye alt 4611 ft

Graph: Min, Avg, Max Elevation: 485, 663, 795 ft

Range Totals: Distance: 2556 ft | Elev Gain/Loss: 421 ft, -257 ft | Max Slope: 66.1%, -60.2% | Avg Slope: 26.9%, -22.8%

795 ft
750 ft
700 ft
650 ft
600 ft
550 ft
485 ft

Max Slope: 66.1%

680 ft

-9.7%

250 ft 500 ft 750 ft 1000 ft 1250 ft 1500 ft 1750 ft 2000 ft 2250 ft 2554 ft

Brea Canyon Parcels
Aera Energy Lands

583 ft
447 ft 0.0%

Ruler

Line | Path | Polygon | Circle | 3D path | 3D polygon

Measure the distance between multiple points on the ground

Length: 0.09 Miles

☑ Show Elevation Profile

☐ Mouse Navigation Save Clear

Oakcrest Ave
N Dorothy Dr
Northwood Ave
Oak Knoll St

Google Earth

1985

Imagery Date: 4/2/2021 33°56'35.44" N 117°54'06.65" W elev 601 ft eye alt 4083 ft

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679 ft
650 ft
625 ft
600 ft
581 ft

Max Slope: 66.2%

583 ft

0.0%

50 ft 100 ft 150 ft 200 ft 250 ft 300 ft 350 ft 400 ft 447 ft 500 ft 566 ft

OC Public Works / Infrastructure Programs

7-Year Capital Improvement Program
FY 2016-17 to FY 2022-23

Road Capital Improvement Program, Project Name	Dist.	Cost Description	Planned FY 2016-17	Planned FY 2017-18	Planned FY 2018-19	Planned FY 2019-20	Planned FY 2020-21	Planned FY 2021-22	Planned FY 2022-23	7-Year Total Project Costs	Future Project Costs	Total Project Cost	Revenue				Total Revenue
													Gas Tax	M2	Grant Type	Other	
Antonio Parkway, Widening Mitigation	5	Construction Cost Est	900,000	-	-	-	-	-	-	900,000		900,000	900,000	-		-	900,000
at Ortega Highway		Pre-Design/Programming	-	-	-	-	-	-	-	-		-	-	-		-	-
		Design	-	-						-		-	-	-		-	-
		Admin/ProjMgmnt	-	-	-	-	-	-	-	-		-	-	-		-	-
		Survey	30,000	-	-	-	-	-	-	30,000		30,000	30,000	-		-	30,000
		Environ/Permits	-	-						-		-	-	-		-	-
		Utilities	-	-						-		-	-	-		-	-
		Right-Of-Way	-	-	-	-	-	-	-	-		-	-	-		-	-
		Construction Mgmnt/Inspec	-	-						-		-	-	-		-	-
		Mitigation	105,000	-						105,000		105,000	105,000	-		-	105,000
		Total Cost	**1,035,000**	**-**						**1,035,000**	-	**1,035,000**	**1,035,000**	**-**		**-**	**1,035,000**
		On-Going Maintenance	30,000	30,000	30,000	30,000	30,000	30,000	30,000	210,000		210,000	210,000				210,000
Brea Boulevard/Brea Canyon Road	4	Construction Cost Est	-	-	-	-	-	19,194,164	19,194,164	38,388,328		38,388,328	8,086,371	30,301,957	*M2-RCP	-	38,388,328
Canyondale Dr. to Los Angeles County Limit		Pre-Design/Programming	16,679	50,000	50,000	20,000	20,000	10,000	200,000	366,679		366,679	366,679				366,679
		Design	150,000	75,000	4,075,000	75,000	75,000	50,000	25,000	4,525,000		4,525,000	3,335,021	1,189,979	M2-RCP-D		4,525,000
		Admin/ProjMgmnt	20,000	100,000	100,000	100,000	100,000	50,000	25,000	495,000		495,000	495,000				495,000
		Survey	25,000	-	50,000	20,000	20,000	750,000	750,000	1,615,000		1,615,000	1,615,000				1,615,000
		Environ/Permits	50,000	40,000	40,000	40,000	40,000	5,000	5,000	220,000		220,000	220,000				220,000
		Utilities	25,000	-	-	330,000	330,000	330,000	-	1,015,000		1,015,000	1,015,000				1,015,000
		Right-Of-Way	15,000	-	150,000	1,150,000	1,000,000	-	-	2,315,000		2,315,000	949,500	1,365,500	*M2-RCP	-	2,315,000
		Construction Mgmnt/Inspec		-	-	-	-	3,150,000	3,150,000	6,300,000		6,300,000	6,300,000				6,300,000
		Mitigation		-	-	-	-	-	-	-		-	-				-
		Total Cost	**301,679**	**265,000**	**4,465,000**	**1,735,000**	**1,585,000**	**23,539,164**	**23,349,164**	**55,240,007**	-	**55,240,007**	**22,382,571**	**32,857,436**		**-**	**55,240,007**
		On-Going Maintenance	-	-	-	-	-	383,883	383,883	767,766	-	767,766	767,766				767,766
Brea Boulevard/Brea Canyon Road, Mitigation	4	Construction Cost Est	-	-	-	-	-	1,500,000	-	1,500,000		1,500,000	1,500,000				1,500,000
Canyondale Dr. to Los Angeles County Limit		Pre-Design/Programming		-	-	-	-	-	-	-		-	-				-
		Design		-	-	-	-	-	-	-		-	-				-
		Admin/ProjMgmnt	4,000	-	10,000	10,000	10,000	5,000	-	39,000		39,000	39,000				39,000
		Survey	-	-	150,000	25,000	-	200,000	-	375,000		375,000	375,000				375,000
		Environ/Permits		-	-	-	-	-	-	-		-	-				-
		Utilities		-	15,000	-	-	-	-	15,000		15,000	15,000				15,000
		Right-Of-Way		-	-	-	-	-	-	-		-	-				-
		Construction Mgmnt/Inspec		-	-	-	-	300,000	-	300,000		300,000	300,000				300,000
		Mitigation		-	90,000	50,000	50,000	110,000	90,000	390,000	120,000	510,000	510,000				510,000
		Total Cost	**4,000**	**-**	**265,000**	**85,000**	**60,000**	**2,115,000**	**90,000**	**2,619,000**	120,000	**2,739,000**	**2,739,000**	**-**		**-**	**2,739,000**
		On-Going Maintenance	-	-	-	-	-	22,500	22,500	45,000	45,000	90,000	90,000				90,000
Crawford Canyon Road Drainage Improvements & Reconstruction	3	Construction Cost Est	3,190,000	-	-	-	-	-	-	3,190,000		3,190,000	2,790,000		OCParks	400,000	3,190,000
Newport Boulevard to City of Orange Boundary		Pre-Design/Programming		-	-	-	-	-	-	-		-	-				-
		Design	125,000	40,000	-	-	-	-	-	165,000		165,000	165,000				165,000
		Admin/ProjMgmnt	24,000	24,000	-	-	-	-	-	48,000		48,000	48,000				48,000
		Survey	93,710	150,000	-	-	-	-	-	243,710		243,710	243,710				243,710
		Environ/Permits	10,000	-	-	-	-	-	-	10,000		10,000	10,000				10,000
		Utilities	45,000	-	-	-	-	-	-	45,000		45,000	45,000				45,000
		Right-Of-Way	45,000	-	-	-	-	-	-	45,000		45,000	45,000				45,000
		Construction Mgmnt/Inspec	50,000	400,000	-	-	-	-	-	450,000		450,000	450,000				450,000
		Mitigation	-	-	-	-	-	-	-	-		-	-				-
		Total Cost	**3,582,710**	**614,000**	**-**	**-**	**-**	**-**	**-**	**4,196,710**	-	**4,196,710**	**3,796,710**	**-**		**400,000**	**4,196,710**
		On-Going Maintenance	-	39,875	39,875	39,875	39,875	39,875	39,875	**239,250**	-	239,250	239,250				239,250
Crown Valley Parkway and Oso Parkway Slurry Seal Project	5	Construction Cost Est	1,145,215	-	-	-	-	-	-	1,145,215		1,145,215	645,215		F-APM	500,000	1,145,215
		Pre-Design/Programming	-	-	-	-	-	-	-	-		-	-				-
		Design	-	-	-	-	-	-	-	-		-	-				-
		Admin/ProjectManagement	-	-	-	-	-	-	-	-		-	-				-
		Survey	50,000	-	-	-	-	-	-	50,000		50,000	50,000				50,000
		Environ/Permits	10,000	-	-	-	-	-	-	10,000		10,000	10,000				10,000
		Utilities	15,000	-	-	-	-	-	-	15,000		15,000	15,000				15,000
		Right-Of-Way	-	-	-	-	-	-	-	-		-	-				-
		Construction Mgmnt/Inspec	300,000	-	-	-	-	-	-	300,000		300,000	300,000				300,000
		Mitigation	-	-	-	-	-	-	-	-		-	-				-
		Total Cost	**1,520,215**	**-**	**-**	**-**	**-**	**-**	**-**	**1,520,215**	-	**1,520,215**	**1,020,215**	**-**		**500,000**	**1,520,215**
		On-Going Maintenance	-	17,178	17,178	17,178	17,178	17,178	17,178	**103,068**	-	**103,068**	103,068				103,068
Edinger Avenue Bridge Replacement	2	Construction Cost Est	8,074,095	-	-	-	-	-	-	8,074,095		8,074,095	-		F-HBP	8,074,095	8,074,095
over Bolsa Chica Channel		Pre-Design/Programming	20,000	-	-	-	-	-	-	20,000		20,000	20,000				20,000
		Design	165,945	65,000	-	-	-	-	-	230,945		230,945	230,945				230,945
		Admin/ProjMgmnt	32,000	80,000	-	-	-	-	-	112,000		112,000	112,000				112,000
		Survey	240,000	240,000	-	-	-	-	-	480,000		480,000	480,000				480,000
		Environ/Permits	80,000	80,000	-	-	-	-	-	160,000		160,000	160,000				160,000
		Utilities	8,000	-	-	-	-	-	-	8,000		8,000	8,000				8,000
		Right-Of-Way	33,000	-	-	-	-	-	-	33,000		33,000	33,000				33,000
		Construction Mgmnt/Inspec	500,000	500,000	-	-	-	-	-	1,000,000		1,000,000	139,470		F-HBP	860,530	1,000,000
		Mitigation	40,000	-	-	-	-	-	-	40,000		40,000	40,000				40,000
		Total Cost	**9,193,040**	**965,000**	**-**	**-**	**-**	**-**	**-**	**10,158,040**	-	**10,158,040**	**1,223,415**	**-**		**8,934,625**	**10,158,040**
		On-Going Maintenance	-	100,926	100,926	100,926	100,926	100,926	100,926	605,556	-	605,556	605,556				605,556
Foothill Boulevard & Hewes Street Asphalt Overlay Project	3	Construction Cost Est	1,280,434	-	-	-	-	-	-	1,280,434		1,280,434	780,434		F-APM	500,000	1,280,434
		Pre-Design/Programming		-	-	-	-	-	-	-		-	-				-
		Design		-	-	-	-	-	-	-		-	-				-
		Admin/ProjMgmnt		-	-	-	-	-	-	-		-	-				-
		Survey	50,000	-	-	-	-	-	-	50,000		50,000	50,000				50,000
		Environ/Permits	10,000	-	-	-	-	-	-	10,000		10,000	10,000				10,000
		Utilities	15,000	-	-	-	-	-	-	15,000		15,000	15,000				15,000
		Right-Of-Way		-	-	-	-	-	-	-		-	-				-
		Construction Mgmnt/Inspec	300,000	-	-	-	-	-	-	300,000		300,000	300,000				300,000
		Mitigation	-	-	-	-	-	-	-	-		-	-				-
		Total Cost	**1,655,434**	**-**	**-**	**-**	**-**	**-**	**-**	**1,655,434**	-	**1,655,434**	**1,155,434**	**-**		**500,000**	**1,655,434**
		On-Going Maintenance	-	19,207	19,207	19,207	19,207	19,207	19,207	**115,242**	38,414	153,656	153,656				153,656

Project list, schedule and costs shown are estimate and subject to change.

OC Public Works

OC Public Works Capital Improvement Program
FY 2023-24 to 2029-30

	Road Capital Improvement Program, Project Name	Dist	Cost Description	Project Costs: Budgeted FY 2023-24	Planned FY 2024-25	Planned FY 2025-26	Planned FY 2026-27	Planned FY 2027-28	Planned FY 2028-29	Planned FY 2029-30	7 yr. Total Project Cost	Project Revenue: Gas Tax	RMRA	M2	Road Fee	Federal	Other	Total Revenue	Comments
1	**ADA (Americans with Disabilities Act) Upgrades** Project Limits: Various streets within Unincorporated Orange County Project Description: The project consists of curb ramp, sidewalk, and driveway upgrades and improvements to satisfy current ADA standards and requirements. Priority Criteria: A, B Expected Project Delivery Method: JOC	All	Project Administration	-	208,000	155,000	208,000	155,000	208,000	155,000	1,089,000	1,089,000	-	-	-	-	-	1,089,000	Program costs continued in future years
			Project Support	-	15,000	40,000	15,000	40,000	15,000	40,000	165,000	165,000	-	-	-	-	-	165,000	
			AE Services	-	30,000	100,000	30,000	100,000	30,000	100,000	390,000	390,000	-	-	-	-	-	390,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	-	1,000,000	-	1,000,000	-	1,000,000	-	3,000,000	3,000,000	-	-	-	-	-	3,000,000	
			Total Cost	**-**	**1,253,000**	**295,000**	**1,253,000**	**295,000**	**1,253,000**	**295,000**	**4,644,000**	**4,644,000**	**-**	**-**	**-**	**-**	**-**	**4,644,000**	
2	**ADA (Americans with Disabilities Act) Upgrades La Colina Dr and Browning Ave Intersection** Project Limits: Intersection of La Colina and Browning Ave Project Description: This project consists of upgrading non-compliant curb ramps, cross gutter, spandrel, and sidewalk to ADA standards. Priority Criteria: A, B Expected Project Delivery Method: JOC	3	Project Administration	130,400	-	-	-	-	-	-	130,400	-	130,400	-	-	-	-	130,400	
			Project Support	25,000	-	-	-	-	-	-	25,000	-	25,000	-	-	-	-	25,000	
			AE Services	54,375	-	-	-	-	-	-	54,375	-	54,375	-	-	-	-	54,375	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	165,000	-	-	-	-	-	-	165,000	-	165,000	-	-	-	-	165,000	
			Total Cost	**374,775**	**-**	**-**	**-**	**-**	**-**	**-**	**374,775**	**-**	**374,775**	**-**	**-**	**-**	**-**	**374,775**	
3	**Antonio Parkway and Crown Valley Parkway Intersection Improvements** Project Limits: Intersection of Antonio Parkway and Crown Valley Parkway Project Description: The project consists of adding travel lanes to the intersection to accommodate future traffic demands. Priority Criteria: B Expected Project Delivery Method: DBB	5	Project Administration	540,000	50,000	-	-	-	-	-	590,000	343,729	-	-	246,271	-	-	590,000	SCRIP (Design Phase and Construction Phase) $246,271
			Project Support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			AE Services	60,000	-	-	-	-	-	-	60,000	60,000	-	-	-	-	-	60,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	68,500	-	-	-	-	-	-	68,500	68,500	-	-	-	-	-	68,500	
			Total Cost	**668,500**	**50,000**	**-**	**-**	**-**	**-**	**-**	**718,500**	**472,229**	**-**	**-**	**246,271**	**-**	**-**	**718,500**	
4	**Antonio Parkway Gateway Improvements** Project Limits: Along Antonio Parkway from 1,250-feet north of Meandering Trail to northernly City of Rancho Santa Margarita/County Limit. Project Description: The project consists of installing a raised median along Antonio Parkway. Priority Criteria: A, G Expected Project Delivery Method: DBB	5	Project Administration	-	185,000	360,000	-	-	-	-	545,000	-	545,000	-	-	-	-	545,000	
			Project Support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			AE Services	-	190,000	-	-	-	-	-	190,000	-	190,000	-	-	-	-	190,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	-	-	1,105,000	-	-	-	-	1,105,000	-	1,105,000	-	-	-	-	1,105,000	
			Total Cost	**-**	**375,000**	**1,465,000**	**-**	**-**	**-**	**-**	**1,840,000**	**-**	**1,840,000**	**-**	**-**	**-**	**-**	**1,840,000**	
5	**Barrett Lane Drainage and Sidewalk Improvement** Project Limits: Along Circula Panorama, Fairhaven Extension and Barrett Lane Project Description: The proposed project consists of installing a storm drain system and constructing sidewalk improvements. Priority Criteria: A, B Expected Project Delivery Method: DBB	3	Project Administration	346,000	-	-	-	-	-	-	346,000	-	346,000	-	-	-	-	346,000	
			Project Support	115,000	-	-	-	-	-	-	115,000	-	115,000	-	-	-	-	115,000	
			AE Services	138,000	-	-	-	-	-	-	138,000	-	138,000	-	-	-	-	138,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	2,000,000	-	-	-	-	-	-	2,000,000	-	2,000,000	-	-	-	-	2,000,000	
			Total Cost	**2,599,000**	**-**	**-**	**-**	**-**	**-**	**-**	**2,599,000**	**-**	**2,599,000**	**-**	**-**	**-**	**-**	**2,599,000**	
6	**Collins Yard - Utility Undergrounding** Project Limits: Eckhoff Street from Collins Avenue to cul-de-sac, and Collins Avenue from Eckhoff Street to cul-de-sac Project Description: Underground existing overhead utilities at the Collins Yard. Priority Criteria: G Expected Project Delivery Method: DBB	2	Project Administration	110,000	230,000	-	-	-	-	-	340,000	-	340,000	-	-	-	-	340,000	
			Project Support	190,000	285,000	-	-	-	-	-	475,000	-	475,000	-	-	-	-	475,000	
			AE Services	50,000	55,000	-	-	-	-	-	105,000	-	105,000	-	-	-	-	105,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	-	280,000	-	-	-	-	-	280,000	-	280,000	-	-	-	-	280,000	
			Total Cost	**350,000**	**850,000**	**-**	**-**	**-**	**-**	**-**	**1,200,000**	**-**	**1,200,000**	**-**	**-**	**-**	**-**	**1,200,000**	
7	**Crawford Canyon Road Sidewalk Extension** Project Limits: Crawford Canyon Road (westside) from Newport Ave. to Country Haven Lane, and Newport Ave. from Hyde Park Drive to Crawford Canyon Road. Project Description: The project will extend the sidewalk along Crawford Canyon Rd. and Newport Ave. to enhance pedestrian safety and access by addressing the gap in connectivity, including upgrades to the existing traffic signal system at the Newport Ave. intersection. Priority Criteria: A, D, E Expected Project Delivery Method: DBB	3	Project Administration	850,000	-	-	-	-	-	-	850,000	-	850,000	-	-	-	-	850,000	
			Project Support	25,000	-	-	-	-	-	-	25,000	-	25,000	-	-	-	-	25,000	
			AE Services	15,000	-	-	-	-	-	-	15,000	-	15,000	-	-	-	-	15,000	
			Contingency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
			Construction Contract	200,000	-	-	-	-	-	-	200,000	-	200,000	-	-	-	-	200,000	
			Total Cost	**1,090,000**	**-**	**-**	**-**	**-**	**-**	**-**	**1,090,000**	**-**	**1,090,000**	**-**	**-**	**-**	**-**	**1,090,000**	

EVALUATION OF THE COAL CANYON BIOLOGICAL CORRIDOR

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There are no hopeless cases, only people without hope and expensive cases.
Michael Soulé, Viable Populations for Conservation, p.181

Executive Summary

The Santa Ana Mountains and the Puente-Chino Hills together encompass about 511,000 acres of wildlands containing biological resources of statewide and worldwide significance. The habitat linkage between these two areas, once several miles wide, is now narrow and tenuous due to the Riverside Freeway and associated urban development. Loss of the linkage would have greatest impact on species that exist in low numbers. In the Puente-Chino Hills we expect that at least 21 vertebrate species have populations below 500, and that at least 4 of these populations probably number fewer than 50 breeding adults; these would be vulnerable to extirpation if the corridor is lost. The linkage also benefits the Santa Ana Mountains (where grasslands are rare) because the Puente-Chino Hills may harbor source populations of grassland specialists such as American badger, black-tailed jackrabbit, and grasshopper sparrow. If large carnivores were to become extinct or significantly reduced in the Puente-Chino Hills, populations of medium sized predators would probably increase, with potentially profound impacts on bird communities.

We predict that, after restoration of the underpass area, the Coal Canyon Biological Corridor will allow inter-range travel by most terrestrial vertebrates, by plant seeds and other propagules that depend on mammals or birds for dispersal, and by habitat specialist birds such as the California gnatcatcher. Such travel would be precluded by urbanization of the corridor properties. In addition to its functions as a biological linkage, the corridor would make possible a trail connecting these two important natural areas. If uses of the underpass are limited to carefully managed, non-motorized activities such as hiking, mountain biking, and equestrian uses, this trail connection should be compatible with the biological functions of the corridor.

Fortunately, the opportunity remains to not only protect this natural linkage, but to improve it dramatically. We strongly urge purchase of the properties for preservation, and prompt restoration of the underpass area to natural vegetation. Restoring a natural linkage in what is now a roaded underpass would set a global precedent. We are aware of no other restored biological corridor of this type and scale. Conservation-minded citizens throughout the world could look to Coal Canyon as an inspiring example of how an ecological error was corrected through thoughtful public action.

Introduction

Conservation biologists agree that "hotspots" of biodiversity deserve special attention, as do regions at great risk of biodiversity loss. Southern California is both kinds of region. The southwest ecoregion of southern California contains a greater diversity of vegetation types, vertebrate species, and endemic species (i.e. species not found elsewhere) than any other area of comparable size in the United States (Wilson 1988). This region is also one of the global epicenters of extinction risk, consistently ranking in the top 4 regions of the United States in terms of its number of species and ecosystems at risk of extirpation (Flather et al. 1995, Noss et al. 1995, Noss and Peters 1995, Dobson et al. 1997). One plant community alone (southern California coastal sage scrub) contains over 35 species of plants, 2 insects, 7 reptiles, 4 birds, and 7 mammals that, as of 1993, were either listed or candidates for listing under the federal Endangered Species Act (Noss et al. 1995: Appendix D). Set in the heart of this region of diversity and danger, the Santa Ana Mountains and the Puente-Chino Hills together encompass about 511,000 acres of wildlands (Beier 1993). These particular 511,000 acres contain biological resources of statewide and worldwide significance, including several rare and endemic communities (Table 1).

Table 1. Some of the rare communities and ecosystems in the 511,000 acres of wildlands in the Santa Ana Mountains and Puente-Chino Hills. References in Noss et al. (1995), Burkett (1989), and Beier and Barrett (1993).

›mmunity or Species	Notes
›astal Sage Scrub	′0-90% lost
uvial Sage Scrub	Rare and declining plant community; present in Coal Canyon Biological Corridor
′asslands	Statewide over 99% of native grasslands have been lost. Chino Hills State Park, with the largest protected (ungrazed by livestock) grasslands in southern California, is the most promising reintroduction site for pronghorn in the region.
ɛrnal pools	›95% loss in San Diego County
›uthern California walnut woodland	Southern limit occurs in Chino Hills State Park, less than 1 mile from Coal Canyon.
ɛcate cypress forest	Endangered. The species' northernmost stand (in Coal Canyon) contains the world's oldest and largest trees of this species.
g-cone Douglas-fir forest	Endemic
ıgelmann oak woodlands	The largest remaining woodlands occur in the southern Santa Anas
ınta Margarita River	The least impacted River System in southern California
ın Mateo Creek	The only perennial stream between Santa Barbara and the Mexican

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border that is wild throughout the entire watershed.

The habitat linkage between the Santa Ana Mountains and the Puente-Chino Hills, once several miles wide, is now narrow and tenuous due to the Riverside Freeway (State Route 91) and associated urban development. The northernmost protected parcels in the Santa Ana Mountains (Trabuco Ranger District of Cleveland National Forest, CDFG Tecate Cypress Reserve, and Irvine Company NCCP lands) are separated from the southernmost protected parcel in the Chino Hills (Chino Hills State Park) by private land parcels, all of which have Freeway frontage and potential for urban development. Conservation agencies (including CDFG, California State Parks) and organizations (including Friends of Tecate Cypress, Hills for Everyone, Sierra Club, Mountain Lion Foundation) have called for acquiring and preserving a portion of those private lands as a habitat corridor, with the Coal Canyon watershed as the defining topographic feature of the corridor. The proposed acquisition area consists of approximately 653 acres on the south side of the freeway (Saint Claire Property) and 32 acres on the north side of the freeway (Mancha Property).

Small reserves benefit from linkage to larger wildlands through a ''rescue effect,'' whereby animals dispersing into the reserve bolster populations, provide new genetic material, and help prevent local extinctions. Some of these benefits may also accrue to plants. Because the Puente-Chino Hills-Prado Basin area (about 40,000 acres) is much smaller than the Santa Ana Mountains (about 473,000 acres), it would receive a larger benefit from maintaining a connection between the 2 areas. However, even the Santa Ana Mountains are small relative to the needs of some of its species (see ''Costs of losing the corridor'' below); hence, the Santa Anas would certainly benefit from maintaining and enhancing the connection to the Puente-Chino Hills. At present, almost half of the wildlands in the Puente-Chino Hills are in protected status, representing a public investment of over $100 million (California Department of Parks and Recreation is developing an accurate estimate). About 63% of the Santa Ana Mountains is protected (Beier 1993), obviously representing a much larger public investment. The cost of acquiring the Coal Canyon Biological Corridor must be evaluated in light of these investments and the benefits of connectivity to these investments. Although wildland acquisitions are usually evaluated in terms of content (''What scenic, recreational, or wildlife values exist on the parcel?''), the Coal Canyon Biological Corridor, quite correctly, is being evaluated primarily in terms of context (''How does this parcel enhance the biodiversity and recreational values of the larger landscape?'').

The Wildlife Corridor Conservation Authority (WCCA) is a joint powers authority recently

created expressly to maintain connectivity among the protected parcels in the Whittier-Puente-Chino Hills and northern Santa Ana Mountains. Its members include local governments, public representatives, the Santa Monica Mountains Conservancy, the California Department of Fish and Game, and the California Department of Parks and Recreation (CDPR). In cooperation with WCCA, local government entities have recently completed several key land purchases which contribute to this effort, including the acquisition of Powder Canyon. WCCA is currently negotiating additional acquisitions, including acquiring property in upper Tonner Canyon from the Boy Scouts. In addition, the CDPR recently acquired over 900 acres encompassing portions of Sonome Canyon which provides a habitat linkage between the State Park and Tonner Canyon.

In this report, we evaluate the importance of the Coal Canyon Biological Corridor to conservation of plant species, animal species, and ecosystems in the Puente-Chino Hills and Santa Ana Mountains. We considered the scientific basis for the utility of corridors, current and potential levels of movement in the corridor, possible alternative corridors, the biological costs of losing the corridor, and social benefits of enhancing the corridor.

The Scientific Basis for the Utility of Corridors

Scientists have long recognized that larger habitat areas have more species than small areas. Early work on oceanic islands showed that across taxa (including beetles, reptiles, amphibians, birds, and mammals), smaller islands contained fewer species than large islands. Darlington (1957) examined species lists for Caribbean islands and calculated that the number of species doubled as island size increased 10-fold. MacArthur and Wilson (1967) hypothesized that an island's size controlled its extinction rate, and its distance from the mainland controlled the rate of colonization; together these 2 rates determine the number of species expected on the island. Historical evidence analyzed by Diamond (1975, 1984) and Jones and Diamond (1976) supported MacArthur and Wilson's hypothesis that extinction rate depends on island size, and showed that extinction rates are highest for the smallest populations. Rare species are the most likely to be lost as area decreases because small populations depend on immigrants from other areas. The importance of immigration in avoiding extinction of populations on real and virtual islands was dramatically illustrated in a population model by Brown and Kodric-Brown (1977), who coined the term rescue effect.

Habitat fragments on continents manifest similar patterns of extinction as oceanic islands, with fewer species supported on smaller fragments once they become isolated from larger habitat areas. Brown (1971) studied mammals in forest remnants on mountain tops (“sky islands”) in the desert southwest and found many fewer species on the smallest

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mountaintops. The desert between the islands created a nearly absolute barrier to movement of small mammals. This has obvious implications for habitats fragmented and isolated by urban areas.

Soulé et al. (1988) studied rapid extinctions of chaparral birds in canyon fragments in San Diego County. They found that extinction risk was strongly related to size of fragment and time since isolation. Surprisingly, extinction risk was not related to how far the fragment was from nearby suitable habitat, apparently because many birds were unable to disperse through even 100m of urban landscape. Soulé et al. (1988) also concluded that habitat corridors can counteract the effects of fragmentation.

Nature reserves by definition are islands of protection in an ocean of lands managed for other purposes; this makes them vulnerable to isolation and subsequent ecosystem decay. Newmark (1987) researched historical species lists of western national parks and noted that mammalian extinctions were related to Park size, with smaller parks (Zion, Bryce, Mount Lassen) losing forty percent of their larger mammal species, while larger parks had suffered few losses. Newmark concluded that the parks had experienced a mammalian faunal collapse, most likely caused by insularization.

Mammalian carnivores are particularly vulnerable to extinction due to fragmentation because they live at low density and their populations require large land areas (Shaffer 1983, Beier 1993, Noss et al. 1996). Top predators such as mountain lions, coyotes, and bobcats are most likely to disappear from fragmented systems. The disappearance of top predators can cause a cascade of effects in the ecosystem. Dominant carnivores can suppress smaller carnivores through competition and predation (Sargeant et al. 1987, Harrison et al. 1989). Conversely, the loss of top predators may lead to large increases in smaller predators (mesopredators) such as gray foxes, raccoons, striped skunks, opossums, and domestic cats, a phenomenon known as "mesopredator release." Larger numbers of such mesopredators, in turn, can cause decline and even extinction of some prey species, especially birds (Soulé et al. 1988). This occurs because the mesopredators are particularly effective predators on birds and bird nests, which are largely ignored by the larger predators.

Although a paper by Simberloff et al. (1992) is often cited as "refuting" the utility of corridors, these authors do nothing of the sort. Indeed, they strongly agree that landscape connectivity is important in maintaining biodiversity and ecosystem function. They simply argue that a better strategy than corridors is to manage "the entire landscape... as a matrix supporting the entire biotic community" (Simberloff et al 1992:500). We fully agree. However, in urban areas in general, and in the Coal Canyon area in particular, this is

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impossible. Our only choice is between habitat fragmentation (which Simberloff et al. agree is disastrous) or a corridor.

Simberloff et al. (1992) also claimed that few empirical studies demonstrate that narrow habitat corridors provide connectivity on a landscape, i.e., that animals will actually use corridors. However, Beier and Noss (in prep.) reviewed 31 empirical studies and concluded that the preponderance of empirical evidence supports the hypothesis that animals can and do use corridors in a way that reduces risk of extinction and/or promotes recolonization of habitat patches. Nonetheless, Simberloff et al. (1992) and Beier and Loe (1992) correctly point out that, for most species, we do not know what corridor traits (length, width, adjacent land uses, etc.) are required for a corridor to be useful. In the case of the Coal Canyon Corridor, questions concerning optimal width and length are somewhat moot because the feasible options are already extremely limited (in terms of remaining habitats or potentially restorable vegetative communities). The issue here is not how wide an ideal corridor should be but whether the extremely limited options that remain are adequate to provide a functional biological linkage. Our review focuses on this critical question.

Current and Potential Levels of Movement in the Corridor

We evaluated the potential for animal and plant movement through the Coal Canyon Biological Corridor in light of several important facts. Although these are self-evident truths to biologists, they may not be as obvious to our audience, and therefore we emphasize them here:

The Coal Canyon Biological Corridor includes the entire Coal Canyon watershed north from the Tecate Cypress Reserve, the entire Mancha Property at the mouth of Coal Canyon, and the southern slopes of Scully Hill in effect virtually all of the currently unprotected land between the Tecate Cypress Reserve and Chino Hills State Park. We caution against equating the biological corridor with its most degraded section, namely the box culvert and vehicle underpass under State Route 91. We emphatically reject the notion that a development project can ‘‘protect’’ the ‘‘corridor’’ simply because it does not occlude the box culvert and leaves vegetation along Coal Canyon wash.

1 The potential for plant and animal movement will be far greater after restoration of the area than it is today. Current usage of the culvert and underpass area (the most degraded portion of the corridor) should be taken as a very minimal estimate of the potential for movement.

1 We evaluated this corridor as a biological linkage between the Chino Hills and the Santa Ana Mountain Range for the largest possible suite of species, not just carnivores. Although (as noted above) corridors are important for large carnivores, and loss of

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carnivores can have cascading effects on biodiversity, clearly Coal Canyon is the last possible linkage for all plants and animals. Similarly, although Beier's 5-year telemetry study provides data on mountain lion use of the corridor, our ignorance of how other species may use it does not make this solely a "mountain lion corridor." Although the cougar provides useful information on the importance of the corridor, its location, and the minimum width needed to serve one species, we base our recommendations on the fact that this is the last best linkage for all species.

The most recent (1997) study of animal use of the corridor has focussed on carnivore use of the most degraded portions of the corridor, namely the Riverside Freeway and Santa Ana River. Nonetheless, this estimate of minimum movement potential is encouraging. Chris Haas and Kevin Crooks (UC Santa Cruz, personal communication) have documented use of the Coal Canyon Biological Corridor by coyotes, bobcats, skunks, raccoons, opossums, foxes, and cougars. Their most recent cougar detection was on May 20 1997 (memo from Chris Haas to Andrea Gullo, June 1997). Earlier, Beier (1993, 1995) documented that 3 different mountain lions used the Coal Canyon Biological Corridor to cross between the Santa Ana Mountains and the Chino Hills during 1990-1992. One mountain lion (Male #6) used the Corridor 22 times, splitting his home range between the two areas.

On our field visit to the site (December 15-16 1997) we noted 2 pairs of California gnatcatchers on the Saint Claire property, including one pair within 50 ft of the Freeway interchange. Because California gnatcatchers are extreme habitat specialists with poor dispersal ability, Coal Canyon could provide a critical stepping stone in maintaining connectivity for this species between the Santa Ana Mountains and areas to the north. In addition, deer use this parcel, but fences prevent them from reaching the underpass at the Riverside Freeway. The deer population in the Puente-Chino Hills is apparently small at present. Without a functional corridor for deer to provide a rescue effect, deer in the Puente-Chino Hills could be extirpated, especially if urbanization continues and if a series of wildfires converts much of the remaining woodland and shrubland to grassland.

We are unable to directly assess plant movement through the corridor. To the extent that plant seeds and propagules are transported via the fur and feces of mammals, or via the feces of birds, we expect that the Coal Canyon Biological Corridor will greatly facilitate interchange of plant material between the Santa Ana Mountains and the Puente-Chino Hills. The corridor may also facilitate dispersal via downstream flow of seeds in the Coal Canyon drainage. For instance, Coulter's Matilija poppy occurs at several locations in upper Coal Canyon, and also on the Mancha property in locations where its seeds may

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have been transported by streamflow.

For this corridor to realize its full potential for plant and animal movement, the bottleneck at the Riverside Freeway must be improved. Although mountain lions, coyotes, skunks, and raccoons can and do use culverts, most other organisms (including deer, rabbits, rodents, and birds) usually will not do so. We predict that many of these other species would use the vehicle underpass if the underpass and its approaches are improved. The following enhancements are critically important:

Use fencing to direct animals that approach the freeway toward the underpass. The underpass not the culvert should be the focal point of the fencing.

Remove most or all of the pavement in the underpass, and plant woody and herbaceous vegetation in the underpass.

Remove lighting from the underpass and the approach to the underpass. Prohibit night-time traffic in the vehicle underpass.

South of the Riverside Freeway, restore native vegetation to the area between the Coal Canyon sediment basin and the underpass. North of the Freeway, restore native vegetation throughout the Mancha parcel

Consult a hydrologist and civil engineer to evaluate the feasibility of re-routing at least half of the Coal Canyon water flow through the underpass.

Consult an acoustical engineer to evaluate the feasibility of building a sound wall to reduce traffic noise in the area approaching the underpass.

We predict that, after restoration of the underpass area, the Coal Canyon Biological Corridor will:

Allow inter-range travel by most terrestrial vertebrates. Such travel would be precluded by development of the Saint Clair and Mancha properties. Field evidence clearly shows that, even in its current degraded state, the corridor enables inter-range travel by top carnivores such as mountain lions, bobcats, and coyotes. We have every reason to believe that with restoration it would also serve other mammal, reptile, and amphibian species.

Allow inter-range travel by plant seeds and other propagules that are depend on mammals or birds for dispersal. Such travel would be precluded by development of the Saint Clair and Mancha properties.

Facilitate inter-range travel by avian species such as California gnatcatchers. Such travel would be impeded by development of the Saint Clair and Mancha properties, with the greatest impediment facing sedentary habitat specialists like the federally-listed California gnatcatcher.

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Possible Alternative Corridors

Our inspection from the ground and air suggests only one potential alternative inter-range corridor besides Coal Canyon. This potential corridor would consist of (south of the Riverside Freeway) the canyon 1 mile east of Coal Canyon ("Mindermann Ranch" on the USGS maps) and (north of the Freeway) the Green River Golf Courses.

This canyon is clearly inferior to Coal Canyon in terms of watershed size (about 10% that of Coal Canyon), proximity to urban development, inclusion of a golf course, and reliance on a freeway underpass that is much smaller (about 6 x 6 feet in cross section) than the Coal Canyon vehicle underpass. Furthermore the value of this canyon as a corridor would be greatly diminished by urban development of the Saint Claire parcel. For instance, Beier and Barrett (1993) documented that most cougars accessed Mindermann canyon via the Saint Claire parcel in Coal Canyon. We conclude that there is no practical alternative to the Coal Canyon Biological Corridor for maintaining and enhancing plant and animal movement between the Santa Ana Mountains and the Puente-Chino Hills.

We also attempted to assess whether portions of the Mancha or Saint Claire properties might be excluded from the Coal Canyon Biological Corridor. We strongly believe that the entire Mancha property must be included in the corridor, with no urban use beyond possible highway or commercial signage. We believe that urban use of the westernmost portion of the Saint Claire parcel would have minimal impact on the biological corridor, as long as the entire Coal Canyon watershed, extending at least 100 m west of the Coal-Gypsum ridgeline, is included in the protected corridor. Additional westward offset would likely be needed to accommodate fire control buffers, urban lighting, and human access (roads and trailheads).

Costs of Losing the Corridor.

Because the Puente-Chino Hills are approximately one-tenth the size of the current regional wildlands (i.e., the greater Santa Ana Mountains including the Puente-Chino Hills), loss of the Coal Canyon Corridor would create 2 islands, with the smaller island about one-tenth the size of the current single entity. The observations and inferences of Darlington (1957), Brown (1971), Williamson (1981), and Wilson (1992) suggest that half the species in the Puente-Chino Hills may become extinct as a result of fragmentation. We are reluctant to make such a dire prediction based on these results, because each case is unique, making it difficult to extrapolate to a particular case. Nonetheless, over time, isolation of the Chino-Puente Hills from the Santa Ana Mountains will probably trigger substantial extinctions in the smaller area, and quite possibly in the Santa Anas as well. The species most likely to be lost are those species most vulnerable to small population size or

inbreeding.

Although identifying such species is an imprecise science, in Table 2 and Table 3 we list those species expected to be most at risk, following two rules of thumb known as the ‘‘Rule of 50’’ and the ‘‘Rule of 500.’’ The Rule of 50 reflects the fact that chance variation in birth and death rates, or in sex ratios, is likely to cause rapid extinction in populations of fewer than 50 breeding individuals (Frankel and Soulé 1981: Chapter 6). Many detailed single-species models (e.g. Shaffer 1983, Beier 1993) and several empirical studies (e.g., Berger 1990) have confirmed this rule. According to the Rule of 500, populations with an effective population size of fewer than 500 individuals will suffer loss of genetic information over time, eventually leading to inbreeding depression and increased risk of extinction (e.g., Lande and Barrowclough 1987:98). In either case, a corridor, by effectively creating a larger population, would reduce extinction risk. We emphasize that these rules of thumb represent only crude estimates for short time spans (10-100 years). We would prefer a viability analysis for each species, because each species is different, but such an effort would go far beyond the scope of this report. We offer this species list not to predict population viability or extinction risk for any particular species, but to illustrate the magnitude of what is at stake. These tables may well underestimate the number of species at risk in that even relatively abundant species like shrews and ground squirrels can become extinct on habitat islands similar in size to the Puente Chino Hills (Brown 1971).

Table 2. Estimated population sizes (numbers of breeding adults) for selected vertebrate species in the Santa Ana Mountains (SAM) and Puente-Chino Hills (PCH), calculated by multiplying estimates of density (adults per 100 acres) by the wildland acreage in SAM or PCH. Our calculations optimistically assume that all 38,000 acres of wildlands in PCH will be preserved, and that 526,000 acres will be preserved in the SAM (the current 299,000 acres of protected land plus half [227,000 of 454,000 acres] of the currently-unprotected wildlands). These calculations also assume that our study area has densities similar to those in published studies, which may not be the case.

Species	Santa Ana Mountains	Puente-Chino Hills	Citations on animal density
Southwestern pond turtle	?	<100	Beier, personal observation
California spotted owl	2-10 pairs	<3, likely 0	Beier, personal observation
Black-tailed jackrabbit	low	low	Beier, personal observation
Mule deer	4,000	400	Beier and Barrett 1993 (for SAM and PCH)
Raccoon	>500	200	Fritzell 1978a, Fritzell 1978b
American badger	<500	100-250 [a]	Hein and Andelt 1995, Lindzey 1971, Messick and Hornocker 1981, Clark et al. 1982;
Striped skunk [b]	>500	150	Storm 1972
Long-tailed weasel	>500?	<100?	no density estimates available.
Mountain lion	15-20	1-2	Beier 1993 (for SAM and PCH)

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Bobcat	<500	<50	Jones and Smith 1979, Lawhead 1984, Rolley 1985, Rucker et al. 1989
Gray fox	large	<200	Fritzell and Haroldson 1982
Coyote	>500	60	Pyrah 1984, Gese et al. 1989, Babb and Kennedy 1989

[a] assumes PCH grasslands are better badger habitat than SAM chaparral and woodland.
[b] No density estimate available. Therefore we used home range estimates and assumed 50% home range overlap within sex, and 100% overlap between sexes.

Based on estimated densities and habitat areas, we expect that the Puente-Chino Hills have at least 21 vertebrate species with populations below 500, and that at least 4 of these populations probably number fewer than 50 breeding adults (Tables 1, 2). Risk to all of these species would increase in the absence of a corridor. Beier (1993) demonstrated that even rare immigration, as low as one individual per decade, can dramatically reduce the extinction risk for small populations. The Coal Canyon corridor would allow at least this level of immigration for many species. Although most bird species can travel across inhospitable habitat, many of these sensitive birds are habitat specialists and would certainly benefit from stepping stones of suitable habitat within the Coal Canyon Biological Corridor.

The corridor would also benefit the Santa Ana Mountains, where at least 4 species number fewer than 500 adults, and at least 2 species (mountain lion and California spotted owl) number fewer than 50. Indeed some species, namely those that specialize in grasslands, are probably more abundant (or have more productive populations) in the Puente-Chino hills than in the Santa Ana Mountains. Because grasslands occur in less than 3300 acres of the Trabuco Ranger District (Burkett 1989), the Puente-Chino Hills may well represent source populations for grassland specialists such as American badger, black-tailed jackrabbit, kangaroo rat, horned lark, grasshopper sparrow, tricolored blackbird, northern harrier, and black-shouldered kite. For instance, in 5 years of field-work, Beier and his field crews (personal observation) never observed a single jackrabbit in the Trabuco Ranger District; a few individuals were observed on Fallbrook Naval Weapons Station, a grassland-dominated area (similar to much of the Chino Hills) south of the Trabuco Ranger District. As urbanization of the region continues, preservation of the Coal Canyon Biological Corridor will become increasingly crucial for the Santa Ana Mountain Range, second in importance only to the connection between the Santa Ana Mountains and the Palomar Range south of Temecula (Beier 1993, Beier and Barrett 1993).

Table 3. Threatened, endangered, rare, or sensitive vertebrate species likely to exist in small numbers in the Puente-Chino Hills and Santa Ana Mountains, but for which no quantitative estimates are possible. Names in **bold** indicate

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species that may exist in higher numbers in the Puente-Chino Hills than in the Santa Ana Mountains, such that the Santa Ana Mountains would benefit from any immigration via the Coal Canyon Biological Corridor. Scott and Cooper (1997) mapped distribution of several of the bird species in the Puente-Chino Hills.

Species
San Diego horned lizard
Western spadefoot toad
Arroyo southwestern toad
Arroyo chub
California horned lark
California gnatcatcher
San Diego cactus wren
Yellow warbler
Grasshopper sparrow
Yellow-breasted chat
Least Bell's vireo
Southern California rufous-crowned sparrow
Bell's sage sparrow
Tricolored blackbird
Northern harrier
Black-shouldered kite
San Bernardino and Stephens' kangaroo rats

The mountain lion and bobcat (and possibly coyote) would be expected to feel the loss of the Coal Canyon Biological Corridor first and most severely. After a 5 year study that included population viability modeling and intensive radio tracking, Beier concluded that Coal Canyon was the only viable linkage between the Santa Ana Mountains and the Puente-Chino Hills for mountain lions (cougars): "The Chino Hills cannot support a population of cougars if it were to become isolated (from the Santa Ana Mountains). Quite simply, if there is no corridor, then there will be no cougars in the Chino Hills" (Beier and Barrett 1993). The City of Anaheim similarly concluded, regarding a proposed urban development on the Saint Claire parcel (then the Hon Company parcel), that "[the project would] result in the loss of potential for a cougar population to occur in the Chino Hills." Beier (1993) also concluded that the cougar population in the Santa Ana Mountains was so small that the additional habitat provided by a linkage to the Chino Hills would enhance the prospect for survival of mountain lions in the Santa Ana Mountains. Conversely, loss of the Puente-Chino Hills, eight percent of the total mountain range, could "push the cougar

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population to the steeply rising part of the extinction curve."
Of the 3 carnivores, coyotes are so adaptable that urbanization of the corridor might not entirely preclude immigration (McClure, Smith and Shaw 1996). With an estimated carrying capacity of 60 adults, the Puente-Chino Hills might maintain a coyote population even if isolated. However, after isolation (especially if high-density urban development encircles the Puente-Chino Hills) the coyote population might decrease so that it would be less effective in controlling smaller predators. If large carnivores were to become extinct or significantly reduced in the Puente-Chino Hills, mesopredator release would follow, with profound impacts on bird communities (Soulé et al. 1988).
The Coal Canyon Biological Corridor is the only route available for transport of plant seeds that depend on mammals for their dispersal. The corridor, by providing stepping stones of suitable habitat for birds, will also facilitate seed dispersal by birds. Dispersal of seeds by animals is an important ecological process. The seeds of over 60% of tree species in the temperate zone are dispersed by animals (Perry 1994), and 49 to 66% of woody shrubs and trees in scrublands produce seeds and fruits that are dispersed by animals (Herrera 1984). In a review of recent literature, Fleming and Sosa (1994) conclude that mammals are important in pollination and seed dispersal of plants, but that "the population and genetic benefits of such dispersal are just beginning to be investigated." Although we cannot assign an extinction risk to any plant species due to loss of this corridor, clearly Coal Canyon represents our last best chance to maintain this connectivity.
Although we have stressed the value of the Coal Canyon Biological Corridor in terms of its context, not its content, the 2 parcels contain significant biological resources, including two federally listed species (the California gnatcatcher, and Braunton's Milk-vetch), a rare and 75%-extirpated plant community (Riversidian alluvial sage scrub), and 20 acres of Tecate cypress. With restoration, the endangered least Bell's vireos also might occupy the site. However, the most important value of the land is in providing a biological linkage between two large and critically important wildland areas. The value of the acquisition is far greater than the net acreage and its on-site resources.

Social and Economic Benefits

While the primary goal of this paper is to evaluate the biological significance of the Coal Canyon Corridor, we would be remiss not to address the socio-economic importance of these two major open spaces and the linkage connecting them.
Access to nature is an important amenity for many cities. Indeed, communities throughout the U.S., Europe, and elsewhere are increasingly recognizing the importance of integrating conservation considerations into metropolitan planning (Shaw et al. 1992, Barker 1997).

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Many Americans place a high value on access to wildlife near their homes (Shaw et al. 1985, Harris and Shaw 1997). The importance of wildlife viewing opportunities is well evidenced in a recent national survey conducted by the U.S. Fish and Wildlife Service (1996) which found that nationally, 60.8 million Americans 16 years and older participated in some form of wildlife watching or enjoyment near their homes in 1996. This amounts to about 30% of total U. S. population 16 years or older.

Fortunately, conservation planning in metropolitan environments is frequently synonymous with good urban planning when a long term perspective is taken (Porter 1997.) In addition to providing a critical refuge for the region's indigenous biota, the Puente-Chino Hills and Santa Ana Mountains perform a host of functions that enhance the quality of the area as living space for humans. These benefits include watershed protection, air quality enhancement, scenic beauty, outdoor educational opportunities and recreational open space.

Of these benefits, opportunities for environmental education and nature-oriented recreational experiences are tied to the Coal Corridor in two ways. As explained in previous sections of this report, a functional biological linkage is critical for maintaining the communities of native plants and animals found on these lands. This biodiversity is one of the features that makes this area attractive for participants in outdoor educational and recreational activities. The linkage is essential for maintaining the full potential of these lands for outdoor recreation because in addition to its functions as a biological linkage, the corridor would make possible a trail connecting these two important natural areas. If uses of the underpass are limited to carefully managed, non-motorized activities such as hiking, mountain biking, and equestrian uses, this trail connection should be largely compatible with the biological functions of the corridor.

With this linkage, outdoor enthusiasts could hike, or ride mountain bikes or horses from Tonner Canyon in Los Angeles County, continue through San Bernardino County (Chino Hills) and cross via the corridor into Orange and Riverside Counties, continuing on to San Diego County. Along the way, they would experience rare endemic plant communities that include the walnut groves of Tonner Canyon and Chino Hills State Park (totally absent south of the Santa Ana River), southern California's last remaining large grasslands in the Chino Hills, the rare groves of Tecate Cypress in the northern Santa Anas, endemic conifers such as big-cone Douglas-fir and knobcone pine in the central Santa Anas, stands of pure coastal sage scrub in Orange County, and the largest remaining Engelmann Oak woodlands and vernal pools of the Santa Rosa Plateau. These wildlands also include San Mateo Creek, the only 100% wild watershed with a perennial stream between Santa

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Barbara and Mexico. Indeed, this region contains greater diversity of vegetation types than any other area of comparable size in the entire United States. Future generations of hikers and equestrians should be able to experience this *world-class* treasure of biological diversity as an unbroken chain. The only paved roads one would cross in this 5-county trip would be Carbon Canyon Road, the Riverside Freeway, and the Ortega Highway.

The Puente-Chino Hills/Santa Ana Mountains complex comprise an archipelago of natural open space thrust into one of the world's largest metropolitan areas. As such, their value for biodiversity conservation, environmental education, outdoor recreation, and scenic beauty are immense. Furthermore, this contiguous chain of natural open space could form the foundation of a comprehensive interconnected system of natural space. throughout Southern California. In the interest of environmental quality, many cities are investing huge amounts to restore habitat linkages and provide a scenic network of natural open spaces within the urban matrix. Although it may seem far-fetched to many, it is not unrealistic to envision a future system of natural and restored opens spaces that connects the Puente-Chino Hills/Santa Ana Mountains with the San Gabriel and Santa Monica Hills through restored habitat linkages. The chances of realizing this vision however, are significantly lessened if the Coal Canyon Corridor is not protected and habitat fragmentation continues.

Conclusion

Coal Canyon clearly represents the last viable opportunity to maintain and enhance a critical ecological linkage between the Puente-Chino Hills and the Santa Ana Mountains. These two areas are naturally connected; indeed, they are fundamentally one ecological system. It is only the very recent, intensive, and unsustainable activities of humans in this region that threaten to sever this natural connection. If such a severance is allowed to proceed, the biological, ecological, educational, recreational, and spiritual impacts will be substantial. We have reviewed some of the expected consequences of severing the Coal Canyon corridor in this report. Suffice it to say that both humans and nonhuman species in the region will be worse off. Some species may become locally or regionally extinct.

Fortunately, the opportunity remains to not only protect this natural linkage, but to improve it dramatically. We strongly urge that the State of California purchase the properties involved and proceed with restoration of the underpass area to natural vegetation. It must be understood that the value of Coal Canyon and the proposal to acquire and restore a habitat corridor here extend well beyond the local area and the southern California region. As reviewed at the outset of this report, this region is of global significance in terms of its biodiversity. Moreover, restoring a natural linkage in what is now a roaded underpass would set a global precedent. We are aware of no other restored biological corridor of this type

and scale. Conservation-minded citizens throughout the world could look to Coal Canyon as an inspiring example of how an ecological error was corrected through thoughtful public action. It will be money well spent.

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Maintaining Ecological Connectivity Across the "Missing Middle" of the Puente-Chino Hills Wildlife Corridor

Final Report
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CONSERVATION BIOLOGY INSTITUTE

Maintaining Ecological Connectivity Across the "Missing Middle" of the Puente-Chino Hills Wildlife Corridor

Final Report

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The Conservation Biology Institute provides scientific expertise to support conservation and recovery of biological diversity in its natural state through applied research, education, planning, and community service.

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Executive Summary

The Puente-Chino Hills Wildlife Corridor is a peninsula of mostly undeveloped hills jutting about 42 km (26 miles) from the Santa Ana Mountains into the heart of the densely urbanized Los Angeles Basin. Intense public interest in conserving open space here has created a series of reserves and parks along most of the corridor's length, but significant gaps in protection remain. These natural habitat areas support a surprising diversity of native wildlife, from mountain lions and mule deer to walnut groves, roadrunners, and horned lizards. But maintaining this diversity of life requires maintaining functional connections along the entire length of the corridor, so that wildlife can move between reserves—from one end of the hills to the other.

Already the corridor is fragmented by development and crossed by numerous busy roads, which create hazards and in some cases barriers to wildlife movement. Proposed developments threaten to further degrade or even sever the movement corridor, especially within its so-called "Missing Middle." This mid-section of the corridor system, stretching from Tonner Canyon on the east to Harbor Boulevard on the west, includes several large properties proposed for new housing, roads, golf courses, and reservoirs. Such developments would reduce habitat area and the capacity to support area-dependent species and, if poorly designed, could block wildlife movement through the corridor.

This report builds on an impressive array of previous ecological and wildlife movement studies in the Puente-Chino Hills, as well as the general literature on wildlife movement corridors as it applies to this unique peninsula of wildness. It supplements the existing information with an analysis of gaps in protection—with special focus on the vulnerable Missing Middle—and recommends conservation and management actions to prevent further loss of ecological connectivity and retain native species.

Methods

I performed a meta-analysis of corridor function using existing scientific information on the distribution and movement patterns of wildlife species in the study area, as supplemented by field reconnaissance and examination of aerial and satellite imagery. Following the lead of previous researchers, I segmented the range of hills into nine geographic units by roads and other breaks in habitat contiguity. From southeast to northwest these are:

- A biological "core" area (defined below), represented by the Santa Ana Mountains;
- Seven segments of the functional Puente-Chino Hills Wildlife Corridor (from southeast to northwest: 1-Chino, 2-Carbon-Tonner, 3-Shell-Aera, 4-Powder-Schabarum, 5-San Miguel, 6-East Whittier, 7-West Whittier); and
- One isolated patch off the tip of the range of hills (Whittier Narrows), which is effectively disconnected from the functional corridor segments by major roads and urban barriers.

The Missing Middle consists of the western portion of Segment 2 (including the large and biologically diverse Tonner Canyon) and all of Segment 3 (Shell-Aera property and adjacent lands between Highway 57 and Harbor Boulevard). The eastern portion of Segment 2 (between Tonner and Carbon Canyons) is largely conserved already, but Tonner Canyon and Shell-Aera are unprotected and threatened by development projects.

Each of the nine geographic units was initially characterized for how it appears to function in supporting populations of target species, including mountain lion, mule deer, bobcat, coyote, coast horned lizard, and greater roadrunner, as well as in the richness of its reptile and amphibian community. The following coarse-scale definitions apply to these units:

- *Core* areas must be larger than 2,000 sq. km and capable of supporting a population of 20 adult mountain lions (the most area-dependent target species). Due to large size and relatively low "edge effects," a core area will support the greatest diversity of species and should support populations of all target species. The Santa Ana Mountains are the only core in the study area. This core serves as a source for mountain lions and other species to enter the corridor system.
- *Subcores* are smaller (but at least 60 sq. km) and capable of supporting a population of bobcats, the second-most area-dependent target species. Subcores can sustain populations of most target species and have moderate to high species diversity. Corridor Segment 1 (Chino Hills between Highways 91 and 142) is the only subcore, although Segment 2 appears to function as an extension of this subcore, as discussed below.
- *Patches* are smaller than 60 sq. km, but may support small numbers of bobcats and significant populations of other target species. Patches may also provide significant live-in or move-through habitat for mountain lions and bobcats, whose home ranges may cover multiple geographic units. Most segments in the corridor system are patches, but they vary greatly in size (from about 1.5 to 44.3 sq. km), vegetation composition, isolation by roads, and ability to support target species.

The roads delimiting these segments were next characterized for their effects on target species movements—as barriers, semi-permeable "filters," or highly permeable filters. Based on the scientific literature and field reconnaissance, each road was assessed for how easily target species can cross it, the availability and effectiveness of crossing structures (e.g., bridges and underpasses), and relative frequency of roadkill. Roads considered highly permeable to wildlife movement allow adjacent segments to function as one larger segment, such that two areas originally classified as separate patches may effectively serve as one larger patch (summing the area of adjacent units), or even a subcore, for certain target species.

I assigned each newly defined unit, or composite unit, a function relative to supporting individuals or populations of each target species based on unit size, habitat composition, and other factors, as follows:

- *Population* — capable of supporting a breeding population of at least 20 *adults* and potentially serving as a source of individuals that disperse into other units.
- *Subpopulation* — capable of supporting at least two but less than 20 breeding individuals. Subpopulations may exchange individuals with other areas within a larger metapopulation (a set of partially isolated populations linked by occasional dispersal) and may provide individuals to recolonize habitat patches in case of local extirpation.
- *Home Range Part* — incapable of supporting at least two breeding individuals on its own, but may provide live-in habitat (e.g., foraging or resting cover) and form a part of one or more individuals' home range(s).
- *Move-through* — not contributing significant live-in habitat for a species as part of a functional home range, but capable of accommodating movements between more substantial units within a home range, or potentially used for dispersal between other habitat units.

This system for characterizing geographic units and movement impediments was used to assess how the overall corridor system functions to support target species, and how these functions might change with potential development scenarios, such as new roads or housing that could add movement barriers or reduce wildlife carrying capacity in corridor segments.

Results

Existing Corridor Function

The Puente-Chino Hills Wildlife Corridor appears functional for at least larger mammals and birds, although tenuously so in the Missing Middle (due to several barrier or near barrier roads) and across smaller Segments 4 and 5 (due to their small size, strong edge effects, and high human and pet activity). Essentially all roads in the study area are considered barriers or at least strong filters to movements by many reptiles, amphibians, and small mammals; however, most birds and larger mammals currently can move between all segments either at-grade (with mortality risks) or via critical road-crossing structures. Despite many crossing constraints through the corridor, especially in and just west of the Missing Middle, target species are confirmed or highly likely to occur in all seven Puente-Chino Hills corridor segments, except for coast horned lizard, which may already be absent (or will disappear in the future) west of Highway 57.

Individual mountain lions are capable of traversing the length of the corridor, albeit at some risk of roadkill, and one or more lions still hunt as far west as the western Puente Hills (known locally as the Whittier Hills). Most other target species (e.g., bobcats, roadrunners) appear to persist throughout the corridor as metapopulations that are connected genetically and demographically by at least occasional dispersal between geographic units.

Carbon Canyon Road (between Segments 1 and 2) and Turnbull Canyon Road (between Segments 6 and 7) are considered highly permeable to at least larger mammals and birds, so I

merged Segments 1 and 2 to form a larger Chino-Tonner subcore, and I merged Segments 6 and 7 to form a larger Whittier Hills patch. The most critical road-crossing structures are the Coal Canyon Wildlife Underpass (connecting the Santa Ana Mountains Core to the Chino Hills under Highway 91); a box culvert under Carbon Canyon Road known to be used by bobcat and other species; the Tonner Canyon Bridge on Highway 57 (the only viable crossing beneath this busy freeway for deer, mountain lion, bobcat, and other species); and the Colima Service Tunnel (used by bobcat, deer, coyote, and other species to cross under Colima Road between San Miguel Canyon and the Whittier Hills). In addition, a new wildlife tunnel is being built under Harbor Boulevard (between Segments 3 and 4) at a location well-documented as a roadkill "death trap."

There appears to be a gradient of declining amphibian and reptile diversity and evenness moving west from the Chino Hills, probably due to increasing edge effects coupled with increasing distance and number of barriers and filters that must be crossed the farther west one moves from source habitats in the east. A similar gradient may exist for other taxa, such as small mammals, that are similarly limited in their dispersal abilities.

Given the length of the corridor relative to species movement abilities, the capacity of corridor segments to support many species depends both on

- The potential for individual movement between each set of adjoining segments (a function of roads and road-crossings), and
- Having sufficient live-in habitat along the way to support populations or subpopulations that contribute dispersing individuals.

The greater a segment's distance from units supporting populations or subpopulations of a species, the lower the probability that the segment can continue supporting a species. If the distance between occupied segments becomes too great, or if barriers prevent inter-segment movement, local extinctions are inevitable in the isolated segments. Thus, any reduction in the capacity of segments to support populations or subpopulations increases the probability of local extinctions in that segment, as well as in all other "downstream" segments to the west.

Habitats in the Missing Middle are critical to maintaining overall corridor function. The Tonner Canyon area serves as an extension of the large Chino-Tonner subcore, with significant live-in habitat that can contribute dispersing animals to move into other segments. Likewise, Segment 3 (Shell-Aera) presumably supports significant numbers of target species that disperse (currently at some risk) across Harbor Boulevard into Powder Canyon (Segment 4) and beyond.

Future Scenarios

I assessed the likely effects of several proposed development projects in the Missing Middle on species persistence through the corridor system. This qualitative assessment uses the conceptual model developed above, based on how projects might affect the capacity of geographic units to support populations or individuals and the ability of individuals to cross between units. The projects include a new residential community, a series of reservoirs, and a major new road.

All three proposed developments have the potential to extirpate target species from large portions of the Puente-Chino Hills Wildlife Corridor. By impeding species movements or metapopulation dynamics, a project's impacts on species persistence may extend far beyond project boundaries, potentially rippling through the range of hills to eliminate wildlife populations as far west as the Whittier Hills (10-12 km west of the Missing Middle). The proposed Shell-Aera Master Planned Community would seriously degrade the ability of Segment 3, and all segments farther west, to support target species, especially mountain lion and bobcat. This would have cascading effects on flora and fauna in all segments from this point west.

A plan by the City of Industry to build three water reservoirs in Tonner Canyon could also have substantial adverse impacts on corridor function. Although a reservoir or other development in upper reaches of Tonner Canyon might not greatly affect corridor function, any development in middle and especially lower Tonner Canyon could have severe impacts on corridor function, especially if wildlife use of the Tonner Canyon Bridge (to cross Highway 57) is reduced. Any development that blocks access through the bridge area would make Highway 57 a complete barrier to many species and would likely lead to wildlife extirpations in segments farther west. At the very least, creation of these reservoirs would reduce the size of the Chino-Tonner subcore and its capacity as a source of animals that disperse into the rest of the corridor system.

Finally, plans by the City of Industry to build a new road running the length of Tonner Canyon could split the Chino-Tonner subcore in two, potentially isolating about 21.2 sq. km of habitat from this currently large and contiguous source habitat. The road would probably require major cut and fill to construct and could render disfunctional the critical Tonner Bridge wildlife undercrossing. This would almost surely result in the rapid loss of mountain lion and bobcat from more westerly segments, with cascading effects through the ecological community. Deer and other species would also likely disappear from westerly segments over a longer time period.

A full impact analysis for any of these proposed projects should address cumulative impacts on wildlife populations and movements through the corridor. Among these cumulative impacts would be inducement of further development, such as additional residential, commercial, or industrial development along the road. Increases in traffic and roadkill should also be analyzed and mitigated for. Any combination of two or more of these projects, even if well designed, would likely render the Puente-Chino Hills Wildlife Corridor non-functional west of Chino Hills State Park, regardless of mitigation.

Discussion

The scientific literature on the functions and values of wildlife corridors is huge and growing. Movement corridors connecting reserves or larger "core areas" of habitat have been documented to counter many adverse effects of isolation by fragmentation on species and ecological processes. Some critics have argued that there are costs as well as benefits to conserving corridors and that, under certain circumstances, creating or maintaining corridors could harm some species or communities. However, the overwhelming weight of scientific evidence is that maintaining connectivity is beneficial, especially for those species and ecological communities

for which connectivity "is the natural state of things." Most arguments against corridors boil down to nothing more than cautions against viewing them as conservation panaceas. Nevertheless, I reviewed the following arguments made against corridor conservation as they apply to the Puente-Chino Hills Wildlife Corridor:

1. Corridors may serve as conduits for the spread of deleterious species;
2. Corridors may spread detrimental processes, such as wildfire or disease, among reserve areas;
3. Corridors may facilitate movements by highly mobile and adaptable animals (like coyotes), but may not help more sedentary or at-risk species;
4. Corridors could attract wildlife into edge-affected habitats with high mortality rates; and
5. Corridor conservation may be more expensive or less beneficial than other options, such as increasing the size or management of core reserves.

Critical review of these concerns for the Puente-Chino Hills Wildlife Corridor finds them irrelevant or insignificant in this case; at least, the biodiversity benefits of conserving the corridor far outweigh any potential for harm.

Mitigating the adverse effects of roads, including barrier effects and increased mortality, is essential to maintaining corridor functions. The scientific literature on effective mitigation actions, especially wildlife road-crossing structures, is also large and growing, with many success stories. The main types of structures, from most to least effective, are vegetated land-bridges (wildlife overpasses), bridges, underpasses, and culverts. Vegetated overpasses are quieter than underpasses, maintain ambient conditions, seem less intimidating for some species than dark tunnels, and have proven highly successful in the U.S., Canada, and Europe for a wide variety of wildlife species. Bridges are also highly effective, especially if wide and open with natural vegetation growing beneath, such as under the Tonner Bridge. Culverts and other tunnel-like structures can be effective for some species, but only very large culverts (such as box culverts and equestrian tunnels) are effective for larger mammals. Earthen flooring is preferable to concrete or metal. Regardless of crossing type, wildlife fencing is crucial for keeping animals off the road and for funneling them toward the crossing structure. Vegetative cover near the entrances also increases wildlife use of crossing structures.

Conclusions and Recommendations

Given the huge investment already made to maintain the Puente-Chino Hills Wildlife Corridor, additional conservation investment in the Missing Middle seems not only prudent, but essential if society believes the continued presence of deer, bobcats, roadrunners, and other wildlife is desirable in this unique peninsula of wild in a sea of development. My recommendations for how to do this are largely concordant with previous recommendations by other biologists.

I recommend conserving all of Segment 3 (the Shell-Aera property) and at least the middle and lower portions of Tonner Canyon, including prohibiting any new road or other development that

would fragment this critical habitat block or degrade in any way the utility of the Tonner Bridge as a wildlife underpass. I also emphasize the following recommendations for improving road-crossing structures and reducing roadkill.

A. Add wildlife fencing on either side of Carbon Canyon Road to reduce roadkill and encourage wildlife to use existing culverts, especially the concrete box culvert near the entrance to Chino Hills State Park. Add another wildlife crossing structure (bridge or vegetated over-crossing), designed to accommodate all large mammals, as mitigation for any future road upgrades.

B. Prohibit any development that would increase traffic under the Tonner Bridge or add any new impediments (structures, lights, noise, etc.) to the vicinity of the bridge. Restore riparian vegetation along Tonner Creek, where degraded by oil development activities. Fence along Highway 57 if monitoring suggests road mortality is high.

C. Secure rights to install wildlife fencing along both sides of Harbor Boulevard to reduce roadkill and ensure maximum utility of the wildlife tunnel being built here. Plant screening vegetation on either side of the tunnel to provide cover to wildlife approaching the entrances.

D. Secure remaining "at-risk" parcels in the narrow, constricted portion of the corridor between Powder Canyon and Hacienda Boulevard. Enlarge or otherwise improve the existing equestrian tunnel under Hacienda Boulevard to enhance its use by wildlife, including adding screening vegetation on the western end. Add wing fencing on either side of the tunnel to help funnel wildlife to it. Do not fence extensively along Hacienda Boulevard, unless coupled with new crossing structures, because most large mammals currently cross at-grade. Consider building a wildlife overpass (a vegetated wildlife bridge) over Hacienda Boulevard, taking advantage of steep slopes rising up from either side of the road, as mitigation for any future road improvements that would increase traffic volume or speed.

E. Maintain and improve the Colima Service Tunnel as a critical wildlife underpass. Add fencing or screening vegetation if necessary, based on further site-specific inspection or monitoring. Limit actions that would increase disturbance in the vicinity of the Service Tunnel from sunset to sunrise, such as artificial lighting or nighttime traffic or recreational uses through the tunnel.

Introduction

The Chino and Puente Hills form a peninsula of wild uplands that jut from the Santa Ana Mountains into the heart of one of the largest unbroken urban areas in North America (Figure 1). Created by shifting Earth plates, this peninsula of wild in a sea of development supports a surprising diversity of native wildlife. Mountain lions still hunt mule deer in the area's diverse mosaic of grasslands, chaparral, coastal sage, and oak and walnut woodlands; roadrunners, California gnatcatchers, northern harriers, and other birds in decline throughout Southern California still persist here; as does a remarkably rich reptile and amphibian fauna.

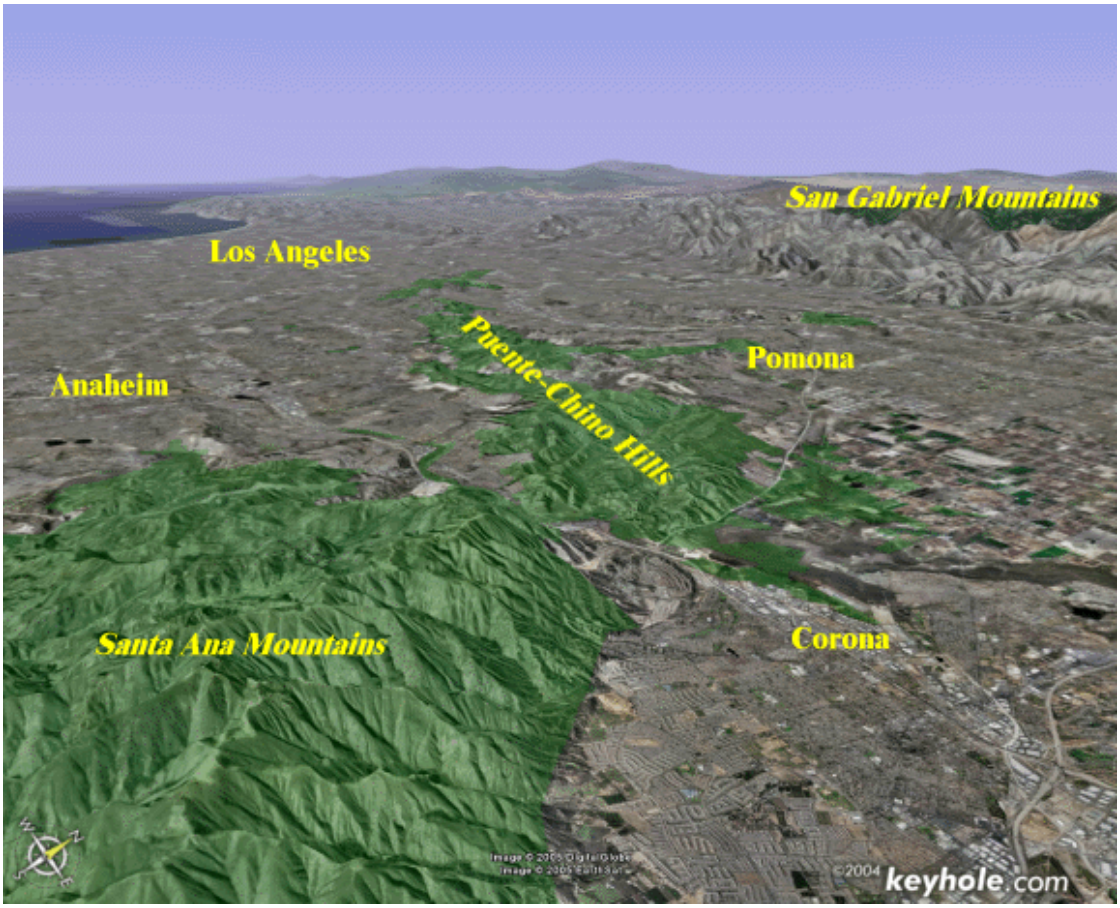


Figure 1. The Puente-Chino range of hills juts into the heavily urbanized Los Angeles Basin from the tip of the Santa Ana Mountains range (Keyhole screenshot).

Maintaining this diversity, and the web of healthy ecological interactions it represents, presumably requires keeping this range of hills fully connected by wild habitats along its 42 km (26 mi) length. Severing connections or blocking movement along this corridor with roads or housing projects threatens to extirpate species from this urban reserve system and degrade ecological health throughout this range of hills—thus eliminating a remarkable ecological classroom within easy reach of millions of people craving a connection with nature.

This loss would be doubly unfortunate given the tremendous public investment already made to conserve and restore biological open space and unfettered wildlife movement through this range of hills—from the Coal Canyon wildlife underpass at Highway 91, through Chino Hills State Park, Powder Canyon, Schabarum Park, and other private and public open space dedications to the western end of the Puente Hills (known locally as the Whittier Hills[1]). According to the California Department of Parks and Recreation, nearly a *quarter billion dollars* have already been expended or committed to acquiring and restoring natural open space in the Puente-Chino Hills Wildlife Corridor (http://hillsforeveryone.org/state_investment_table.htm). But the benefits of these existing investments is severely threatened by proposed development projects—including new roads, housing developments, golf courses, and reservoirs.

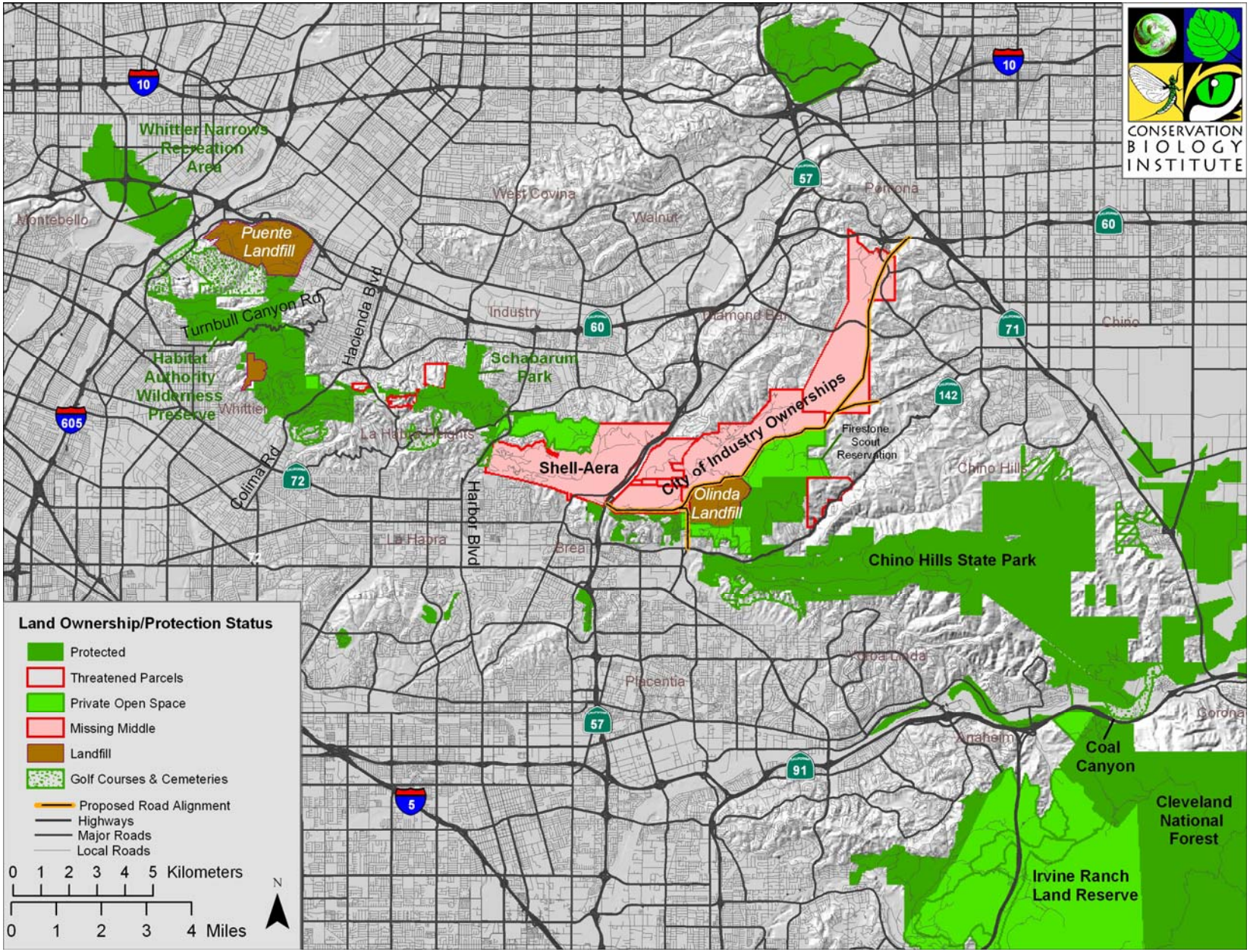
These threats are most urgent in the so-called "Missing Middle" of the corridor—from Tonner Canyon on the east (mostly owned by the City of Industry) to Harbor Boulevard on the west (Map 1). No major reserves are yet established in this broad midsection of the Puente-Chino Hills, and connectivity is threatened by a major new housing development, a proposed road, and a series of new dams and reservoirs that would flood Tonner Canyon. Should one or more of these projects sever functional connectivity, reserves farther west (e.g., Habitat Authority Wilderness Preserve, Powder Canyon, and Schabarum Regional Park, among others) could lose key species and suffer further ecological degradation.

This report reviews available scientific evidence on wildlife movement corridors, reserve design, and local biological resources to define conservation priorities for maintaining connectivity from one end of the corridor to the other. It focuses on the Missing Middle, because this portion is least protected and is at most immediate risk of further degradation. The purpose of this analysis is to identify (a) those portions of the Missing Middle whose conservation would most contribute to continued wildlife movement and ecosystem health throughout the corridor system, and (b) remedial actions that would most improve the situation for native wildlife—such as retrofitting existing roads with wildlife crossing structures to reduce roadkill and improve movement opportunities.

Report Objectives

- Synthesize the science of wildlife movement corridors as it pertains to the Puente-Chino Hills Wildlife Corridor.
- Analyze existing conditions and potential future conditions for the persistence and movement of wildlife populations in the corridor system.
- Recommend conservation and management priorities to sustain and improve connectivity through the Missing Middle and hence the greater Puente-Chino Hills Wildlife Corridor.

[1] Although "Whittier Hills" is not an official geographic name recognized by the U.S. Geological Survey, the western portion of the Puente Hills is known locally as the Whittier Hills, and previous researchers have used this place name. I therefore also use Whittier Hills to refer to the hills west of Colima Boulevard.



Map 1. Study area showing the Missing Middle of the Puente-Chino Hills Wildlife Corridor.

Study Area

This study considers two nested study areas (Map 1): the entire Puente Hills-Chino Hills Wildlife Corridor, extending about 42 km from the Santa Ana Mountains to the San Gabriel River, and the so-called "Missing Middle" of this larger landscape. The Missing Middle is that section of the Puente-Chino Hills Wildlife Corridor from Harbor Boulevard on the west to and including Tonner Canyon on the east. The Missing Middle is largely unconserved and is threatened by a variety of development projects.

Biogeography

The Puente-Chino Hills are the northernmost extension of the Peninsular Mountain Range, which begins in Baja California, Mexico. They are a topographic expression of the 500-km-long Whittier-Elsinore fault system, pushed up between the Whittier and Chino sections of this major slip-shear fault system. The geologically dramatic origins of the hills also contribute to their relatively undeveloped status, because steep slopes, earthquakes, landslides, tar pits, and active and former oil wells have tended to limit development, at least until recently.

The hills rise from the flat Los Angeles Basin, at less than 100 m (300 ft) elevation, to over 540 m (nearly 1,800 ft) at San Juan Hill. The regional climate is mild and Mediterranean, which contributes to the high diversity of species in coastal Southern California. Vegetation in the hills is a mosaic of open grasslands (which have been affected by grazing over the years), coastal sage scrub, chaparral, oak woodlands, riparian scrub, riparian woodlands, and rare California black walnut woodlands—a grossly under-protected resource that could be considered an "endangered habitat." These communities support flora and fauna relatively typical of the biodiversity in Southern California—which is remarkable given that the hills are entirely surrounded by the largest urbanized area in the U.S.

Previous Studies

The Puente-Chino Hills represent one of the most closely scrutinized and intensively researched wildlife movement corridors in Southern California, if not North America. Its existence and importance are well appreciated by the local populace, with 53% of local residents having "heard of the wildlife corridor in the Puente Chino Hills area" and 83% in favor of maintaining the corridor (51% "strongly" supported this) (Decision Research 2003). The area's flora, fauna, and ecological functions are well studied, with a number of intensive studies of wildlife distributions and movements covering all or substantial portions of the area (Table 1). In 1994 an entire scientific conference was focused on the biological functions and values of this unique range of hills (Natural Resources in the Puente Hills-Chino Hills Corridor: Implications for Land Use and Planning. A symposium at Whittier College, March 18-19, 1994)[2].

[2]Abstracts of papers presented at this conference can be found at http://www.hillsforeveryone.org/PDF_Files/whittier_college_symposium.pdf.

Table 1. Summary of previous studies of wildlife populations and movements in the Puente-Chino Hills study area.

Reference	Target Species	Major Focus	Study Area	Methods	Relevant Results	Recommendations
Robertson et al. 1995	Large mammals	Assess likely movement routes and constraints.	Entire Puente-Chino Hills Wildilfe Corridor from the Santa Ana River to the San Gabriel River.	Field reconnaissance, walking the length of the corridor to assess likely movement routes and constraints. Incidental observations of wildlife sign and roadkill.	At least one pathway without complete obstruction existed for large mammals, from the Santa Ana River to the Whittier Hills, in 1994-95, but with several significant constraints. The most critical impediment was Harbor Blvd. and adjacent development. Movement across Interstate 605 to the San Gabriel River (Whittier Narrows Recreation Area) considered "highly improbable."	Conserve land to connect existing reserves (especially in the middle portions of the Corridor); restore native vegetation; retrofit undercrossings at problem roads, especially Harbor Blvd., with tunnels or bridges to reduce roadkill and improve connectivity for large mammals.
Noss et al. 1997	All vertebrate wildlife	Assess importance of Coal Canyon linkage to maintaining viable species populations in the Santa Ana Mountains and Puente-Chino Hills.	Entire Puente-Chino Hills Wildlife Corridor and Santa Ana Mountains.	Literature review, field reconnaissance, and analysis of which species' populations were likely to benefit from protecting and improving the Coal Canyon linkage and underpass.	Coal Canyon is the last viable linkage between the Chino Hills and Santa Ana Mountains. At least 21 vertebrate species have populations <500 individuals in the Puente-Chino Hills, and at least four of these have <50 breeding adults. Risks of extirpation from the hills would increase for all these species in the absence of the Coal Canyon corridor. The corridor also benefits species in the Santa Ana Mountains, especially the mountain lion and several grassland species. Mountain lion and bobcat would likely be the first species adversely affected by loss of the corridor.	Protect and restore a functional undercrossing at the Coal Canyon interchange with Highway 91. Remove pavement and restore natural soils, vegetation, and drainage through the undercrossing, and install wildlife fencing to funnel wildlife off the highway and through the underpass.

Table 1. Continued.

Reference	Target Species	Major Focus	Study Area	Methods	Relevant Results	Recommendations
Haas and Crooks 1999, Haas 2000, Haas and Turschak 2002	Large and medium-bodied mammals	How landscape variables and underpass characteristics affect the distribution and relative abundance of target species in the study area, and the frequency of underpass usage by each species.	Entire Puente-Chino Hills Wildlife Corridor, from Santa Ana River to Whittier Hills.	*Field methods*: scat transects, remote-triggered camera stations, and baited track stations. *Statistical analyses:* Correlated probability and frequency of species use with landscape variables (e.g., corridor width, % wild) and underpass characteristics.	Bobcat and long-tailed weasel were negatively associated with habitat fragmentation. Fragmentation was negatively associated with probability of underpass usage by coyote, bobcat, and long-tailed weasel, and negatively associated with the frequency of use by bobcat. Underpass dimensions were important in determining probability of use by deer and gray fox, and with frequency of use in coyote, gray fox, deer, and domestic cat, with more open underpasses used most. The amount of natural cover surrounding the underpass entrance was important for bobcat. Fencing and roadway dividers were most effective on coyote use of underpasses. Overall, the probability of an underpass being used depends primarily on landscape characteristics, while its frequency of use depends primarily on underpass dimensions.	Bobcats are an excellent target species for conservation in the study area. Habitat acquisition and restoration should be concentrated in the narrowest portion of the corridor and at chokepoints along roadways. Existing underpasses should be surrounded by natural cover and use fencing to direct wildlife under the roadway. Future underpasses should be large and situated as far from residential areas as possible.

Table 1. Continued.

Reference	Target Species	Major Focus	Study Area	Methods	Relevant Results	Recommendations
Cooper 2000	Breeding birds	Determine distribution of breeding land birds to identify priority conservation areas.	Entire Puente-Chino Hills Wildlife Corridor, from Santa Ana River to Whittier Hills.	Point counts and walking transects to determine presence/absence.	California gnatcatcher, cactus wren, and other rare or declining species documented in diverse locations. Greater roadrunner widespread but not common; most commonly observed in middle portions of the Corridor. California quail found throughout study area except smallest fragments. Burrowing owl apparently extirpated from the study area during the 1990s. Several areas of high-quality habitats supporting diverse avifauna identified.	Conserve three priority areas based on size, threats, and support of declining species: (a) coastal sage scrub in northern Brea and Yorba Linda (southern portion of Missing Middle); (b) extensive grassland and savannah south of Rowland Heights (northern portion of Missing Middle); (c) grasslands of upper Tonner Canyon (northeastern portion of Missing Middle).
PCR et al. 2000	General wildlife	Analyze the Puente Hills area as a Significant Ecological Area (SEA) recognized by the County of Los Angeles.	That portion of the study area within Los Angeles County, from the Whittier Narrows to Tonner Canyon.	No original field studies; review and analysis of existing information.	The area meets several designation criteria as an SEA, including that it is regionally important to many resident and migrating species, especially large mammals, wintering raptors, and songbirds, in large part due to regional connectivity.	Retain connectivity and linkage values between major canyons of the SEA, and especially at choke points and major road crossings.

Table 1. Continued.

Reference	Target Species	Major Focus	Study Area	Methods	Relevant Results	Recommendations
Lyren 2001	Coyotes and bobcats	Home range and movement characteristics, roadkill, and underpass use by bobcats and coyotes.	Primarily along SR 71 and adjoining areas occupied by telemetered animals.	Radio telemetry (29 coyotes, 4 bobcats); roadkill surveys along SR-71.	Home ranges of about half of all telemetered animals overlapped SR-71, indicating frequent road crossing by individuals. Most animals crossing the road were documented using underpasses; coyotes used underpasses more than bobcats. Coyote use of underpasses seemed suppressed by traffic volume. No bobcats were found road-killed; coyotes frequently were road-killed, with concentrations where no wildlife fencing was present along road.	Wildlife fencing should be used to funnel wildlife to underpasses.
Schlotterbeck 2001	Large and medium-bodied mammals; reptiles and amphibians.	Assemble existing data from Haas and Crooks 1999 and Case and Fisher 1998 into a GIS database.	Entire Puente-Chino Hills Wildlife Corridor, from Santa Ana River to Whittier Hills.	No original field studies. Interviews with previous researchers and compilation and analysis of existing field data.	See entries for Haas and Crooks (1999) and Case and Fisher (1998) below. A comprehensive GIS database of their results was made available for research and monitoring.	Conservation and restoration of numerous lands, and proper management of these lands, is essential to stave off further species losses and ecological collapse in the Puente and Chino Hills.

Table 1. Continued.

Reference	Target Species	Major Focus	Study Area	Methods	Relevant Results	Recommendations
Haas et al. 2002, Case and Fisher 1998	Reptiles and amphibians	Determine distribution and diversity of herpetofauna; identify management needs to maintain diversity.	Scattered locales across the Puente-Chino Hills Wildlife Corridor, from Chino Hills State Park to Whittier Hills.	*Field methods:* Pitfall drift-fence arrays and snake traps. *Statistical analyses*: Several measures of species richness and diversity analyzed relative to landscape position.	Species richness and diversity were generally highest in the Chino Hills (22 species) and Whittier Hills (14 species), with lower levels in the narrower, more fragmented areas between (10-12 species). The number of sensitive species declined from seven in the Chino Hills to four in the Whittier Hills, and the western limit for some species lies somewhere between Chino Hills and Whittier Hills. Several species (e.g., coast horned lizard, western skink, red diamond rattlesnake) showed decreased population densities moving west through the corridor.	Maintain habitat linkages to maintain gene flow and reestablishment of populations if localized extinctions occur.
PCR 2002	General wildlife, with focus on large mammals.	Assess onsite biological resources and wildlife movement corridors to understand constraints to development on the Shell-Aera property.	Shell-Aera property and immediate vicinity; representing the western half of the Missing Middle (between SR-57 and Harbor Blvd.).	Sign reconnaissance; unbaited track stations, camera stations, and scat surveys focused on expected corridors and bottlenecks, such as road crossings; analysis of roadkill records.	Documented use of Shell-Aera property by deer, bobcat, coyote, roadrunners, and other native wildlife. Greatest evidence of wildlife movement was concentrated from the southeast corner of the property (associated with Tonner Bridge) to the northwest corner (associated with Drainage 26 and an area of high roadkill on Harbor Blvd.). Documented primary and secondary movement corridors across the property.	N/A--This biological constraints analysis describes existing conditions on the property and does not present recommendations.

Methods

This study synthesized and updated existing information on wildlife distribution and movements in the Puente-Chino Hills Wildlife Corridor (see Table 1) to serve as a "meta-analysis" of overall corridor function and of the role that each portion of the corridor plays in supporting native wildlife and wildlife movement. After analyzing existing conditions, I also considered how land-use changes in the Missing Middle could affect the continued persistence of wildlife populations throughout the corridor and in each portion of the corridor. The analytical process involved

1. Selecting a suite of target species for which there is sufficient local information to assess distribution and movements;
2. Defining geographic units of the corridor system and assessing their functions in supporting these target species;
3. Assessing the roads that segment the study area as potential barriers or filters to movement; and
4. Assessing how the current functionality of these segments could change with various development scenarios.

Reconnaissance

The analysis of existing literature was supplemented with reconnaissance surveys in the field as well as using satellite imagery, high-resolution aerial photographs, and digital photographs taken during flyovers by Melanie Schlotterbeck. In particular I used the Keyhole program (www.keyhole.com) to perform a "virtual reconnaissance" of the study area, including properties where physical access was not possible. Keyhole[3] allows a user to zoom, pan, tilt, rotate, and otherwise explore a three-dimensional digital model of the Earth's surface covered with high resolution satellite imagery (2004-5 color images at 1-m resolution) and Geographic Information System (GIS) data that can be layered onto this imagery. This proved to be an ideal tool for "exploring" the terrain prior to the field visit, and while reviewing previous studies in the area, to determine how topography, vegetation, development, and other landscape features might influence target species movements. By zooming in, rotating, tilting, and moving along this virtual landscape, a wildlife biologist can readily see where steep terrain, road cuts, bridges, vegetation, housing developments, and other landscape features would tend to funnel movements by larger species across the study area. (For example, I predicted, based on Keyhole reconnaissance, that the stretch of Harbor Boulevard just south of Wellington Lane would be a deadly road crossing for large mammals, which was later confirmed by personal observations in the field and my literature review.)

[3] Reduced-resolution screen captures of Keyhole imagery are used to illustrate landscape issues throughout this report.

After extensive exploration of the study area using Keyhole, GIS, and high-resolution aerial imagery, I visited the study area on March 2, 2005. I drove all roads crossing the area, stopping to investigate road-crossing structures (bridges, culverts, etc.), walking sections of trails, and looking for wildlife and wildlife sign. I photographed key locations, roadkills, habitat conditions, and other pertinent scenes, and noted signs of wildlife on aerial photographs. Because my fairly cursory field observations strongly reinforced the quantitative results of more intensive studies (see Table 1), they are not presented in detail, but are cited as supporting or supplemental evidence for the results and recommendations of these previous studies.

Target Species

It is important to clearly define what species and ecological processes are expected to benefit from a wildlife movement corridor (Rosenberg et al. 1997, Beier et al. in press). Target species were selected based on data availability (see Table 1) and how well they reflect overall corridor function or serve as indicators of habitat fragmentation and movement constraints. They include species that require large areas to survive, are most susceptible to extirpation by habitat fragmentation, are most susceptible to roadkill, or for which roads may serve as physical barriers. In addition, previous studies provide some more general measures of ecosystem health and corridor function, such as species richness for amphibians and reptiles (Haas et al. 2002) and avifauna (Cooper 2000).

Although it is tempting to think of one or a few larger mammal species as most obviously served by movement corridors, the ecological effects are far broader than any single species or set of species. Ultimately, the objective of securing and managing the Puente-Chino Hills Wildlife Corridor is more than ensuring that mountain lions can continue roaming the area (although that is certainly one objective)—it is ensuring that healthy ecological communities can continue to thrive and support the broadest possible range of native species.

Mountain Lion

The mountain lion or puma (*Puma concolor*) is the top carnivore in Southern California. It is a true "keystone" species whose presence helps maintain ecological balance by controlling populations of deer and other prey (Soulé and Terborgh 1999, Crooks and Soulé 1999). Mountain lions require huge contiguous habitat blocks to persist, with individual lions roaming home ranges as large or larger than the entire Puente-Chino Hills study area. Only contiguous habitat areas large enough to support at least 20 individuals—about 2,000 sq. km in Southern California—are expected to support lion populations over even the short term (Beier 1993, Beier et al. in press). Due to demographic instability and inbreeding concerns, even populations meeting these criteria, such as the population of about 20 adult lions occupying the 2,070-sq.-km Santa Ana Mountains Range, must be connected to even larger populations for long-term persistence (Beier 1993).

Although the Puente-Chino Hills are too small (at about 163 sq. km) to support a population of mountain lions on their own, one to several lions live totally or partially within the hills as an

extension of the larger Santa Ana Mountains population (Beier 1993, Noss et al. 1997). The Coal Canyon wildlife underpass on Highway 91 was restored specifically to ensure the continued presence of these large predators in the Puente and Chino Hills, thus ensuring a more healthy and balanced ecosystem (Noss et al. 1997). Lions have been detected all the way to the westernmost portions of the corridor (Whittier Hills) in recent years (A. Henderson, A. Gullo, and C. Schlotterbeck, personal communications).

Lions are very prone to roadkill. During Beier's (1993, 1995) study of mountain lions in the Santa Ana Mountains, vehicles killed 33% of the population, including four lions killed at one road-crossing during a 2-year period. Thus, mountain lions are good focal species for conservation planning in the study area, due to their keystone status, large area requirements, dependence on intact corridors, and susceptibility to roadkill.

Bobcat

Bobcats (*Lynx rufus*) are excellent indicators of functional landscape connections at the scale of interest in the Puente-Chino Hills study area (Crooks 2002, Haas 2002, Tigas et al. 2002, Riley et al. 2003). In Southern California, bobcat home ranges average about 2 to 6 sq. km, and population densities average about 1.1 to 1.6 bobcats per sq. km (Riley et al. 2003, Lembeck 1978, Lyren 2001). The probability of bobcat occurrence in a habitat patch is directly related to both the size of the patch and its isolation from other patches (Crooks 2002), with patches as small as 10 sq. km highly likely to support a few individuals if they are close enough together (within 1 km or less) and adequately connected to allow inter-patch movement (Crooks 2002). Using radio telemetry in the Santa Monica Mountains, Riley et al. (2003) found habitat blocks as small as 3.15 sq. km to support a few individuals, as long as movement was possible to larger, source population areas. Taking into account variation in habitat quality, Beier et al. (in press) concluded that contiguous habitat blocks of about 60 sq. km are necessary to support potential source populations of 20-25 adult bobcats over the short term in Southern California. Noss et al. (1997) estimated that a population of less than 50 bobcats inhabited the Puente and Chino Hills and less than 500 bobcats inhabited the Santa Ana Mountains. Haas (2002) found bobcats to be associated with wider portions of the Puente-Chino Hills, with lower densities in narrower segments. He concluded that bobcats used smaller segments primarily as "move-through" rather than "live-in" habitat.

Bobcats are behaviorally secretive and tend to avoid roads and other human disturbances, although they remain quite susceptible to roadkill. Bobcats are less likely to use road underpasses than coyotes, especially narrow underpasses or underpasses near residential areas, and so may be better indicators of high-quality road-crossing structures for wildlife.

Coyote

Coyotes (*Canis latrans*) are more adaptable, more abundant, and less averse to fragmentation than bobcats and mountain lions—and thus less dependent on high-quality landscape connections. Nevertheless, coyotes are important to maintaining ecological balance (Crooks and

Soulé 1999) and are good indicators of problem road-crossings, as many are killed on roads in the study area and elsewhere (Lyren 2001, Haas 2000, Robertson et al. 1995). Concentrations of coyote roadkills provide good indicators of potential crossing locations for other species, including bobcats, mountain lions, and mule deer. Noss et al. (1997) estimated a carrying capacity of roughly 60 adult coyotes for the Puente and Chino Hills and less than 500 in the Santa Ana Mountains.

Mule Deer

Mule deer (*Odocoileus hemionus*) are the primary prey of mountain lions and require relatively large habitat areas to support populations. Although they adapt to living in close proximity to humans, and are found in portions of the study area that are effected by fragmentation and development edges (Haas 2000), they are prone to roadkill and highly selective of road-crossing structures. In general, deer will use only the largest, most open types of structures (bridges or very open box culverts) within well-vegetated habitat areas to cross under (or over) roads (Haas 2000, Clevenger and Waltho 1999, Evink 2002). Noss et al. (1997) estimated that about 400 mule deer may inhabit the Puente and Chino Hills and about 4,000 may inhabit the Santa Ana Mountains.

Greater Roadrunner

Greater roadrunners (*Geococcyx californianus*) are associated with coastal scrub and open brush mosaics in coastal Southern California. They are highly susceptible to roadkill (Unitt 2004) and particularly sensitive to habitat fragmentation, rapidly disappearing from isolated habitat patches (Unitt 2004, Crooks et al. 2001, Soulé et al. 1988, Garrett and Dunn 1981). Soulé et al. (1988) and Crooks et al. (2001) identified the roadrunner as the most sensitive to habitat fragmentation of eight scrub-dwelling species they addressed in San Diego County. Crooks et al. (2001) found roadrunners persisting in only one of 34 canyons isolated by urbanization, and estimated that the roadrunner has a good chance of persisting only in patches 1.6 sq. km or larger. Based on more exhaustive surveys, Unitt (2004) concluded that this underestimates roadrunner sensitivity to isolation; he suggested that even 4.0-sq. km patches may be too small to sustain populations for long. As snakes and lizards are important prey, roadrunners may decline with reductions in reptile diversity and abundance.

Cooper (2000) reported that roadrunners are scattered in association with scrub habitats throughout the Puente-Chino Hills study area, with particular concentrations in the hills north of Brea and Yorba Linda (including significant portions of the Missing Middle). He estimated there were more than 50 breeding pairs (100 adult individuals) living in the Puente and Chino Hills.

Coast Horned Lizard

The coast horned lizard (*Phrynosoma coronatum*) was once common and widely distributed in coastal sage and chaparral habitats of Southern California, but has been extirpated from much of

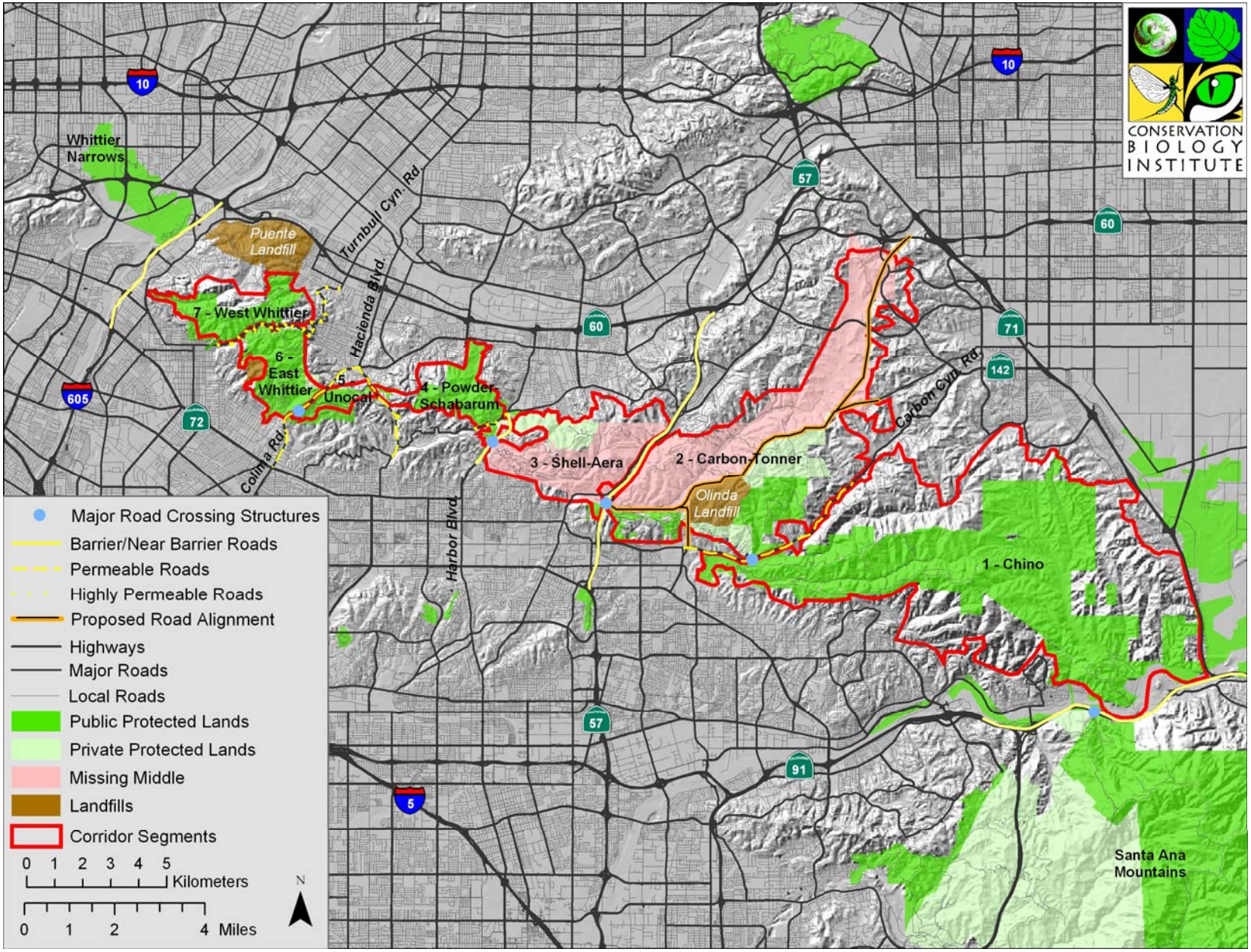
its former range by habitat loss and fragmentation (Fisher et al. 2002). This species is highly impacted by edge effects, such as invasions by the nonnative Argentine ant, which eliminates the native harvester ants that comprise more than 95% of the horned lizard's diet (Suarez et al. 2000). Argentine ants are closely associated with human-altered (especially irrigated) landscapes in Southern California, but can invade hundreds of meters into native scrub habitats; their adverse effects on native invertebrate populations ripple through the ecological community with devastating effects on biological diversity (Suarez et al. 1998). Thus, horned lizards serve as good indicators of relatively intact ecological webs and processes or, conversely, of the adverse effects of habitat fragmentation and edge effects on ecological communities (Fisher et al. 2002). They are also highly susceptible to roadkill and trampling. Case and Fisher (1998) and Haas et al. (2002) found coast horned lizards in the Chino Hills, as far west as the ridges between Carbon Canyon and Tonner Canyon (near the Olinda Landfill), but did not detect them at points farther west. Therefore, this species may already be extirpated, or likely will be soon, in corridor segments west of Highway 57 due to isolation of populations by roads and high mortality in remaining habitat areas.

Other Target Resources

The above target species certainly do not comprise a complete list of resources subject to loss due to habitat fragmentation and associated effects. They serve as indicators for a much more diverse community of organisms, and were chosen largely on this basis as well as the availability of distribution data in the study area. In addition to these species, I examined information on the diversity and abundance of reptiles and amphibians (from Case and Fisher 1998, Haas et al. 2002) and birds (Cooper 2000), and considered, at least qualitatively, the effects of habitat fragmentation on other species and ecological processes in the study area.

Defining Geographic Units, Barriers, and Filters

Although the entire study area serves as a wildlife movement corridor at a gross scale, it functions more like a peninsula of somewhat discrete habitat blocks segmented by roads and other discontinuities (Haas 2000, Haas and Crooks 1999, Schlotterbeck 2001, Robertson et al. 1995). The Puente-Chino Hills Wildlife Corridor was therefore subdivided into discrete geographic units based on habitat contiguity and intervening roads. Each unit, including the Santa Ana Mountains (the core area from which the corridor system projects) and the isolated terminal segment at the Whittier Narrows (Robertson et al. 1995), was given a geographic name to facilitate comparison (Map 2). Following Haas and Crooks (1999), the seven units between these two extremes (or between Highway 91 and Interstate 605) were also numbered 1 to 7, from east to west. These seven segments comprise the functional Puente-Chino Hills Wildlife Corridor system. They are convenient for comparing results across the various field studies and for assessing how each segment, and the habitat breaks between them, contribute to overall functionality of the corridor system. These segments are therefore useful tools for conservation planning.



Map 2. Geographic units of the Puente-Chino Hills Wildlife Corridor.

Initial Classification of Geographic Units

Each geographic unit was first classified by the primary role it appears to play in the overall functioning of the wildlife corridor system—as a biological *core*, *subcore*, *patch*, or *isolate*. These functional categories, defined below, reflect the relative size and contiguity of the units and their ability to sustain populations or facilitate movements of target species, as supported by literature and results of previous wildlife studies here. These definitions are tailored to this particular study, based on well established conventions in reserve design (e.g., Noss 1987, Meffe and Carroll 1997, Soulé and Terborgh 1999), and modified slightly from concepts and definitions developed for the South Coast Missing Linkages project—a science-driven approach to conserving landscape connectivity throughout the South Coast ecosystem (Beier et al. in press). The most significant deviation from the definitions of Beier et al. (in press) is the inclusion of an intermediate-sized "subcore" class (which corresponds to a "patch" in Beier et al. in press).[4]

- *Core* — A core area must be large enough (> 2,000 sq. km) to sustain populations of most or all target species without the need for frequent immigration from other areas, and should have relatively high biological diversity and a low proportion of edge. Core areas support source populations of target species, which may contribute individuals to other, less substantial, blocks of habitat. Basically, a core should be large enough to support a population (at least over the short term) of the most wide-ranging and area-dependent target species, which in this case is the mountain lion.

- *Subcore* — Subcores are contiguous blocks of habitat at least 60 sq. km, but less than 2,000 sq. km (corresponding to a "patch" as defined by Beier et al. in press). Subcores are too small to sustain a population of mountain lions in isolation, but large enough to support a population of bobcats with at least occasional dispersal. Subcores may support one or a few individual mountain lions, or at least provide significant "live-in" habitat as part of one or more lion home ranges. Subcores are more edge-effected than cores and may sustain lower overall species diversity, but can nevertheless represent significant source populations for numerous other target species, such as roadrunners, coyotes, and horned lizards.

- *Patch* — Patches, at less than 60 sq. km, are smaller and more edge-effected than subcores and are expected to support overall lower numbers and diversity of species. In isolation, patches may be too small to support a population of bobcats, and perhaps other target species having intermediate area requirements, although they could support a small number of such species or at least represent live-in or move-through habitat for individuals of such species. Although they may support populations of less area-

[4] Concepts like "core" and "corridor" are species- and scale-dependent, such that what might be considered a movement corridor for one species (e.g., mountain lion) can be core "live-in" habitat for other species (e.g., lizards, songbirds, or rodents). This entire study area is widely recognized as a "wildlife corridor," even though numerous on-the-ground travel routes, population concentrations, etc., can exist within this overall corridor system at finer resolution.

dependent target species, patches may serve mainly as dispersal stepping stones (or "move-through" habitat) for individuals of larger species (like mountain lions) moving between larger geographic units.

- *Isolate* — An isolate is any patch that is separated from another geographic unit by barriers to movement for target species. For example, the Whittier Narrows are separated from the Whittier Hills by Interstate 605, other significant roads, and commercial development, and are considered functionally isolated from the corridor for nearly all reptiles, amphibians, and mammals (Haas and Crooks 1999, Haas et al. 2000, Robertson et al. 1995, personal observations).

Note that these initial landscape categories were defined based primarily on the needs of the most area-dependent target species (mountain lion and bobcat). However, such concepts as "core" and "patch" can also be defined separately for each target species, based on their own requirements. Thus, a patch of habitat too small to support mountain lions could represent a "core" population area for less area-dependent species, like the roadrunner or horned lizard. Such species-specific issues were treated in more detail in later analytical steps.

Classifying Barriers and Filters to Movement

Roads and other discontinuities in habitat were also classified based on their relative effects on movements and population distributions of species, as follows:

- *Barriers* and *Near Barriers* — Roads or other discontinuities between geographic units that are never (for barriers) or rarely (for near barriers) crossed by target species. Barriers effectively isolate target species populations on adjacent habitat units from one another, while near barriers may separate subpopulations into a "metapopulation" system, with individuals occasionally dispersing between subpopulations in different units. For wide-ranging species like bobcats or mountain lions, barriers or near barriers may define one boundary of a home range, as individuals recognize it as the edge of available habitat. Major freeways and associated physical features (e.g., embankments, drainage improvements, retaining walls, lane dividers, fences, wide areas devoid of vegetation) create impassible barriers for nearly all ground-dwelling species, unless sufficient crossing structures (e.g., bridges, culverts, vegetated over-crossings) facilitate movements (Beier et al. in press, Evink 2002, Haas 2002, Lyren 2001). For example, the concentration of roads and commercial developments associated with Interstate 605, separating Whittier Hills from Whittier Narrows, represents a barrier for most or all target species. Near barriers are similar, but they may have one or more crossing structures that can be used by at least some target species; or target species may occasionally cross at-grade, on the road surface (perhaps at high risk of roadkill). Highway 57 and Harbor Boulevard are examples of near barriers in the study area. Both have high traffic volumes and physical characteristics that discourage crossings, except at one excellent bridge crossing at Tonner Canyon (for Highway 57) and one stretch where wildlife cross Harbor Boulevard at-grade—albeit with frequent roadkill.

- *Filter (Permeable and Highly Permeable)* — Filters are discontinuities in habitat connectivity that are readily to moderately crossable by most but not all target species. For example, two-lane paved roads with low traffic volumes and little associated development are readily crossed by larger mammals (although there may be occasional roadkill); but other species, like horned lizards, may be reluctant to cross or may suffer high roadkill. Thus, such roads serve to "filter" some species out of the community of wildlife crossing between adjoining habitat units. Several permeable to highly permeable roads cross the study area, such as Turnbull Canyon Road through the Whittier Hills (between Segments 6 and 7). The larger mammals, roadrunners, and some reptiles probably cross this road at-grade with little hesitation, and individual home ranges may straddle it. However, some smaller or more sedentary species may have their populations segmented by this road into subpopulations, with only occasional cross-road dispersal.

Analyses — Assessing Existing and Future Functionality

For each target species, I followed the following analytical steps:

1. I assigned each of the nine geographic segments to one of the functional categories (core, subcore, patch) as if each functioned independently of the others (i.e., as if roads separating the units acted as barriers or near barriers to dispersal). This initial categorization was based exclusively on unit size. For example, any unit less than 60 sq. km would be considered a patch if it functioned independently of other units in supporting a target species.

2. I assessed each road separating the units to determine whether it acted as a barrier (or near barrier) or filter (permeable to highly permeable). If a road was not considered a barrier/near barrier for a target species, and the two units it separated appeared to function as one larger unit for that species, the area of the two units was summed and the function of the new composite unit was reassessed. For example, if the composite unit exceeded 60 sq. km, it was considered to function as a subcore rather than two separate patches.

3. Based on this revised, species-specific functionality assessment, I assigned each newly defined unit (or composite unit) a function relative to supporting individuals or populations of each target species based on unit size, habitat composition, and other factors gleaned from the literature and field reconnaissance. These species-specific functions were defined as follows:

    - *Population* — capable of supporting a breeding population of at least 20 adults and potentially serving as a source of individuals that disperse into other units.

    - *Subpopulation* — capable of supporting at least two but less than 20 breeding individuals. Not likely to be a reliable source population, but may exchange individuals with other areas within a larger metapopulation (a set of partially isolated

populations linked by occasional dispersal) and may provide individuals to recolonize habitat patches in case of local extirpation.

- *Home Range Part* — incapable of supporting at least two breeding individuals on its own, but may provide live-in habitat (e.g., foraging or resting cover) and form a part of one or more individuals' home range(s).
- *Move-through* — not contributing significant live-in habitat for a species as part of a functional home range, but capable of accommodating movements between more substantial units within a home range, or potentially used for dispersal between other habitat units.

4. This classification system was used to assess likely effects of future scenarios on wildlife populations or movements, such as (a) adding new roads or development that would introduce new barriers or reduce the size of a functional unit, or (b) adding or improving wildlife crossing structures that would allow two independent units to serve as one larger one.

Results

Functionality of Geographic Units

Table 2 summarizes characteristics of the geographic units, including their size, vegetation composition, known or inferred presence/absence of target species, initial functional classification (core, subcore, patch), and reserve status (conserved/unconserved). Only the Santa Ana Mountains unit met the definition of a core area (larger than 2,000 sq. km and capable of supporting a mountain lion population). The Chino Hills between Highways 91 and 142 met the definition of a subcore (60-2,000 sq. km and capable of supporting a population of bobcats). Six other segments of the Puente-Chino Hills Wildlife Corridor met the definition of patch, but with great variation in their capacity to support wildlife and wildlife movements. The disjunct Whittier Narrows met the definition of an isolate.

Table 3 summarizes pertinent characteristics of the major roads dividing these units, with a focus on their role as barriers or filters to wildlife movement. Following below is a more detailed, unit-by-unit review of the information, concerning how each unit appears to function in supporting wildlife populations and movements, considering the effects of intervening roads and other factors. This review starts with the Santa Ana Mountains Core Area, then describes the seven segments of the functional Puente-Chino Hills Wildlife Corridor, and ends with the isolated Whittier Narrows.

Santa Ana Mountains (Core)

At about 2,070 sq. km, wildlands in the Santa Ana Mountains comprise the only true core in the study area. They support a high diversity of wildlife in a relatively intact and healthy representation of Southern California's South Coast ecosystem (Spencer et al. 2001), including substantial populations of all the target species. Noss et al. (1997) estimated populations of breeding adults in the Santa Ana Mountains at about 4,000 mule deer, 15-20 mountain lions, up to 500 bobcats, and more than 500 coyotes. These populations are large enough to persist, at least in the short term, within the Santa Anas without immigration from other habitat areas—although at least the mountain lion needs occasional immigration from adjacent mountain ranges to persist in the long term (Noss et al. 1997, Beier 1993). Of course, all species and ecosystem functions benefit from connectivity to other wildlands. The breeding population of about 15-20 mountain lions serves as a source of lions moving into the Puente-Chino Hills via the Coal Canyon Underpass (Beier 1995, Noss et al. 1997).

The Santa Ana core area is separated from the Chino Hills by busy Highway 91 and associated developments. However, the Coal Canyon Wildlife Underpass was restored specifically to mitigate this strong barrier to movements and appears to be functional (Figure 2).

Table 2. Characteristics of geographic units comprising the Puente-Chino Hills Wildlife Corridor (from east to west).

	Santa Ana Mountains	Segments of the Functional Puente-Chino Hills Wildlife Corridor							Whittier Narrows
		Chino	Carbon-Tonner	Shell-Aera	Powder-Schabarum	San Miguel	E. Whittier	W. Whittier	
Segment Number	N/A	1	2	3	4	5	6	7	N/A
Size (sq. km.)	~2,070	85.6	44.3	13.3	5.7	1.5	5.2	7.1	~4.5
Vegetation Mosaic									
Shrubland	N/A	51.3%	51.9%	45.2%	48.9%	57.1%	43.4%	67.0%	N/A
Grassland		36.5%	29.4%	37.7%	21.0%	31.8%	36.1%	17.1%	
Woodland		12.1%	18.7%	17.2%	30.1%	11.4%	20.4%	15.9%	
Wetland		0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	
Spp. Presence/Absence*									
Mountain lion	P	P	P	P?	P?	P?	P	P	A?
Bobcat	P	P	P	P	P	P	P	P	A?
Coyote	P	P	P	P	P	P	P	P	P?
Mule deer	P	P	P	P	P	P	P	P	?
Roadrunner	P	P	P	P	P?	P?	P	P	?
Coast horned lizard	P	P	P	A?	A?	A?	A?	A?	A?
Biological Function	core	subcore	large patch	patch	patch	small patch	patch	patch	isolate
Reserve Status	substantially conserved	substantially conserved	Carbon Cyn partly conserved, Tonner Cyn unprotected & threatened	unprotected & threatened	partly conserved, partly threatened	partly conserved, partly threatened	substantially conserved	substantially conserved	substantially conserved

*See Table 1 for supporting literature. P = confirmed present; A = likely absent; ? = presence or absence inferred by indirect evidence and geographic context, but no confirmatory data found.

Table 3. Characteristics of roads crossing the Puente-Chino Hills Wildlife Corridor.

Road	Geographic Units Separated	Critical Crossing Structures*	Characteristics	Effect on Movements
SR 91	Santa Ana/Chino	Coal Canyon Wildlife Underpass	Major, 6-lane freeway with heavy traffic and significant physical barriers to wildlife.	Barrier, except for Coal Canyon Underpass
Carbon Canyon Rd. (SR 142)	Chino/Carbon-Tonner	Square box culvert near Chino State Park entrance.	Busy 2-lane highway through mostly wild open space. Moderate-high coyote roadkill. Few physical barriers.	Permeable filter, with some roadkill (esp. coyote). Mix of at-grade crossings and culverts, at least one used by bobcat.
SR 57	Carbon-Tonner/Shell-Aera	Tonner Canyon Bridge	Major 6-lane freeway with heavy traffic and significant physical barriers to wildlife.	Barrier except for Tonner Canyon Bridge, with documented use by deer, bobcat, and coyote.
Harbor Blvd.	Shell-Aera/Powder-Schabarum	Harbor Blvd. Wildlife Tunnel (proposed)	Major 4-lane arterial with heavy traffic and significant barriers to wildlife. High roadkill.	Barrier, except for occasional at-grade crossing, with very high roadkill.
Hacienda Blvd.	Powder-Schabarum/San Miguel	none (except a little-used equestrian tunnel that could be improved)	Busy 2-lane road with steep slopes and cut banks, but several at-grade crossing areas.	Filter, with moderate roadkill risk.
Colima Rd.	San Miguel/East Whittier	Colima Service Tunnel	Busy 4-lane road with physical barriers, including fences that may help funnel wildlife to undercrossing.	Filter, with relatively low roadkill due to fences and a well-used undercrossing with known use by deer, bobcat, and coyote.
Turnbull Canyon Rd.	East Whittier/West Whittier	none	Winding, 2-lane road with light traffic through wild habitat.	Highly permeable filter, with at-grade crossings in wild open space.
Interstate 15 & Workman Rd.	West Whittier/Whittier Narrows	none	Major 6-lane freeway with heavy traffic, plus other major and minor roads, commercial development, and other physical barriers to wildlife.	Barrier to essentially all ground-dwelling species.

*Includes only those structures used by diverse target species and especially larger mammals. Numerous smaller culverts that may serve some target species also occur, as do some larger equestrian tunnels that are in landscape positions not favoring use by target species. See Haas (2000) and Robertson et al. (1995) for a more comprehensive review of crossing structures in the study area.

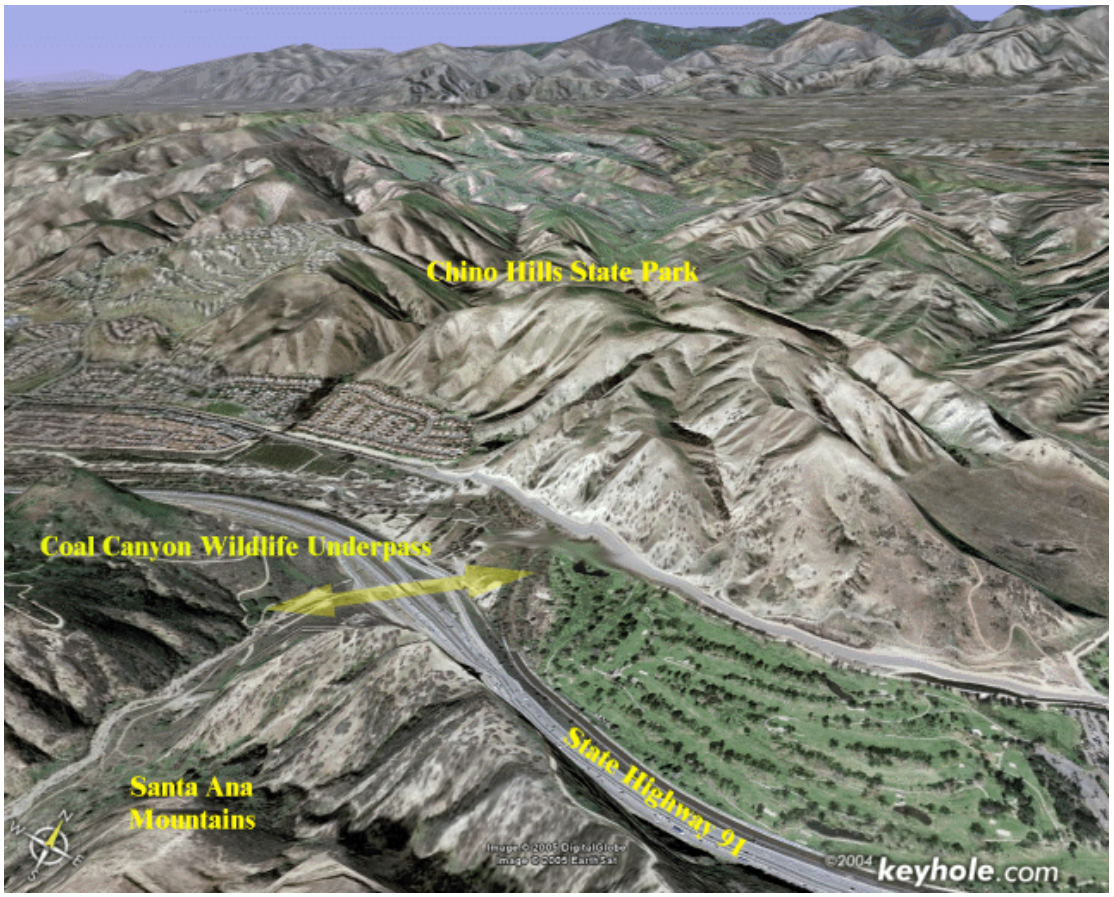


Figure 2. View northwest across Coal Canyon Wildlife Underpass, which links wildlife movement between the Santa Ana Mountains and Chino Hills State Park (Keyhole screenshot).

Corridor Segment 1—Chino

At over 85 sq. km, the Chino Hills represent a substantial subcore supporting diverse and relatively healthy ecological communities. It supports one to a few mountain lions, forming at least a portion of their home ranges, due to its connection to the Santa Ana Mountains population via the Coal Canyon Wildlife Underpass. Segment 1 also supports significant populations of all other target species (Lyren 2001, Cooper 2000, Haas and Crooks 1999, Haas 2000, Noss et al. 1997) and has higher overall biological diversity than other segments. For example, of all the segments they sampled for reptiles and amphibians in the Puente-Chino Hills Wildlife Corridor, Haas et al. (2002) reported the highest richness of herpetofauna (22 species captured) in the Chino Hills. They further reported the highest levels of species diversity (using a variety of diversity indices) and evenness (an index of relative abundance across all species) in the Chino Hills, with a general decline in these measures as one moves west through the corridor. Moreover, the number of sensitive amphibian and reptile species recorded by the study dropped from 7 in the Chino Hills to 4 in the Whittier Hills. No western spadefoot toads (*Spea hammondii*), western pond turtles (*Clemmys marmorata*), coast horned lizards, or coast patch-nosed snakes (*Salvadora hexalepis*) were found west of the Chino Hills. These results

undoubtedly reflect the larger size of Segment 1 (and adjoining Segment 2) compared with other segments, its proximity to the Santa Ana Mountains Core, and the increasing number of barriers and filters encountered moving west from this source area through the corridor. Similar patterns in diversity, abundance, and evenness measures would be expected for other taxa (e.g., birds, small mammals, insects, plants) if comparable data were available to document them.

Segment 1 is largely conserved already as Chino Hills State Park, although efforts continue to increase the size and buffering of this important reserve area. It is separated from Segment 2 by Carbon Canyon Road (Highway 142). This busy 2-lane road suffers some roadkill, especially coyote (Robertson et al. 1995), but is generally quite permeable to target species due to extensive, naturally vegetated land on both sides, lack of development over much of its length, and availability of several undercrossings. The most significant undercrossing is a 1.4-m (4.5-ft) high square box culvert used by bobcats and other target species (Robertson et al. 1995). This road is therefore classed as a permeable filter, allowing Segments 1 and 2 to function as one larger subcore for most species and ecological processes. Notably, Haas et al. (2002) and Case and Fisher (1998) recorded coast horned lizards on both sides of Carbon Canyon Road, but not farther west along the corridor.[5]

Corridor Segment 2—Carbon-Tonner

This large (44.3 sq. km) patch appears to function more as an extension of the Chino Hills subcore, being separated only by permeable Carbon Canyon Road (see previous). It is biologically diverse and supports all target species, including the westernmost observations of horned lizards by Haas et al. (2002) and Case and Fisher (1998). The southern portion of Segment 2 (including lower Carbon and Tonner Canyons and associated ridges) has been identified as a conservation priority for birds due to its support of several regionally rare or declining species, including greater roadrunners, loggerhead shrike, cactus wren, California gnatcatcher, grasshopper sparrow, and sage sparrow, among others (Cooper 2000). The northern portion of the segment (upper Tonner Canyon) is also rated as a conservation priority for birds, including golden eagle, burrowing owl, northern harrier, cactus wren, tricolored blackbird, and grasshopper sparrow, among others (Cooper 2000). Tonner Canyon also supports significant California walnut woodlands.

The eastern half of Segment 2 contains the western slopes and ridges of the Carbon Canyon landscape and is partially conserved as part of Chino Hills State Park and the Firestone Scout Reservation. The western half of this segment, containing most of Tonner Canyon, is unconserved and threatened by several proposed developments. Tonner Canyon is almost entirely owned by the City of Industry, which proposes a new road along the east side of Tonner Canyon (Map 2) and new water reservoirs within the canyon. This threatened half of the segment comprises the eastern portion of the Missing Middle.

[5] During my literature review, I found no recent confirmed records for coast horned lizards farther west than a ridge between Carbon and Tonner Canyons near Olinda Landfill (Haas et al. 2002). However, one table in a draft report (LSA 2005) listed the species as "observed" in the Whittier Hills, although another table in the same reference indicated the horned lizard as potentially present but not observed there.

The Olinda Landfill occupies a large footprint in the south-central part of Segment 2, between Tonner and Carbon Canyons. The landfill eventually will be closed and restored to natural vegetation as a County regional park, adding to the area of conserved open space here (C. Schlotterbeck, personal communication).

Segment 2 is divided from Segment 3 by busy Highway 57. This freeway is a near total barrier to ground-dwelling wildlife, except for one high-quality underpass in lower Tonner Canyon (Figure 3 and Photo 1). This bridge over Tonner Creek is very wide and open, with sufficient natural cover to facilitate movement by all target species. The bridge is used by mule deer, bobcat, coyote, and numerous other species (PCR 2002, Haas 2000, Haas and Crooks 1999, Robertson et al. 1999, personal observations). Maintaining this function is widely considered critical to maintaining the functional Puente-Chino Hills Wildlife Corridor, but it is threatened by the City of Industry plan for a new road originating here and traveling up Tonner Canyon to Diamond Bar.

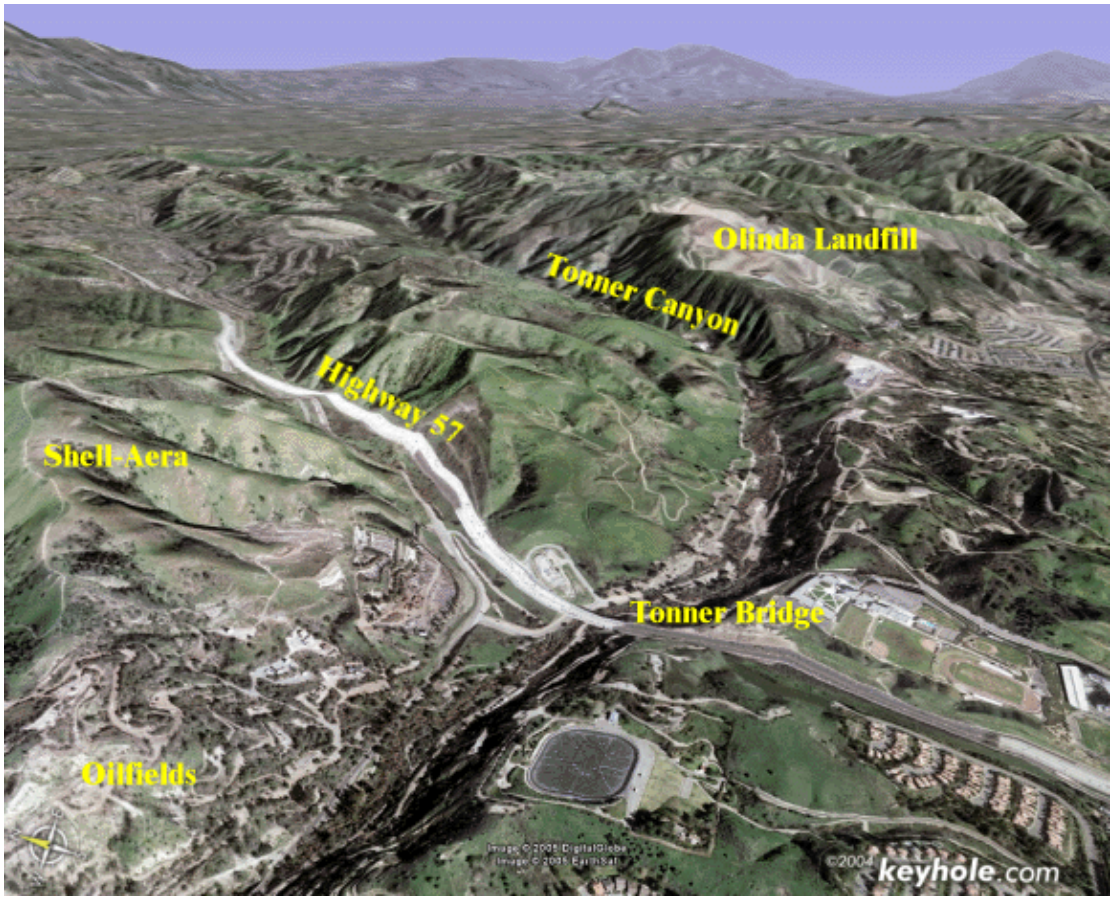


Figure 3. View northeast across Tonner Bridge and Highway 57 (Keyhole screenshot).
Wildlife on both sides of Highway 57 (a barrier road) are funneled to cross under Tonner Bridge.

Photo 1. View east under the Tonner Bridge, the only functional crossing beneath Highway 57 for deer, mountain lion, bobcat, and other wildlife species.

Corridor Segment 3—Shell-Aera

This segment, between Highway 57 and Harbor Boulevard, comprises the western portion of the Missing Middle. It is named for the Shell-Aera Master Planned Community property (2,935 acres or 11.9 sq. km), which comprises 90% of the segment's remaining undeveloped land and is proposed for development. In addition to the Shell-Aera property, Segment 3 includes some privately owned open space lands conserved as mitigation for previous developments in the vicinity, such as the Shea homes development off of Harbor Boulevard in the northwest portion of the segment.

Although smaller than Segments 1 and 2, and bounded by two near-barrier roads, this substantial habitat block (13.3 sq. km) supports diverse vegetation and wildlife communities and is generally recognized as essential to maintaining connectivity through the Puente-Chino Hills Wildlife Corridor (PCR 2002, PCR 2000, Haas 2000, Robertson et al. 1995, personal observations). Cooper (2000) recognized the area as being of high conservation concern for its support of rare or declining bird species, including greater roadrunner, golden eagle, and grasshopper sparrow, among others. The Shell-Aera property was not open to sampling by most studies included in this analysis. However, PCR (2002) performed biological surveys on the property and confirmed presence and movements of all target species except mountain lion and horned lizard. Although horned lizards are likely extirpated here, mountain lions undoubtedly do use the property—probably both as move-through habitat and as foraging habitat. There is essentially no other way for lions to make it to segments farther west, where lion presence has

been confirmed (A. Henderson, A. Gullo, and C. Schlotterbeck, personal communications), from the source populations to the east. The segment also supports deer and other prey species and appears to have suitable cover, despite a history of grazing that has degraded woodland and shrubland habitats. The Shell-Aera property also supports some of the best remaining examples of California walnut woodland in Southern California (approximately 16,000 walnut trees covering 475 acres), although regeneration has been hampered by grazing (Quinn 1998, in PCR 2002).

Harbor Boulevard, which forms the western boundary of Segment 3, is a formidable barrier to target species movement. It is wide, with fast and heavy traffic, and currently lacks any underpasses. A combination of natural and man-altered topography tends to funnel wildlife to a stretch of road just south of the Shea Homes development, where a steep-sided riparian drainage ("Drainage 26") abuts a steep fill slope below the road, adjacent to housing (Figure 4). A variety of wildlife trails converge here, and several cross the road and continue northwest along a powerline right-of-way into Powder Canyon. Signs of target species usage (bobcat, deer, coyote) are especially abundant in Drainage 26, and roadkill frequency is very high in this stretch of road, especially for coyote (PCR 2002, Robertson et al. 1995, personal observations). Figure 4 illustrates major movement concentrations on the Shell-Aera property as they relate to this problem road-crossing area. Photo 2 shows a road-killed coyote I observed on March 2, 2005,

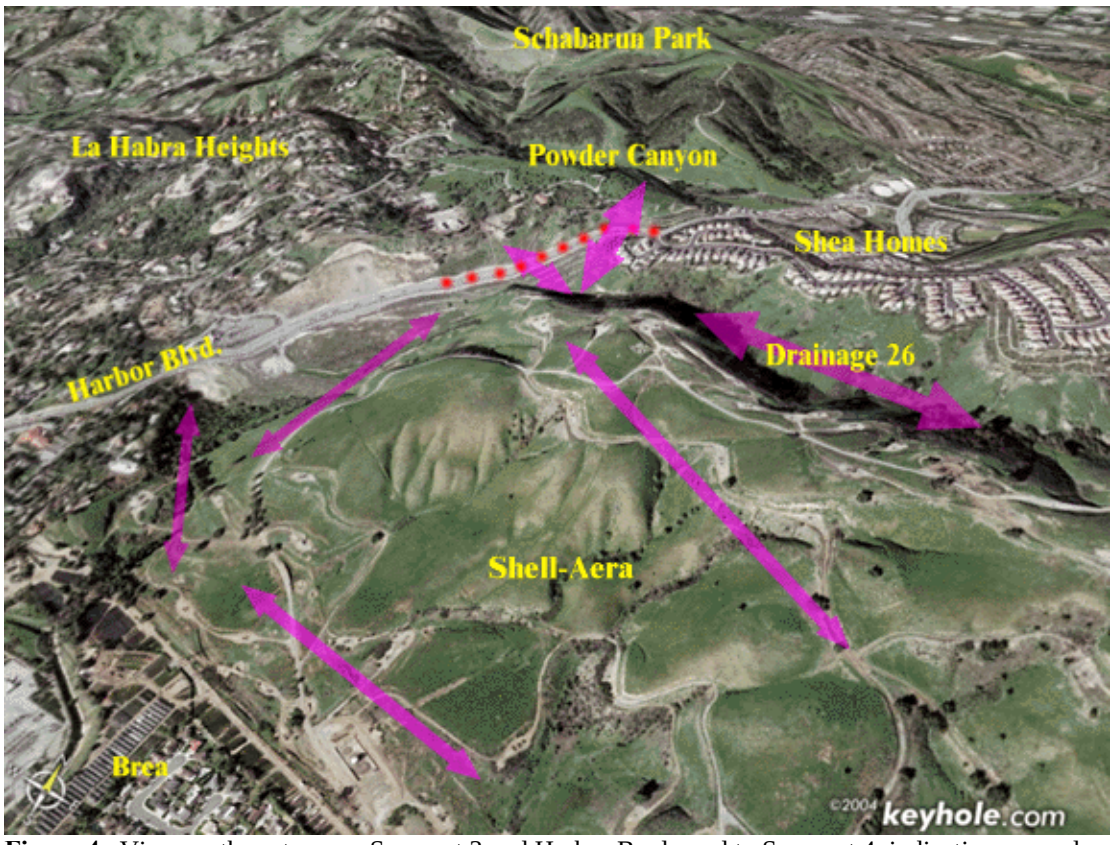


Figure 4. View northwest across Segment 3 and Harbor Boulevard to Segment 4, indicating general trends in wildlife movements (Keyhole screenshot). Arrow widths indicate inferred relative use levels. Red dots indicate stretch of highest roadkill.

where Harbor Boulevard crosses the Shea Homes development after Drainage 26. I surmised that this coyote entered the roadway out of Drainage 26 via one of several clear wildlife trails. Fortunately, recognition of this problem road-crossing has resulted in approval of a wildlife underpass here, although fencing to direct wildlife to the tunnel, considered essential to its success, has not been approved on the Shell-Aera property (A. Henderson, personal communication).

Photo 2. View southeast across the Harbor Boulevard "deathtrap." Drainage 26 extends out of view to the left from the bend in Harbor Boulevard. Note road-killed coyote and heavy traffic.

Corridor Segment 4—Powder-Schabarum

This segment (about 5.7 sq. km) is relatively small but nevertheless significant, especially as a link between larger habitat units to the east and west. Deer, bobcat, and coyote are commonly seen moving through the segment (Robertson et al. 1995). Haas (2000) recorded a lower frequency of bobcat visitations to track stations in this segment (and adjoining Segment 5) than in larger segments in the study area, which he attributed to the narrowness of this stretch of the wildlife corridor and consequently greater edge effects and disturbance factors.

Powder Canyon open space makes up the southern portion of Segment 4, and Schabarum Regional Park makes up the northern portion. The segment averages about 1.5 km wide over most of its length, but narrows to about 0.5 km in the western portion approaching Hacienda Boulevard. Wildlife movement becomes quite constrained in this narrow portion by existing housing, fences, and other impediments. Hacienda Boulevard separates this constrained portion of Segment 4 from Segment 5. Although Hacienda Boulevard has lower traffic volumes and speeds than the highways discussed above, it has very steep slopes and cuts, with no reliably

used crossing structures. An existing equestrian tunnel, that is infrequently used by target species, could be improved with fencing and revegetation (Haas 2000 and personal observations). Hacienda Boulevard has several at-grade crossing concentrations and trails (Haas 2000, Robertson et al. 1995, personal observations), which are probably associated with moderate roadkill. I rated this as a permeable filter, as it is crossable by most target species; however, it may act as a strong filter due to these and other constraints, and it represents a bottleneck to movement in need of improvement (Haas 2000).

Corridor Segment 5—San Miguel

This is the smallest (1.5 sq. km) segment of the entire corridor system. Along with the narrow constriction in the west end of Segment 4, this segment represents the narrowest habitat constriction along the wildlife corridor system (0.5 to 1.0 km wide). It is also perhaps the most disturbed by humans and their pets, particularly on northern slopes (Haas 2000, Robertson et al. 1995). Haas recorded low use by target species (no bobcat use) on the northern portions of this segment, along the Skyline Trail, but high levels of cats, dogs, striped skunks, and raccoons. The abundance of these mesopredators that are adapted to human environments often reflects low presence of coyotes and other large predators, which suppress these species when present (Crooks and Soulé 1999), as well as higher human influences and edge effects. Haas (2000) recorded bobcat activity in the southern portion of the segment, in association with less disturbed areas of San Miguel Canyon and near Skyline Drive. He noted that the transects with the greatest bobcat activity were also those with the lowest dog activity. Haas surmised (as did Robertson et al. 1995) that large mammals travel along Skyline Drive and descend into San Miguel Canyon towards the Colima Service Tunnel (discussed below). Low density housing in this segment, especially near Hacienda Boulevard, may reduce habitat quality for target species, but does not present barriers to movement (Haas 2000, Robertson et al. 1995). For some target species, Segment 5 may function primarily as move-through habitat, although a few coyotes and bobcats probably forage in San Miguel Canyon.

Segments 5 and 6 are divided by Colima Road, a fairly busy 4-lane road winding through a mix of open space and scattered housing. Although flanked by steep slopes, some fences, and other movement impediments, there are several at-grade crossing areas, which are associated with high coyote roadkill (Haas 2000, Robertson et al. 1995). One good under-crossing structure exists at a service tunnel near the southern edge of the habitat area (Colima Service Tunnel). Bobcats, coyotes, and deer use this tunnel (Robertson et al. 1995, Haas 2000, Haas and Turschak 2002), and they continued using it even after a dramatic increase in recreational uses of the tunnel and vicinity by humans and dogs during 2001-2002 (Haas and Turschak 2002). Most wildlife species use the tunnel between sunset and sunrise, whereas human and dog use occurs almost exclusively during daylight (Haas and Turschak 2002). Conserving and improving this tunnel for continued wildlife use, especially at night, is a conservation priority.

Corridor Segments 6 and 7—East Whittier and West Whittier

The wildlife corridor widens again in the Whittier Hills from the narrow and constrained Segments 4 and 5. Segments 6 and 7 are separated by Turnbull Canyon Road, which appears to be the most permeable road analyzed in the study area. It is a narrow, 2-lane road with relatively light traffic, winding through fairly undisturbed wildlands. Haas (2000) recorded no roadkills here and did not consider Turnbull Canyon Road a barrier or major hazard to mammals. Likewise, Robertson et al. (1995) did not consider Turnbull Canyon Road a significant impediment to movement, which corresponds with my field observations. Consequently, Segments 6 and 7 are discussed here together as one continuous geographic unit (Whittier Hills).

The Whittier Hills support significant biological values despite their location at the terminus of the range of connected wildlands, far from the Santa Ana Mountains Core. This area had the highest levels of deer and bobcat activity recorded by Haas (2000), and higher species richness of reptiles and amphibians than narrower segments farther east (Haas et al. 2002). Mountain lion presence has recently been confirmed in the area by several lion-predated goats and deer, and at least one likely lion scat (Haas 2000; A. Henderson, C. Schlotterbeck, and A. Gullo, personal communications).

However, monitoring results also show that the Whittier Hills have lost some species and may be close to losing more due to their distance from core areas and numerous intervening barriers and filters to movement. For example, despite the relatively high total number of reptile and amphibian species they recorded here, Haas et al. (2002) also found the Whittier Hills to have the lowest overall *evenness* in the study area (Haas et al. 2002). This evenness finding means that the local herpetofauna consists of a few abundant species plus many less abundant species, in contrast to the Chino Hills, where high evenness indicated healthy populations of most species. Those species detected in low numbers in the Whittier Hills may represent remnants of dwindling populations, possibly on their way to extirpation with little hope of being "rescued" by new colonists from other areas (Brown and Kodric-Brown 1977) due to the great distances and numerous barriers involved. Moreover, the Whittier Hills support fewer sensitive species of reptiles and amphibians than the Chino Hills, as various species drop out in an apparent east-west gradient from the Chino Hills through the wildlife corridor to the Whittier Hills (Case and Fisher 1998, Haas et al. 2002).

The Whittier Hills are separated from the Whittier Narrows by an array of formidable barriers, including Workman Road, Interstate 605, and a wide, unbroken surface of buildings and pavement. Together, these create a near total barrier to movement for all target species.

Whittier Narrows (Isolate)

Because it is functionally isolated from the Puente-Chino Hills Wildlife Corridor, I did not investigate this area in detail. Although this matrix of wetland and disturbed upland habitats probably supports some coyotes (a semi-isolated subpopulation?), it is unlikely to support other target species in perpetuity.

Summary of Overall Corridor Function

In general, the Puente-Chino Hills Wildlife Corridor appears to be functional for at least larger mammals and birds, although tenuously so in the Missing Middle (due to several barrier roads and near barrier roads) and across smaller Segments 4 and 5 just west of the Missing Middle (due to their small size, strong edge effects, and high human and dog activity). Essentially all roads in the study area are considered barriers or at least strong filters to movements by many reptiles, amphibians, and small mammals, although most birds and larger mammals currently can move between all segments either at-grade (with mortality risks) or via critical crossing structures. Despite constraints in many locations along the corridor, target species are confirmed or highly likely to occur in all seven corridor segments, except for the coast horned lizard, which may already be absent, or will disappear in the future, west of Highway 57.

Mountain lions are capable of traversing the length of the corridor, albeit at some risk of roadkill, and one or more lions still hunt as far west as the Whittier Hills. Most other target species probably persist over the length of the corridor as metapopulations, with subpopulations segregated among geographic units by the presence of barrier or near barrier roads. These subpopulations may be linked demographically and genetically by occasional dispersal, or by within-home range movements of some individuals, depending on each species' ability to navigate roads and crossing structures. For example, bobcats apparently have small subpopulations living in the Whittier Hills and within Segment 3 (Shell-Aera), and a larger source population living within the Chino Hills (Segments 1 and 2). Some individual bobcats probably have home ranges completely or partially within smaller segments (e.g., 4 and 5) between these more substantial habitat areas; or they occasionally move through the smaller segments, between larger ones, and thus keep the overall metapopulation interconnected demographically and genetically. This metapopulation persistence depends on both occasional cross-road movements (i.e., functional road-crossings) and sufficient patch size and habitat quality to sustain small subpopulations within segments.

Haas et al. (2002) described a gradient of declining diversity and evenness of reptile and amphibian species, moving west from the Chino Hills. This must be attributed to higher mortality and edge effects in the more fragmented portions of the study area, exacerbated by the greater distance and increasing number of barriers and filters that must be crossed as one moves farther west from source populations. This pattern of decreasing biological diversity in the western portions of the corridor is likely to be mirrored by other taxa that respond similarly to distance and barrier effects, such as small mammals. In terms of metapopulation dynamics, if a local population or subpopulation dwindles or disappears from one segment (e.g., Whittier Hills), it is less likely to be "rescued" by colonists from other segments (e.g., Chino Hills) the farther away it is from the source population and the greater the number of intervening barriers and filters. Hence, the farther west a segment lies, the greater the likelihood of local population declines or extirpations, at least for less mobile species (Haas et al. 2002).

Table 4 summarizes the conclusions from the preceding review of geographic units and roads and presents a conceptual model of how each geographic unit (or composites of adjoining units lacking barriers) appears to function in supporting populations of target species within this segregated landscape. This table integrates diverse information, including published estimates of home ranges and densities of target species in Southern California, results of the monitoring studies summarized in Table 1, variation in habitat quality and mortality factors throughout the study area, and professional judgment. The carrying capacity estimates (in parentheses for some species) are rough approximations only, intended as order-of-magnitude estimates of the capacity of each geographic unit to support populations or subpopulations of target species, or to function as part of one or more home ranges, or to function as pass-through habitat between other units.

Where adjoining segments are considered to function as one unit for a particular target species (e.g., if individuals readily cross roads and populations are not considered segmented by them), the area of those segments is summed. Thus, Segments 1 and 2 are combined to form new Segment 1/2 (Chino-Tonner), because Carbon Canyon Road is quite permeable for most species. Likewise, Segments 6 and 7 (the Whittier Hills) appear to serve as one contiguous geographic unit for nearly all target species, except the horned lizard, which is likely absent.

Vertical lines separating adjacent segments in Table 4 represent roads considered to segment populations for a given species. However, note that even where barrier roads do not prevent movement between adjoining segments, those segments may be treated separately in the table's classification of segment function for a target species. For example, although the roads bounding Segment 5 are not considered mountain lion barriers, Segment 5 is rated separately as "pass-through habitat" for lions (due to small size and edge constraints), whereas Segment 4 and combined Segments 6/7 are considered foraging habitat and therefore parts of a functional home range for one or two lions that pass through Segment 5 to reach them. Similarly, although Colima Road is not a strong barrier to movement for bobcats, coyotes, or deer, narrow and edge-effected Segments 4 and 5 likely support, at most, small subpopulations (a few resident individuals) or portions of a few individual home ranges for these species, whereas the larger and more contiguous Whittier Hills unit can support more robust and sustainable subpopulations.

By reading across the rows of Table 4 for any species, one can envision how the presence of species is maintained throughout the corridor via individual movements and metapopulation dynamics, with each segment (or combination of segments) serving as stepping stones along the way (either for an individual of a wide-ranging species like mountain lion—which may traverse the entire corridor—or over several generations for smaller species, whose individuals may move over only one or a few segments in a lifetime). For example, the only source population for mountain lions is the Santa Ana Mountains Core. The one to three resident lions that use the combined Chino-Tonner unit would not be there without this core population or the Coal Canyon Wildlife Underpass (Beier 1993, Noss et al. 1997, Haas 2000). One or more of these resident lions at least occasionally use Segment 3 (Shell-Aera) as foraging or pass-through habitat as a portion of their home range (made possible by the Tonner Bridge between Segments 2 and 3). From there, one or more lions occasionally forage in or move through Powder Canyon (Segment 4) and San Miguel Canyon (Segment 5) to forage in the Whittier Hills (combined Segments 6/7).

Table 4. Functional classification of geographic units for supporting target species populations and movements, considering effects of inter-unit barriers and filters, road-crossing structures, habitat quality, and other factors. Vertical lines indicate presence of barriers or near barriers between units for that species (names supplied for major roads). Classifications spanning multiple unit columns indicate those units are assumed to function as one for that species, using the summed size of units. Carrying capacity (numbers in parentheses) are crude estimates only, based on results of monitoring studies (see Table 1), published home range sizes and densities, habitat mosaics in each segment, and professional judgment. They are intended as order-of-magnitude estimates for the purpose of assigning functional classes, and not as precise population estimates.

		Segments of the Functional Puente-Chino Hills Wildlife Corridor							
		1/2–Chino-Tonner					**6/7–Whittier Hills**		**Whittier Narrows (Isolate)**
	Santa Ana Mtns Core Area	**1-Chino**	**2-Carbon-Tonner**	**3-Shell-Aera**	**4-Powder-Schabarum**	**5-San Miguel**	**6-E. Whittier**	**7-W. Whittier**	
Unit Size (sq. km)	~2,070	85.6	44.3		5.7	1.5	5.2	7.1	~4.5
Summed Size		129.9		13.3	7.2		12.3		
Target Species									
Mountain lion	Pop (15-20)	Subpop (1-3)		HR Part (1-2)	HR Part (1-2)	Pass-thru	HR Part (1-2)		Absent
Bobcat	Pop (100-400)	Pop (20-50)		Subpop (2-10)	Subpop/HR Part (2-5)		Subpop (5-15)		Absent?
Coyote	Pop (200-500)	Pop (20-50)		Subpop (5-12)	Subpop/HR Part (2-7)		Subpop (15-25)		Subpop?
Mule deer	Pop (2,000-4,000)	Pop (100-300)		Subpop (10-25?)	Subpop/HR Part (5-15)		Subpop (15-30)		Absent?
Roadrunner	Pop (hundreds)	Pop (20-100)		Subpop (?)	Subpop (?)	HR Part (?)	Pop(?)		Absent?
Coast horned lizard	Pop (thousands)	Pop (hundreds?)	Pop (hundreds?)	Absent?	Absent?	Absent?	Absent?	Absent?	Absent?

SR 91 | SR 57 | Harbor Blvd | Colima Rd | I- 605

Pop = capable of supporting a breeding population of ≥20 individuals and potentially serving as a source population via dispersal to other segments.

Subpop = capable of supporting 2-19 individuals as part of a metapopulation connected by at least occasional dispersal between other segments.

HR Part = could comprise part of one or more individual home ranges in concert with adjoining areas, but by itself is unlikely to support a breeding pair.

Pass-thru = used for movement between adjoining units, but unlikely to support individual life requisites (foraging, breeding, etc.) or a home range.

If any of the critical road crossings becomes non-functional, lions would no longer use more westerly segments, because no segments are capable of supporting a population of lions in isolation (other than the Santa Ana Mountains Core). Moreover, if any segment is reduced in size or quality to become only move-through habitat (rather than live-in habitat), the probability of lions using this unit, or any units lying further west, would drop considerably. Hence, maintaining lions in the Whittier Hills ecosystem depends not only on maintaining the possibility of unimpeded movement by individuals along the corridor, but also on maintaining substantial live-in habitat along the way.

Similarly, subpopulations in the Whittier Hills of bobcats, mule deer, roadrunners, and, to a lesser extent, coyotes exist in part due to other population or subpopulation segments (i.e., source habitats) along the corridor. Thus, the substantial habitat blocks in Segments 2 and 3 are important to continued presence of target species many kilometers away in the Whittier Hills. Substantial reduction in the carrying capacity of any one segment increases the probability of species losses in other segments. Thus, for example, the large area of Segment 3 (Shell-Aera) is a major potential contributor to the continued presence of bobcats, mule deer, mountain lions, roadrunners, and many other species in the Whittier Hills, especially if habitat quality is increased and road crossings are improved.

To summarize, the ability of westerly segments of the corridor to support species depends both on (1) the potential for individual movement between each set of adjoining segments (a function of roads and road crossings), and (2) having sufficient live-in habitat along the way to support populations or subpopulations that contribute dispersing individuals. The greater the distance from or between source populations, the lower the probability of a habitat patch or group of patches to continue supporting that species. If the distance between occupied segments becomes too great, or if barriers prevent inter-segment movement, local extinctions are inevitable in the isolated segments. Thus, any reduction in the capacity of segments to support populations or subpopulations increases the probability of local extinctions in that segment, as well as in all other "downstream" segments to the west.

Importance of the Missing Middle to Corridor Function

This understanding of overall corridor function highlights the importance of the Missing Middle as a part of larger home ranges for more area-dependent species and for maintaining species use of segments farther west. Although there has been much attention to maintaining or improving road-crossing structures and avoiding new impediments to movement, there should be equal attention to maintaining functional habitat blocks, capable of supporting source populations of target species, within the Missing Middle. Currently, the eastern half of the Missing Middle (Tonner Canyon) serves as an extension of the large Chino-Tonner subcore, contributing dispersing individuals of target species to other segments. Likewise, Segment 3 (Shell-Aera), although somewhat smaller and degraded by grazing, undoubtedly supports significant numbers of target species that disperse (at some risk) across Harbor Boulevard into Powder Canyon and beyond.

Future Corridor Functions

The above assessment of population distribution and movements, as summarized in Table 4, can serve as a foundation for assessing likely effects of future projects on the functionality of individual segments or the wildlife corridor as a whole. Although it is beyond the scope of this report to comprehensively analyze any particular project, I qualitatively assessed the likely effects of several proposed projects using the conceptual model presented above. I selected three proposed projects that most threaten corridor function in the Missing Middle and may eliminate wildlife populations and ecosystem functions throughout a much greater area of the Puente and Chino Hills. By impeding species movements or metapopulation dynamics within this peninsula of wild, a project's impacts may extend far beyond its boundaries, potentially rippling through the range of hills to eliminate wildlife populations as far west as the Whittier Hills.

Shell-Aera Master Planned Community

This planned community of 3,600 homes would be scattered over most of Segment 3 and the westernmost portion of Segment 2, straddling Highway 57 and extending west to Harbor Boulevard. Although detailed development plans and environmental analyses are not yet available, I obtained the conceptual development plan shown in Figure 5. (See http://hillsforeveryone.org/PDF_Files/aera_proposal.pdf for another version of the conceptual plan, which shows additional roads and features not included on Figure 5.)

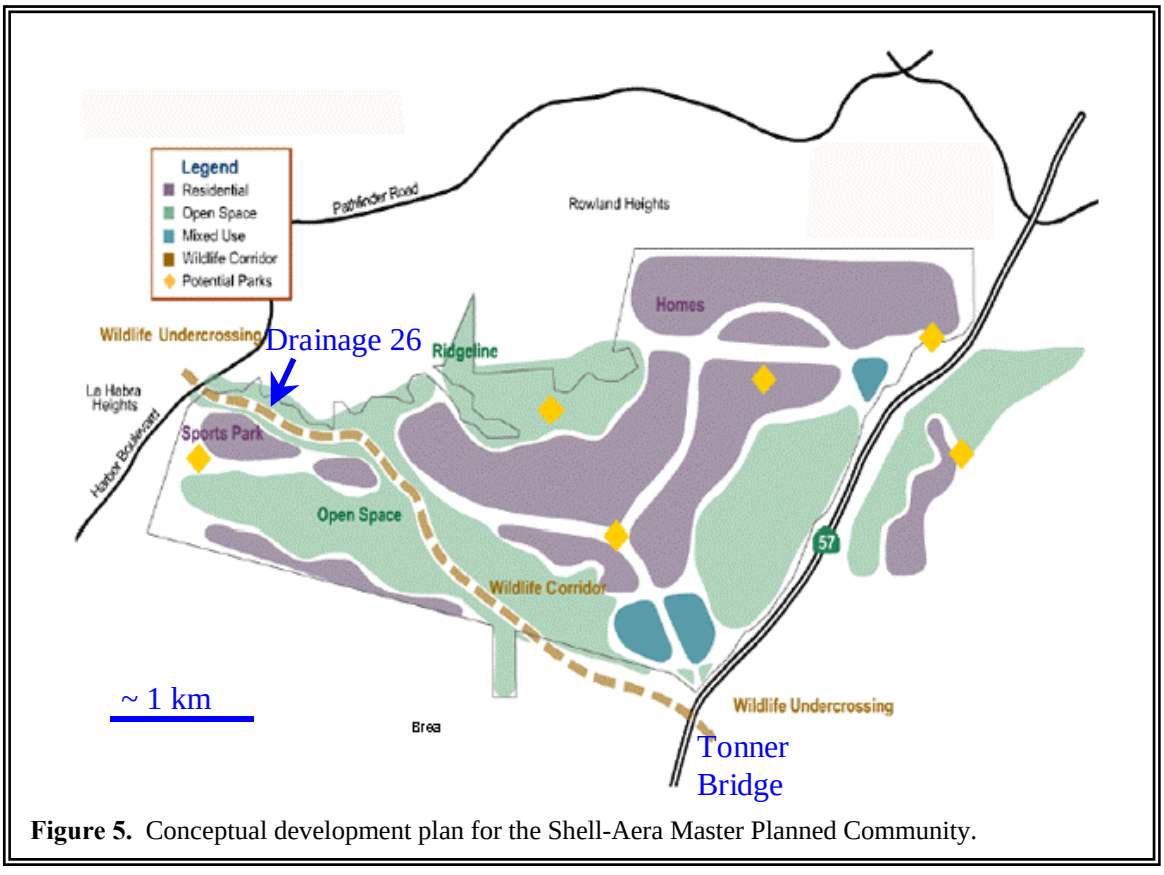


Figure 5. Conceptual development plan for the Shell-Aera Master Planned Community.

Although this conceptual plan appears to show approximately half the property as open space, it is clear that this open space represents far less than 50% of the property's biological value, due to severe fragmentation and edge effects, disruption of movements, and elimination of live-in habitat. Much of the open space would be totally isolated between bubbles of development and roads, such as the open space bubble on the west side of Highway 57. This and other open space patches would be completely isolated from other habitat areas, removing their capacity to support target species and other native wildlife. Moreover, the narrow and highly convoluted bits of open space depicted in this plan would suffer severe edge effects, greatly reducing the area's ability to support wildlife and ecological processes. As just one example, Argentine ants routinely invade several hundred meters from suburban edges into native scrub habitats, and even farther in moist drainages and canyons (Suarez et al. 1998). The open space bubbles are all less then 1 km across—much less in many places. Consequently, most if not all of the open space depicted in Figure 5 will be invaded by Argentine ants, which eliminate numerous native arthropods, plants, and vertebrates (such as the horned lizard) in a process of ecological collapse already well-documented in Southern California ecosystems (Suarez et al. 1998). In conclusion, only a minor fraction of remaining habitat will remain biologically useful in this proposed development area, and even that would be highly degraded relative to existing conditions.

The conceptual plan appears to be sensitive to wildlife movement needs in its depiction of a continuous "Wildlife Corridor" across the property, from Tonner Bridge through Drainage 26, to the location of the new wildlife tunnel being constructed under Harbor Boulevard. However, this characterization, apparently based on the primary movement corridor across the property as mapped by PCR (2002), is simplistic and biologically misleading. As concluded in the above review of corridor functions, long, narrow gauntlets of "move-through" habitat will not ensure continued functionality of the corridor system, which depends heavily on retaining the large blocks of live-in habitat in the Missing Middle. The mapped open-space corridor is about 4.5 km long and averages less than 500 m wide, which is insufficient to provide reliable live-in habitat for mountain lions and bobcats, for example. This is especially true considering that Segments 4 and 5 are also rather narrow and edge-effected, with marginal capacity to support foraging mountain lions or a subpopulation of bobcats. The overall result would be about 13 km of mostly linear, edge-effected, move-through habitat for these species, from live-in habitat east of Highway 57 to the next reliable foraging or subpopulation area in the Whittier Hills. The likelihood of continued movements by at least bobcats and mountain lions between Tonner Canyon and Whittier Hills would therefore drop dramatically with this development scenario.

In conclusion, this proposed housing development would seriously degrade the ability of Segment 3, and all segments farther west, to continue supporting target species, including mountain lion and bobcat. This would have cascading effects on flora and fauna in segments farther west, especially when considered in context with the relatively small and edge-effected Segments 4 and 5 it connects to on the west. Mule deer populations may, at least temporarily, increase in westerly segments like the Whittier Hills, due to removal of mountain lions from the system. In the short term, this may result in increased car-deer collisions on local roads; but in the long term, even deer are likely to disappear from all segments west of Highway 57 due to isolation of this relatively small population.

Tres Hermanos Reservoirs

This series of three reservoirs proposed by the City of Industry in Tonner Canyon (Figure 6) would also have substantial adverse impacts on corridor function. The upper Tonner Canyon

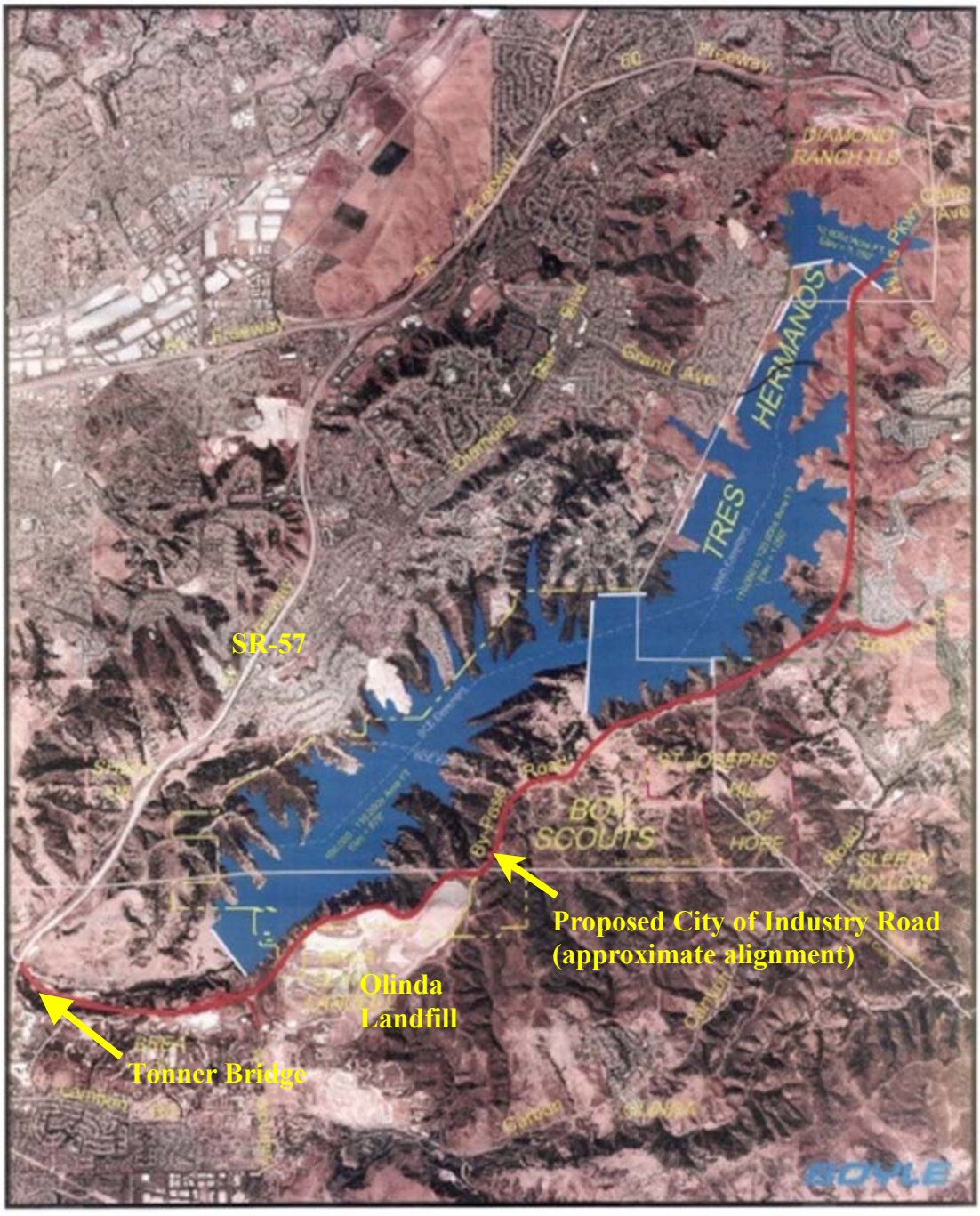


Figure 6. Aerial photograph showing City of Industry's proposed Tres Hermanos reservoirs and new road in Tonner Canyon.

area (northeast of the Firestone Scout Reservation), although supporting some target species and other wildlife, is mostly open grassland and somewhat degraded in habitat quality. Although a reservoir confined to this upper area would incrementally reduce the size of this segment and its capacity to support target species populations, it is far enough removed from the primary corridor connection across the Missing Middle that it would have less effect on overall corridor function than other developments I considered. However, any development (for reservoirs or other purposes) in middle and especially lower Tonner Canyon could have severe impacts on corridor function, especially if they reduced use of the Tonner Canyon Bridge on Highway 57. Any development that blocked access to or through the bridge area would make Highway 57 a barrier to wildlife and likely lead to wildlife extirpations in segments farther west.

At the very least, creation of these reservoirs would incrementally reduce the size of what is now a large Chino-Tonner subcore. Tonner Canyon, representing the westernmost portion of this subcore, is the primary source habitat for animals dispersing into the rest of the corridor system to the west. Hence, the location of this project would magnify its relative impact on continued corridor function by increasing the distance wildlife would have to move from source habitat areas to other segments.

Proposed City of Industry Road

Figure 6 also shows an approximate, conceptual alignment for a proposed road parallel to Tonner Canyon (see also Maps 1 and 2). Although I found no specifications for this road or associated development, it would appear to be a major throughway connecting Highway 57 (from the existing Tonner Bridge intersection) to Highway 60 across the widest portion of the Puente-Chino Hills Wildlife Corridor. Based on its location, the road would require major cut and fill to construct. Perhaps most troubling is its connection at the critical Tonner Bridge wildlife undercrossing. Depending on design, this is highly likely to render this last remaining corridor connection non-functional for mountain lion, deer, bobcat, and numerous other species. Even if this connection could be engineered to retain a functional wildlife undercrossing, the road could severely impact wildlife populations and movements along a broad front. A series of additional undercrossings (or overcrossings) and extensive wildlife fencing would need to be incorporated along the length of the road, or else most of Tonner Canyon would be isolated between two barrier roads (this one and Highway 57) or wildlife would suffer severe roadkill impacts. Approximately 21.2 sq. km of grasslands, forests, and shrublands would be segregated from the large and valuable Chino-Tonner subcore, incrementally diminishing its capacity to support wildlife populations. At best, what is now a broadly contiguous block of habitat would be reduced to a narrow and more edge-effected funnel across the Olinda Landfill to the Tonner Bridge.

Cumulative Effects

A full impact analysis for any or all of these proposed projects would need to address cumulative impacts on wildlife populations and movements through the corridor, which is beyond the scope of this report. Among these cumulative impacts would be inducement of further development,

such as additional residential, commercial, or industrial development along the road. Increased traffic (and hence roadkill) would also need to be analyzed and mitigated for. Any combination of two or more of these projects would likely render the Puente-Chino Hills Wildlife Corridor non-functional west of Olinda Landfill, regardless of mitigation.

Discussion

Before summarizing conservation and restoration recommendations for the Missing Middle, this section reviews the literature on the functions and benefits of wildlife corridors in conservation, including criticisms of corridor conservation.

Functions and Benefits of Wildlife Corridors

> "Connectivity is not just another goal of conservation: it is the natural state of things."
>
> Michael Soulé & John Terborgh (1999)

Landscape linkages and wildlife movement corridors vaulted to the forefront of conservation thinking in recent decades, in response to rising recognition that habitat fragmentation is a principal cause of species extinction and endangerment (Willis 1974, Diamond 1975, Wilson and Willis 1974, Noss 1983, Wilcox and Murphy 1985, Forman 1991, Harrison 1992, Rosenberg et al. 1997). Habitat connections or movement corridors connecting reserves or larger "core areas" of habitat are thought to counter many adverse effects of isolation by fragmentation on species and ecological processes (Preston 1962, Noss 1983, 1987, Soulé 1991, Meffe and Caroll 1994, Rosenberg et al. 1997, Soulé and Terborgh 1999, Beier et al. in press). Although some critics have argued that there are costs as well as benefits to conserving corridors, and that under certain circumstances creating or maintaining corridors could even harm some species or communities (e.g., Simberloff and Cox 1987, Simberloff et al. 1992, Hess 1994), the overwhelming weight of scientific evidence is that maintaining connectivity is generally beneficial, especially for those species and ecological communities for which connectivity "is the natural state of things" (Soulé and Terborgh 1999). Certainly, for most species and ecological communities, maintaining connectivity is less risky than losing connectivity (Hobbs 1992, Beier and Noss 1998, Soulé and Terborgh 1999).

Assessing Connectivity Pros and Cons

> "Those who would destroy the last remnants of natural connectivity should bear the burden of proving that corridor destruction will not harm target populations."
>
> Paul Beier & Reed Noss (1998)

This section reviews specific arguments for and against conserving corridors and how they apply to the Puente-Chino Hills. As elaborated below, in most cases, arguments against corridor conservation are really just cautions against applying corridors as a panacea for conservation, in recognition that there may be special cases where connecting reserves could cause more harm than good or where other approaches to conservation may be more effective or cost-effective (for example, enlarging core reserves rather than connecting existing reserves). These special cases do not apply to the Puente-Chino Hills Wildlife Corridor, where maintaining connectivity would clearly provide net benefits for biological diversity and ecosystem health in these hills. Given that the weight of scientific evidence favors connectivity here, whether and how connectivity can be assured is a societal issue not addressed in this scientific treatment.

The potential disadvantages of creating or maintaining wildlife movement corridors include several ecological arguments and one financial argument (Simberloff and Cox 1987, Simberloff et al. 1992, Hobbs 1992, Hess 1994):

1. Corridors may serve as conduits for the spread of deleterious species, like invasive pests, weeds, or predators.
2. Corridors may serve to spread detrimental processes—such as wildfire or disease—to or among reserve areas.[6]
3. Corridors may facilitate movements by highly mobile animals between reserves even without corridors. (Or, these species may be overly abundant in urban interface areas due to imbalanced ecological conditions.) But corridors may not help movement for more sedentary or at-risk species, for which other conservation approaches may work better than corridors.
4. Corridors could act as population "sinks" (Pulliam 1988), attracting individuals from higher quality habitat areas into edge-effected habitats where death rates exceed birth rates. If this effect is strong enough, it can reduce the regional abundance of the species, or even increase extinction probabilities for a rare species.
5. Corridors may be expensive to create or maintain and may not represent the optimal allocation of limited funding relative to, for example, increasing the size or management of existing core areas.

Note that in one way or another, all of these potential disadvantages hinge on relative comparisons of potential risks and benefits of maintaining vs. losing connectivity. Also, as pointed out by numerous researchers, the risks and benefits of corridors will vary by species. In the sections below, I briefly evaluate these potential disadvantages as they may apply within the Puente-Chino Hills Wildlife Corridor for target species of interest.

Conduits for Deleterious Species

It is difficult to envision how any deleterious species might increase its distribution or adverse effects due to conserving additional lands in this existing archipelago of open space reserves. Connecting these areas with additional conservation would not increase rates with which annual weeds, Argentine ants, rats, house mice, or other potential pest species invade open space areas relative to existing conditions. Sources of such deleterious species are nearly ubiquitous in Southern California, due to existing human land use patterns. Maintaining an existing open space corridor system would not facilitate expansions of such species, either from the more urbanized western portions of the study area into the Santa Ana Mountains, or vice versa, and may even help counter further invasions (relative to more roads or development in the area).

[6]Although wildfire and disease are natural disturbance processes in ecosystems, changes wrought by humans, such as habitat fragmentation and increased fire frequencies in urban interface areas, may create situations where these natural processes cause unnatural harm to biological resources. Corridors could help spread these deleterious effects.

Conduits for Deleterious Processes

Again, it is difficult to conceive how maintaining connectivity in this context could contribute to the spread of deleterious processes. This argument is generally based on the assumption that a new corridor is being *created* (e.g., connecting what are naturally unconnected habitat areas) rather than maintaining "the natural state of things" with an existing, natural corridor (Beier and Noss 1998). As with the argument concerning deleterious species, this seems not to be an issue for the Puente-Chino Hills Wildlife Corridor. Although diseases or parasites may be carried between habitat segments by wildlife, this already occurs and always did. Although fires may spread from one segment to another under certain conditions, the area is already highly segmented by fire breaks in the form of existing roads and other discontinuities. In fact, given the nature of Southern California's most destructive wildfires, which are driven by Santa Ana wind conditions (Keeley and Fotheringham 2001, Keeley et al. 1999, Halsey 2004), fire provides a stronger argument for not building more homes in wildland areas, rather than an argument for not conserving wildland areas.

Ineffectiveness for Rare or Sedentary Target Species

This is clearly a non-argument for the Puente and Chino Hills. Target species selected for review in this report, including both rare and common species, are highly sensitive to habitat fragmentation and benefit from corridor conservation (e.g., Beier 1993, Beier et al. in press, Crooks 2002, Ng et al. 2004). Although some rare or more sedentary species may not benefit directly from corridor conservation here (e.g., some reptile and amphibian species already lost from western segments of the corridor), the ecological benefits that accrue from corridor conservation for the remaining flora and fauna are indisputable. Indeed, research in the Puente-Chino Hills Wildlife Corridor reinforces other research indicating that more common, insensitive, and "pesky" wildlife like skunks and raccoons actually increase in density with reductions in larger carnivores like mountain lions and bobcats, due to losses of landscape connectivity (Haas 2000, Crooks and Soulé 1999). Countering this process of "meso-predator release" (Crooks and Soulé 1999), and the cascade of species losses and other adverse ecological changes that it can bring, is a strong argument for maintaining the Puente-Chino Hills Wildlife Corridor for mountain lions, coyotes, and bobcats.

Population Sinks

This is a legitimate argument that deserves analysis. It may be that, especially for species highly prone to roadkill, mortality in the Puente and Chino Hills is elevated relative to larger, more contiguous areas like the Santa Ana Mountains. It is conceivable that the corridor therefore serves as a "population sink" (Pulliam 1988), where animals enter the corridor from larger or higher quality habitats, only to be killed. However, the potential for this effect to substantially reduce regional wildlife populations in the Santa Ana Mountains seems remote. Moreover, the benefits of these species living within the Puente and Chino Hills, even with elevated mortality rates, are immense, both to ecological health and to quality of life for local human residents.

Suboptimal Conservation Investment

This is a non-argument for this study area. Given the current wildland-development pattern that exists, there is no alternative to corridor conservation and restoration for retaining species populations and maintaining healthy ecological processes in this area. Although one could argue that further investment in conserving these hills could be better spent elsewhere (e.g., enlarging larger wilderness reserves in Southern California mountains), this would come at the detriment of maintaining a unique ecological classroom full of wildlife in close proximity to millions of people craving a connection with nature. According to the California Department of Parks and Recreation, nearly a quarter billion dollars have already been spent on open space conservation in the Puente and Chino Hills, and this investment could be for naught if additional conservation fails to secure a continuous corridor from the Santa Ana Mountains to the Whittier Hills.

Mitigating Road Effects

> "Nothing is worse for sensitive wildlife than a road."
>
> Reed Noss

Roads or the traffic they carry kill animals directly (roadkill), disrupt natural migration and movement patterns, interfere with species communication, change water runoff and flow patterns, and create air, water, and soil pollution (Trombulak and Frissell 2000, Forman and Deblinger 2000, Jones et al. 2000, Reijnen et al. 1997). During Beier's (1993, 1995) study of mountain lions in the Santa Ana Mountains, vehicles killed 33% of the population, including four lions killed at one road-crossing during a 2-year period.

The growing awareness of road impacts on environmental health and imperiled species has created a burgeoning literature on efforts to mitigate these effects with improved wildlife road-crossing structures. Wildlife crossing structures have proved successful in the United States and elsewhere (Transportation Research Board 2002). The main types of structures, from most to least effective, are vegetated land-bridges, bridges, underpasses, and culverts.

About 50 vegetated wildlife overpasses, ranging from 50 m (164 ft) to over 200 m (656 ft) wide, have been built in Europe, Canada, and the U.S. (Evink 2002, Forman et al. 2003). Soil (0.5 to 2 m deep) covers the overpasses, which are planted, usually with native vegetation (Jackson and Griffin 2000). Overpasses are quieter than underpasses and maintain ambient conditions (Jackson and Griffin 2000), so they may be less intimidating for some species than dark tunnels. In Banff Provincial Park, large mammals preferred overpasses to other crossing structures (Forman et al. 2003). Similarly, birds, butterflies, and other open-air wildlife are more likely to use overpasses than underpasses.

Bridges are also effective crossing structures, especially if wide enough to permit growth of both riparian and upland vegetation along stream banks (Jackson and Griffin 2000, Evink 2002, Forman et al. 2003). Bridges with greater openness ratios are generally more successful than low bridges and culverts (Veenbaas and Brandjes 1999, Jackson and Griffin 2000). The Tonner Bridge is a good example of a broad, open bridge with natural vegetation beneath. My observations reinforce those of previous biologists that maintaining access through this structure,

and perhaps improving habitat conditions on either side, is critical to the flow of large mammals across the Puente-Chino Hills landscape.

Although inferior to bridges, culverts and other tunnel-like structures can be effective for some species (Jackson and Griffin 2000). Only very large culverts (such as box culverts and equestrian tunnels) are effective for large mammals (Lyren 2001, Haas 2000, Gloyne and Clevenger 2001). Gloyne and Clevenger (2001) suggest that underpasses for ungulates should be at least 4.27 m high and 8 m wide, with an openness ratio of 0.9 (where the openness ratio = height x width/length). Earthen flooring is preferable to concrete or metal (Evink 2002).

In places where a bridged, vegetated under-crossing or over-crossing is not feasible, placing pipe culverts alongside box culverts can help serve movement needs of both small and large animals. Special crossing structures that allow light and water to enter the structure have been designed to accommodate amphibians.

Noise, artificial night lighting, traffic noise, and other disturbances can deter animal use of a crossing structure (Yanes et al. 1995, Clevenger and Waltho 1999, Forman et al. 2003). Shrub or tree cover can help funnel wildlife to a passage while hiding them or making them feel more secure when approaching crossing structures (Evink 2002, Forman et al. 2003). Regardless of crossing type, wildlife fencing is necessary to funnel animals towards road-crossing structures and keep them off the road surface (Falk et al. 1978, Ludwig and Bremicker 1983, Feldhammer et al. 1986, Haas 2000, Lyren 2001, Forman et al. 2003). Earthen one-way ramps can allow animals that wander into the right-of-way to escape over the fence (Bekker et al. 1995, Forman et al. 2003).

Conclusions and Recommendations

Conservation and Restoration Priorities for the Missing Middle

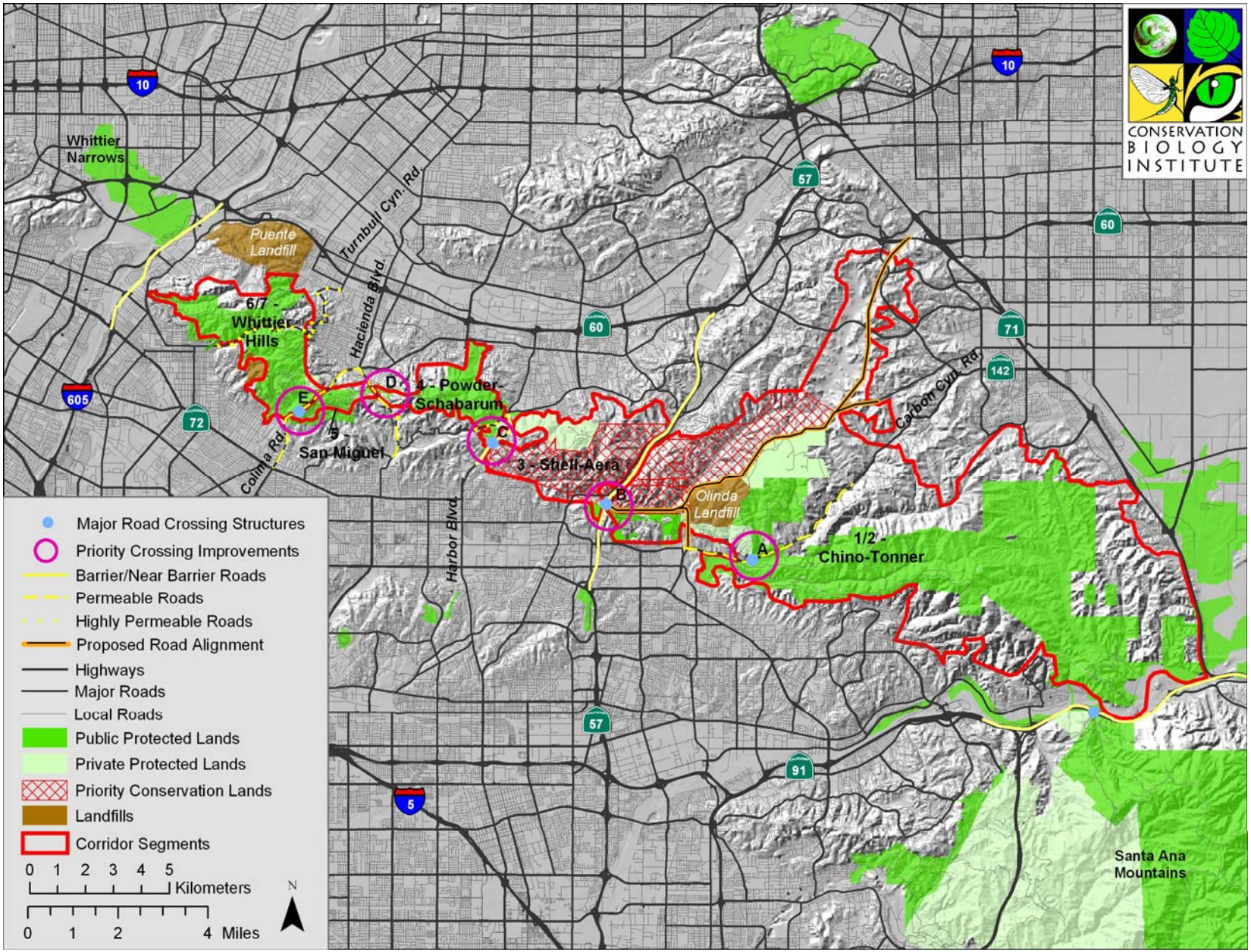
Based on the analysis of corridor function, Map 3 shows locations of priority conservation and restoration actions in and near the Missing Middle. This is by no means a comprehensive summary of all necessary and sufficient actions to maintain or improve biological conditions throughout the Puente-Chino Hills landscape. Rather, it focuses on those locations and actions that seem most critical to maintaining functional connectivity across the Puente-Chino Hills Wildlife Corridor based on the metapopulation analysis.

These recommendations are redundant with those from previous studies, especially concerning the need to secure and improve unimpeded movement by large target species across roads. This should not be surprising, because information on the characteristics and functioning of these corridor segments is quite consistent across studies. Perhaps the greatest benefit of the meta-analysis provided in this report is a renewed focus on the need to conserve not just unimpeded movement, but an archipelago of relatively large habitat blocks with sufficient carrying capacity to ensure continued presence of viable populations through this range of hills. Road-crossings are just one part of the story.

Priority Conservation Lands

Conserving intact habitat blocks within the red-hatched lands on Map 3 is essential to maintaining functional metapopulation dynamics for target species throughout the Puente-Chino Hills Wildlife Corridor. As supported by the geographic unit analysis, the capacity of Segments 2 and 3—from Chino Hills State Park to Harbor Boulevard—to support robust populations of target species and live-in habitat for mountain lions is essential to keeping these species in the study area, all the way to Whittier Hills. Essentially all of the Shell-Aera property, and at least the lower 1/2 to 2/3 of the City of Industry lands in Tonner Canyon, are of high priority for conservation.

Note that the line separating high-priority conservation lands in mid- to lower Tonner Canyon from upper Tonner Canyon is somewhat arbitrary. But the farther up Tonner Canyon one goes, the less essential habitat becomes for ensuring corridor functionality. (Note, however, that Cooper [2000] considered upper Tonner Canyon a high conservation priority for native birds, especially grassland species like raptors and grasshopper sparrows.) I established the northeast boundary of the Tonner Canyon high-priority conservation area primarily to consolidate a contiguous reserve along with the existing Firestone Scout Reservation and Chino Hills State Park. Extending this boundary farther north would increase biological benefits even more, but with decreasing marginal returns for corridor function.



Map 3. Conservation and restoration priorities in the vicinity of Missing Middle.

Essentially all of the Shell-Aera property west of Highway 57 is extremely high priority for conserving corridor integrity. Based on metapopulation analysis, conserving a "move-through corridor" across this property, as depicted in Figure 5, is not enough to ensure continued target species presence through the corridor system. Given this segment's location between two near-barrier roads, and the relatively narrow and constrained status of Segments 4 and 5 to the west, securing a large, intact habitat block capable of supporting populations or subpopulations of target species is essential here. Moreover, this segment could benefit greatly from habitat management and restoration to increase carrying capacity for target species, and thereby to decrease the probability of species extirpations here and all the way to the Whittier Hills.

Priority Crossing Improvements

Map 3 shows five priority road-crossing improvements with magenta circles, labeled A through E from east to west. Most of these recommendations have already been made by others (e.g., Haas 2000), and some may already have been acted on or are in planning stages. At the risk of redundancy, I nevertheless recommend the following improvements in these general locations. Refer to Haas (2000) for additional recommendations and details:

A. Add wildlife fencing on either side of Carbon Canyon Road to reduce roadkill and encourage wildlife to use existing culverts, especially the concrete box culvert near the entrance to Chino Hills State Park. Adding another wildlife crossing structure, designed to accommodate all large mammals, would be even better. Given that traffic on this 2-lane road is increasing due to increasing development in the vicinity (Haas 2000), any future road upgrades should incorporate bridges or other very open wildlife crossing structures as mitigation. A variety of smaller under-crossings with funneling fences, specifically designed to accommodate smaller reptiles, amphibians, and mammals, should also be considered to improve connectivity for these species.

B. Prohibit any development that would increase traffic under the Tonner Bridge or add any new impediments (structures, lights, noise, etc.) to the vicinity of the bridge. Restore riparian vegetation along Tonner Creek, where degraded by oil development activities. Fence along Highway 57 if monitoring suggests road mortality is high.

C. A wildlife underpass tunnel is to be constructed here under Harbor Boulevard, but recommended fencing has apparently not been allowed by a property owner (A. Henderson, personal communication). Secure rights to install wildlife fencing along both sides of Harbor Boulevard to reduce roadkill and ensure maximum utility of the wildlife tunnel. Plant native shrubs and trees on either side of the tunnel to provide cover to wildlife approaching the entrances. Consider adding smaller under-crossings and funneling fences to accommodate smaller reptiles, amphibians, and mammals.

D. Secure remaining "at-risk" parcels in this narrow, constricted portion of the corridor, west of Powder Canyon and Schabarum Regional Park. Enlarge or otherwise improve the existing equestrian tunnel to enhance its use by wildlife, including adding screening

vegetation, especially on the western end. Fence either side of the tunnel to help funnel wildlife to it. However, extensive fencing along Hacienda Boulevard is not recommended, because most large mammals currently cross at-grade. Although Hacienda Boulevard currently has moderate traffic at relatively low speeds, and therefore relatively low roadkill (Haas 2000), road improvements or increases in traffic could make the situation worse. In this case, consider building a wildlife overpass (a vegetated wildlife bridge) over Hacienda Boulevard, taking advantage of steep slopes rising up from either side of the road. Given this terrain, a vegetated overpass somewhere between Skyline Drive and the equestrian tunnel may be feasible and would certainly be superior to culverts or other underpass structures in accommodating wildlife movement. Consider also adding smaller under-crossings and funneling fences to accommodate smaller reptiles, amphibians, and mammals.

E. Maintain and improve the Colima Service Tunnel as a critical wildlife underpass. Add fencing or screening vegetation, if necessary, based on further site-specific inspection or monitoring. Limit and mitigate for any actions that may increase traffic, light, noise, or human activity in the vicinity of the Service Tunnel from sunset to sunrise, when wildlife use is most frequent. Consider also adding smaller under-crossings and funneling fences to accommodate smaller reptiles, amphibians, and mammals.

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