B. Responses to Comment Letters

Very truly yours,

SHUTE, MIHALY & WEINBERGER LLP

Gabriel M.B. Ross

cc: Claire Schlotterbeck, Hills For Everyone
Todd Spitzer, Orange County Board of Supervisors
Steve Harris, Community Development Director, City of Yorba Linda

List of Exhibits:

Exhibit A: Cielo Vista Draft Environmental Impact Report (November 2013)

Exhibit B: Gabriel Ross, Cielo Vista Project Draft Environmental Impact Report, Jan. 22, 2014

Exhibit C: Yorba Linda Water District, Comments Regarding the Notice of Preparation (NOP) of EIR for Proposed Cielo Vista Project (Project No. PA100004), August 2, 2012

Exhibit D: Orange County LAFCO, Response to NOP for Cielo Vista Project, August 1, 2012

Exhibit E: Chino Hills State Park General Plan (1999)

Exhibit F: Orange County Fire Authority, Freeway Complex Fire After Action Report (2009)

Exhibit G: Hills For Everyone, A 100 Year History of Wildfires Near Chino Hills State Park (2012)

Exhibit H: Syphard et al., Land Use Planning and Wildfire: Development Policies Influence Future Probability of Housing Loss, PLoS One, Vol. 8 e71708 (2013)

Exhibit I: Hills for Everyone, M6 Cougar Corridor Movement Study (2014)

Exhibit J: Beier et al., The Cougar in the Santa Ana Mountain Range, California (1993)

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EXHIBIT A

Exhibit A can be found at
the following website:
http://ocplanning.net/planning/land/projects/cielo

EXHIBIT B

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January 22, 2014

Via E-Mail and FedEx

OC Planning
Attn: Ron Tippets
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E-Mail: Ron.Tippets@ocpw.ocgov.com

Re: Cielo Vista Project Draft Environmental Impact Report

Dear Mr. Tippets:

On behalf of Hills For Everyone, we write to comment on the Cielo Vista Project Draft Environmental Impact Report ("DEIR"). Hills For Everyone is a non-profit organization that strives to protect, preserve, and restore the environmental resources and natural environs of the Puente-Chino Hills and surrounding areas for the enjoyment of current and succeeding generations, and is closely following the County's processing of the proposed Cielo Vista Project and the associated Esperanza Hills Project.

As detailed below, the County has failed to comply with the California Environmental Quality Act, Public Resources Code sections 21000, et. seq. ("CEQA") and California Code of Regulations § 15000 et seq. ("Guidelines") in its review of the environmental impacts of the proposed Project. Further, approval of the Project would violate state Planning and Zoning Law, Government Code sections 65000 et seq. The County may not approve the Project until (1) it is revised to comply with state Planning and Zoning law, and (2) environmental review of the revised project fully complies with CEQA.

I. The DEIR Fails to Satisfy CEQA's Requirements.

The EIR is "the heart of CEQA." *Laurel Heights Improvement Ass'n v. Regents of Univ. of Cal.*, 47 Cal. 3d 376, 392 (1988) (citations omitted). It is

> an environmental 'alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return. The EIR is also intended 'to demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action.' Because the EIR must be certified or rejected by public officials, it is a document of accountability.

Id. (citations omitted).

Where, as here, the DEIR fails to fully and accurately inform decisionmakers and the public of the environmental consequences of proposed actions, it does not satisfy the basic goals of the statute. *See* Pub. Res. Code § 21061 ("The purpose of an environmental impact report is to provide public agencies and the public in general with detailed information about the effect that a proposed project is likely to have on the environment . . .")

As a result of the DEIR's numerous and serious inadequacies, there can be no meaningful public review of the Project. The County must revise and recirculate the DEIR in order to permit an adequate understanding of the environmental issues at stake.

II. The DEIR's Flawed Project Description Does Not Permit Meaningful Public Review of the Project.

In order for an EIR to adequately evaluate the environmental ramifications of a project, it must first provide a comprehensive description of the project itself. "An accurate, stable and finite project description is the sine qua non of an informative and legally sufficient EIR." *San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus*, 27 Cal. App. 4th 713, 730 (1994) (quoting *County of Inyo v. City of Los Angeles*, 71 Cal. App. 3d 185, 193 (1977)). As a result, courts have found that even if an EIR is adequate in all other respects, the use of a "truncated project concept" violates CEQA and mandates the conclusion that the lead agency did not proceed in the manner required by law. *San Joaquin Raptor*, 27 Cal. App. 4th at 729–30. Furthermore, "[a]n accurate project description is necessary for an intelligent evaluation of the potential environmental effects of a proposed activity." *Id.* at 730 (citation omitted). Thus, an inaccurate or incomplete project description renders the analysis of significant environmental impacts inherently unreliable.

Here, the DEIR does not come close to meeting these established legal standards. The DEIR fails to describe four of the most critical components of the proposed Project: (1) the adjacent Esperanza Hills development; (2) the nearby Bridal Hills and Yorba

Linda Land developments; and (3) new oil drilling operations on the Project site. Environmental review of Cielo Vista in isolation from these four components of the Project would represent improper segmentation of environmental review under CEQA.

A. The Esperanza Hills Development is a Component of the Project.

The Esperanza Hills Project, a significant residential development, is proposed for the area located directly east of the proposed Cielo Vista Project site. DEIR at 2-1. The County released the Draft Environmental Impact Report for Esperanza Hills ("Esperanza Hills DEIR," attached hereto as Exhibit A) on December 2, 2013. Esperanza Hills would include the construction of 340 dwelling units and major grading activities on a 469-acre parcel adjacent to the Cielo Vista Project site. Cielo Vista and Esperanza Hills will share water and sewer facilities, and at least one of the access corridors to the Esperanza Hills site may be constructed as part of Cielo Vista.

CEQA prohibits piecemealed review of two developments that are truly a single project. The statute defines a "project" as "the whole of an action, which has a potential for resulting in either a direct physical change" or "a reasonably foreseeable indirect change in the environment." CEQA Guidelines § 15378(a); *see also* CEQA Guidelines § 15378(c) (term "project" means the whole of the "activity which is being approved"). Thus, an agency must take an expansive view of any particular project as it conducts the environmental review for that project. *See McQueen v. Bd. of Directors*, 202 Cal. App. 3d 1136, 1143 (1988) (term "project" is interpreted so as to "maximize protection of the environment").

An "EIR must include an analysis of the environmental effects of future expansion or other action if: (1) it is a reasonably foreseeable consequence of the initial project; and (2) the future expansion or action will be significant in that it will likely change the scope or nature of the initial project or its environmental effect." *Laurel Heights*, 47 Cal. 3d at 394–96. *Laurel Heights* requires a project proponent to analyze future expansion and other such action in an EIR if there is "telling evidence" that the agency has either made decisions or formulated reasonably definite proposals as to future uses of a project in the future. *Id.* at 396–97.

Here, there is ample evidence that the Esperanza Hills project is a foreseeable consequence of Cielo Vista, and that the two are, under CEQA's definition, the same project. Most obviously, the Cielo Vista Project will provide Esperanza Hills with required access corridors and water and sewer connections. They are, in effect, a single project building houses on two adjacent and closely-related sites. Access to the Esperanza Hills site may be provided by access corridors to be constructed as part of the Cielo Vista Project. DEIR at 4.10-11. The Yorba Linda Water District has advised

representatives of both development projects that water and sewer services and facilities must be planned and designed together. *See* Yorba Linda Water District, Comments Regarding the Notice of Preparation (NOP) of EIR for Proposed Cielo Vista Project (Project No. PA100004), August 2, 2012 (attached hereto as Exhibit B). Even if Cielo Vista and Esperanza Hills were separate projects, CEQA would still require the County to consider their environmental impacts together. Construction of the Cielo Vista access corridors and utility connections are the first steps toward development of Esperanza Hills.

Established CEQA case law holds that the analysis of environmental effects must occur at the earliest discretionary approval, even if later approvals will take place. *See, e.g.*, *Bozung v. Local Agency Formation Comm.*, 13 Cal. 3d 263, 282 (1975) (expressing the importance of environmental review "at the earliest possible stage"). The environmental impacts associated with this additional development must be analyzed with those of the Cielo Vista Project. The Orange County Local Agency Formation Commission ("LAFCO") has also requested that the County prepare a combined analysis of the environmental impacts of the Cielo Vista and Esperanza Hills projects. *See* Orange County LAFCO, Response to NOP for Cielo Vista Project, August 1, 2012 (attached hereto as Exhibit C).

In any event, because the two developments are so closely related, a single EIR would provide the most efficient and effective environmental review. A single EIR will provide a more comprehensive evaluation of environmental impacts and will also assist the County in crystallizing its analysis of alternatives to the development of widely dispersed, single-family homes in this portion of the Puente-Chino Hills-.

1. Segmenting Review of Cielo Vista and Esperanza Hills Conceals the Magnitude and Significance of the Project's Impacts.

By artificially segmenting its environmental review of the Cielo Vista and Esperanza Hills developments, the County has concealed the magnitude and significance of the Project's environmental impacts. Certain impacts caused by Cielo Vista that are deemed less than significant under the EIR's standards would be significant when combined with the impacts of Esperanza Hills.

For example, the Project's greenhouse gas emissions and impacts on global climate change would be significant according to the threshold in the DEIR if the DEIR also accounted for the greenhouse gas emissions from Esperanza Hills. The DEIR estimates that Cielo Vista will generate 2,283 metric tons of carbon dioxide equivalent ("$MTCO_2e$") per year. DEIR at 4.6-24. The County's threshold for determining whether a Project would result in a significant impact is 3,000 $MTCO_2e$ per year. *Id.* Because

Cielo Vista would not exceed the County's threshold, the DEIR concludes that the Project would result in a less than significant impact with respect to greenhouse gas emissions. *Id.* The Esperanza Hills DEIR estimates that Esperanza Hills will generate nearly 7,000 $MTCO_2e$ per year. Esperanza Hills DEIR at 5-272. Together, these two developments greatly exceed the County's significance threshold.

But according to the DEIR's current analysis, the greenhouse gas emissions and impacts on global climate change from Cielo Vista are not even cumulatively considerable. DEIR at 4.6-27. Yet the Esperanza Hills DEIR admits that the greenhouse gas emissions and impacts on global climate change, as well as noise impacts, from that development alone are significant and unavoidable. Esperanza Hills DEIR at 10-1. The DEIR's claims that these categories of impacts are less than significant for Cielo Vista create a misleading portrayal of the environmental impacts of the whole Project. Only a single EIR would provide the complete environmental review that CEQA requires.

B. The Bridal Hills and Yorba Linda Land Developments Are Components of the Project.

Any developments planned for the Bridal Hills, LLC parcel and the Yorba Linda Land, LLC parcel are also reasonably foreseeable consequences of the Cielo Vista Project, and therefore must be considered part of the Cielo Vista Project. These two parcels—located north and east of the Cielo Vista Project site—are currently undeveloped, but it appears that significant development activity is planned for at least one of these areas. In the Esperanza Hills DEIR, the County admits that the Bridal Hills, LLC parcel "is a reasonably foreseeable development" and includes it in that document's analysis. Esperanza Hills DEIR at 4-2.

The Notice of Preparation for the Esperanza Hills Project explains that access to both the Bridal Hills and Yorba Linda Land parcels will be provided for in the proposed Esperanza Hills lot layout and street design. Esperanza Hills NOP at 1. The Esperanza Hills DEIR also admits that the Esperanza Hills development will provide the access corridor for the Bridal Hills development. Esperanza Hills DEIR at 4-2. In fact, the Esperanza Hills NOP contains a Vegetation/Biological Resources Map for the "Esperanza Hills Specific Plan Area" that includes the Bridal Hills and Yorba Linda Land parcels within the project boundary. Esperanza Hills NOP at 11, Exh. 5.

Development of the Bridal Hills and Yorba Linda Land parcels therefore constitutes a reasonably foreseeable consequence of the Cielo Vista Project, and must be considered part of the Cielo Vista Project. *Laurel Heights*, 47 Cal. 3d at 394–96. The environmental effects of all of these developments, along with those of Cielo Vista, should be collectively evaluated in a single EIR.

C. Oil Drilling on the Project Site is a Component of the Project.

As part of the Project, a 1.8-acre parcel located in Planning Area 1 (the "drilling pad") is proposed to be zoned R-1(O) and may be the site of new and continued oil operations—including consolidation of oil wells relocated from the rest of the project site and slant drilling of new wells below ground. DEIR at 2-28. These new and continued oil operations constitute a reasonably foreseeable consequence of the Cielo Vista Project, and therefore must be considered part of the Cielo Vista Project. An operating well is currently located within the drilling pad area, DEIR at 2-29, and the Project maintains access to the drilling pad.

Nevertheless, the DEIR fails to adequately evaluate the impacts of these continued operations. Instead, the County declines to analyze the impacts of these continued oil operations because "permitting and site planning [will] be pursued by the oil operators" and "the oil drilling pad would be developed for future oil operations as a separate project should the oil operators choose to relocate to this area of the project site." DEIR at 2-29. But CEQA requires the County to analyze impacts at the earliest discretionary approval, even if later approvals will take place. *See Bozung*, 13 Cal. 3d at 282. The County must evaluate the environmental impacts associated with new and continued oil operations as part of the Cielo Vista Project.

III. The DEIR Fails to Adequately Analyze the Project's Environmental Impacts.

A. The DEIR Fails to Accurately Analyze the Project's Geology and Soils Impacts.

The DEIR fails to adequately analyze the Project's significant earthquake safety risks. The DEIR's proposed mitigation measures are vague and incapable of reducing these significant impacts to a less than significant level. The DEIR also fails to acknowledge that the Project is inconsistent with policies of the Orange County General Plan ("OCGP") and the City of Yorba Linda General Plan ("YLGP") regarding geologic hazards. These plan inconsistencies constitute significant and unavoidable impacts.

1. The Project Creates Significant Geologic Safety Hazards.

The Whittier Fault—an active fault with a Fault-Rupture Hazard Zone that is approximately 1,000 feet wide—bisects the Project site. DEIR at 4.5-10. Residential lots are proposed within the fault rupture hazard zone. DEIR at 4.5-14. There is potential for significant ground shaking at the Project site during a strong seismic event on the Whittier Fault, as well as fault rupture, liquefaction, landslides, slope instability, dangerous soil expansion, and severe damage to nearby buildings. DEIR at 4.5-9 to -11.

The DEIR explains that these impacts would be significant if the Project would expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving fault rupture, strong seismic ground shaking, seismic-related ground failure, and landslides. DEIR at 4.5-13. The hazards associated with the Whittier Fault clearly exceed this threshold.

Indeed, the DEIR admits that the Project could expose people or structures to such adverse effects. *Id.* The DEIR concedes that the Whittier Fault could generate an earthquake of Mw6.0 to 7.2 on the moment magnitude scale. DEIR at 4.5-10. An earthquake of that magnitude can lead to "Major" earthquake effects, including "damage to most buildings, some to partially or completely collapse or receive severe damage." Even "[w]ell-designed structures are likely to receive damage." *Id.*

According to the 2013 Geotechnical Feasibility Study[1], a seismic event at the Project site could result in "severe" shaking and could lead to "moderate to heavy" damage. DEIR at 4.5-10.

Moreover, ground surface rupture could occur along the Whittier Fault trace. DEIR at 4.5-9. But the DEIR admits that the precise location of the Whittier Fault trace is unknown. DEIR at 4.5-14. The 2006 Geotechnical Evaluation estimates that the Whittier Fault trace is located along the mid-point of the Whittier Fault Zone, but concedes that a previous investigation determined that multiple branches of the fault exist in the Project area. 2006 Geotechnical Evaluation 4. Active fault splays could occur outside of the "likely" location of the main fault trace. *Id.*

Liquefaction, as well as other ground failure hazards can lead to ground failure that can result in property damage and structural failure. DEIR at 4.5-15. The DEIR determines that a potentially significant impact would occur if any structures are located in areas potentially susceptible to ground failure hazards. *Id.* The DEIR admits that a portion of the Project site clearly has the potential for liquefaction, and that other areas may also be susceptible to liquefaction and seismic settlement. *Id.*

[1] Appendix E to the DEIR includes two preliminary geotechnical reports to support its conclusions: (1) Pacific Soils Engineering, Inc., Geologic and Geotechnical Evaluation (2006) ("2006 Geotechnical Evaluation"); and (2) LGC Geotechnical, Inc., Geotechnical Feasibility Study, Proposed Development of Tentative Tract Map No. 17341, County of Orange, California (2013) ("2013 Geotechnical Feasibility Study").

The DEIR further admits that available information indicates the presence of landslides and other gross slope instability conditions on a portion of the Project site. DEIR at 4.5-15. The proposed grading for the Project is avoids "most areas suspected to be underlain by landslides or susceptible to slope stability hazards," but not all of those areas *Id.* In any event, the 2013 Geotechnical Feasibility Study admits that landslides and other slope instability issues at the Project site have only been subject to a "cursory review." 2013 Geotechnical Feasibility Study at 5. No site-specific investigation has been performed to determine the existence, depth, geometry and other characteristic of landsliding. 2006 Geotechnical Evaluation at 10.

Overall, then, the EIR explains that the Whittier Fault creates a serious potential hazard for the Project. CEQA thus demands a thorough investigation of these environmental impacts. *Berkeley Keep Jets Over the Bay v. Bd. of Port Comrs.* (2001) 91 Cal. App. 4th 1344, 1370 (lead agency must use best efforts to analyze potentially significant impacts).

2. The DEIR's "Mitigation" of the Project's Geologic Hazards Actually Represents Impermissible Deferral of the Analysis of These Hazards.

In an attempt to mitigate these significant seismic impacts, the DEIR proposes Mitigation Measure 4.5-1, which requires the Project Applicant to prepare an additional geotechnical report and receive further County approval prior to the issuance of grading permits, but after Project approval. *Id.* The DEIR claims that the prescribed mitigation measure, and compliance with applicable regulatory requirements, such as the California Building Code, would reduce geologic hazards to less than significance. DEIR at 4.5-13. But the DEIR provides no actual evidence to support this conclusion. The DEIR, and its two supporting geotechnical reports, contain only bare assertions that these geologic hazards will be mitigated.

For example, regarding seismic ground shaking, the future geotechnical report would "determine structural design requirements as prescribed by the most current version of the California Building Code . . . to ensure that structures and infrastructure can withstand ground accelerations expected from known active faults." DEIR at 4.5-18. The DEIR states that the Project would implement these design recommendations to reduce the potential for structural damage and exposure to potential substantial adverse effects, including the risk of loss, injury, or death, but only "to the maximum extent practical." DEIR at 4.5-15. The DEIR asserts that this would reduce potentially significant seismic-related impacts to a less than significant level. Similarly, the 2006 Geotechnical Evaluation states:

> Southern California, in general, is a seismically active region and the proposed improvements are likely to be subjected to significant ground motion during the design life of the project. Remedial grading in conjunction with the design of structures in accordance with prevailing seismic codes is held to be an appropriate mitigation for this condition.

2006 Geotechnical Evaluation at 8. But the document provides no further analysis or evidence to support the conclusion these risks will be mitigated.

In fact, the 2013 Geotechnical Feasibility Study plainly contradicts this conclusion. That later analysis concludes:

> New improvements will need to be designed for seismic forces in accordance with current building codes and regulations. *However, there is still a risk that the proposed residential structure could be damaged as a result of an earthquake*.

Geotechnical Feasibility Study at 9 (emphasis added). The analysis thus makes clear that compliance with applicable building codes, regulations, and ordinances, alone, are not sufficient to reduce seismic ground shaking impacts to less than significant levels. These measures cannot correct for the Project's unwise and uninformed placement of residential buildings in an area of significant seismic hazards.

Regarding risks from fault rupture, the DEIR proposes that residential structures would be located at a distance of greater than approximately 100 feet from the Whittier Fault trace, in order to be consistent with the 50-foot setback requirement of the Alquist Priolo Earthquake Fault Zoning Act. DEIR at 4.15-14. However, as discussed, above, the DEIR admits that the specific location of the fault trace has not even been determined yet. Instead of performing this essential investigation before the County considers the Project, the DEIR would only require the future geotechnical report to later identify the location of the Whittier Fault trace. The Project Applicant would then alter the Project site plan so that proposed residences would be set back from the fault trace. *Id.* But until these hazards are determined, the DEIR has simply failed to undertake the analysis required to support its claim that risks related to surface ruptures are not significant. The County must insist that the Project Applicant prepare the site-specific geotechnical report and locate the fault trace *before* Project approval.

The DEIR also proposes to defer meaningful analysis of ground failure hazards until after Project approval. The DEIR explains that the Project would implement a complex set of design recommendations identified in the future geotechnical report. DEIR at 4.5-15 (Mitigation Measure 4.5-1). Together with compliance with California

Geological Survey Guidelines and applicable building codes, the DEIR claims that the Project would reduce the potential for significant liquefaction and other ground failure hazard impacts "to the maximum extent feasible." *Id.*

The DEIR also defers investigation of the stability of the Project's existing and proposed slopes until completion of the geotechnical report required by Mitigation Measure 4.5-1. DEIR at 4.5-16. That Mitigation Measure requires an engineering analysis to determine any necessary stabilization measures, and requires the developer to remediate the project site pursuant to the County Grading Code. *Id.* The developer must also design foundations and structures to meet Building Code requirements "to ensure the safety of the physical site and structures for future residents." *Id.* The DEIR concludes that potentially significant impacts regarding landslides and slope stability would be reduced to a less than significant level. *Id.*

But until the additional geotechnical report is completed, the DEIR has simply failed to analyze the full range of geologic hazards facing the Project. The DEIR therefore has not provided substantial evidence to support its determination that risks related to fault rupture, seismic ground shaking, ground failure, and landslides are less than significant. The County cannot rely on this "mitigation measure" to reduce significant impacts regarding fault rupture and other geologic hazards to a less than significant level, because the County cannot even be sure of the nature of those hazards until the additional analysis is completed. The County must insist that the Project Applicant prepare the site-specific geotechnical report and locate the fault trace *before* Project approval. *See Sundstrom v. Cnty. of Mendocino*, 202 Cal. App. 3d 296 (1988) (deferral of environmental analysis until after project approval violates CEQA's policy that impacts must be identified before project momentum reduces or eliminates the agency's flexibility to change its course of action). Fully disclosing this type of hazard is not only a core purpose of CEQA, but it is the plainly the responsible approach: the County cannot reasonably approve a project without a complete understanding of the hazards its residents may face.

Moreover, the geotechnical report will provide essential information regarding the risk of geologic hazards on the Project site that could significantly alter the Project site design. Significantly altered to address these unknown geologic hazards, the Project could create a host of new environmental impacts that the County has not yet analyzed.

3. The DEIR Fails to Adequately Analyze the Project's Consistency with the Orange County General Plan and Yorba Linda General Plan Regarding Geologic Hazards.

The Project is inconsistent with the Goals, Objectives, and Policies of the OCGP and YLGP regarding geologic hazards. These plan inconsistencies constitute significant and unavoidable impacts.

OCGP Public Safety Goal 1 is to "Provide for a safe living and working environment consistent with available resources." OCGP Public Safety Objective 1.1 is "To identify natural hazards and determine the relative threat to people and property in Orange County." The Project is inconsistent with both of these requirements. The Project would not create a safe living environment because it would expose people and structures to the risk of loss, injury or death, involving fault rupture, strong seismic ground shaking, seismic-related ground failure, and landslides. The DEIR also acknowledges that an additional geotechnical report must be prepared simply to understand the geologic risks facing residents in the Project area. At the very least, the County has not identified the relevant natural hazards or threats until this report is completed.

The Project is also inconsistent with OCGP Public Safety Goal 2, to "Minimize the effects of natural safety hazards through implementation of appropriate regulations and standards which maximize protection of life and property." The County cannot possibly know how the information from the additional geotechnical report will change the Project or affect the implementation of relevant safety standards. Nor does the DEIR "create and maintain plans and programs which mitigate the effects of natural hazards," as required by OCGP Objective 2.1.

The Project is also inconsistent with the YLGP Safety Element Goal 1, to "Protect the community from hazards associated with geologic instability, seismic hazards." The DEIR does not even identify the full scope of hazards associated with geologic instability and seismic events, much less protect the community from them. YLGP Policy 1.1 is to "[r]equire "review of soil and geologic conditions to determine stability and relate to development decisions, especially in regard to type of use, size of facility, and ease of evacuation of occupants," but the Project Applicant has not undertaken the required investigation.

The County has not performed a complete "review of soil and geologic conditions" until it has completed the additional geotechnical report discussed in part III.A.2. above. The County does not yet know how the information from the geotechnical report will change the Project or affect the implementation of relevant safety

standards. It therefore cannot accurately evaluate decisions regarding the Project's "type of use, size of facility, and ease of evacuation of occupants." Until it completes the geologic analysis that the YLGP requires, the County cannot support the claim that geologic hazards to the Project are less than significant.

B. The DEIR Fails to Accurately Analyze the Project's Wildland Fire Hazards.

The DEIR fails to adequately analyze the Project's significant wildland fire hazards. The DEIR's proposed mitigation measures—particularly its unsubstantiated reliance on an untested emergency evacuation plan—do not reduce these significant impacts to a less than significant level. The DEIR also fails to acknowledge that the Project is inconsistent with the OCGP and YLGP policies regarding fire hazards. These plan inconsistencies constitute significant and unavoidable impacts. *See* CEQA Guidelines, Appendix G.

1. The Project Would Create Significant Wildland Fire Hazards.

The fire hazards caused by and affecting development in the Puente-Chino Hills area cannot be overstated, a fact made abundantly clear by the devastation of the 2008 Freeway Complex Fire. *See* Orange County Fire Authority, Freeway Complex Fire After Action Report (2009) (attached hereto as Exhibit D). The Project site is located in a Very High Fire Hazard Severity Zone and has burned regularly: in addition to the Freeway Complex Fire, it was subject to fires in 1943 and 1980. *Id.* at 15. The Project will increase the size of the area's wildland-urban interface.

Contrary to the DEIR's conclusions, the Project would clearly expose current and future residents and structures in the area to a significant risk of loss, injury or death involving wildland fires. DEIR at 4.7-26. The DEIR nonetheless claims that wildland fire risks will be less than significant. DEIR at 4.7-26 (finding that "compliance with applicable regulatory requirements and implementation of the project features and prescribed mitigation measures would reduce potentially significant impacts in these regards to a less than significant level").

The evidence, however, does not support the DEIR's conclusion. The Project's proposed residences would clearly be threatened by fire. They would be adjacent to and intermixed with wildlands that have burned regularly. Despite the Project's location in an area of severe fire hazards, the Project has been designed so that certain areas of the Project will not benefit from the typical 170-foot fuel modification zone. DEIR at 4.7-33.

In fact, the DEIR implies that the Project, a residential development located in the urban-wildland interface, will actually *reduce* wildland fire risk. The DEIR argues that the existing Project site provides no fuel modification benefits, which exposes the existing single-family residential uses to the west and south of the Project to substantial risks of wildland fires. The DEIR claims that the Project's fuel modification features would substantially reduce the risk of wildland fires to these existing single-family residences. DEIR at 4.7-34; 4.14-70 to -73.

This argument is misleading. Even if the Project reduced the risk of fire to nearby residences, the Project is adding 112 new residences to an area of severe fire risks. All residences, new and old, are potential ignition sources. The DEIR also fails to evaluate the impacts of increased risk of fire originating in the Project to the surrounding environment, specifically the adjacent Chino Hills State Park. Such risk constitutes a potentially significant impact to the park's recreational and biological resources; the EIR must analyze, disclose, and, if necessary, mitigate these additional impacts.

2. The DEIR Does Not Adequately Mitigate the Wildland Fire Hazards.

The DEIR does not ensure that current and future residents of the Project and surrounding developments will be able to safely evacuate the area in the event of a fire emergency. The DEIR claims that in the event of a fire emergency, "the function of the street system would remain and there would be available capacity to accommodate the projected traffic volumes, in addition to emergency service vehicles." DEIR at 4.7-26. As discussed below, however, the DEIR does not demonstrate that the Project will have an effective emergency evacuation plan. The Project's wildland fire hazards therefore remain significant.

The DEIR admits that during the 2008 Freeway Complex Fire, residents experienced gridlock on major streets when they attempted to evacuate the area. DEIR at 4.14-70. The Project, combined with other proposed developments nearby, will only exacerbate this problem. Yet the DEIR does not adequately discuss cumulative impacts associated with emergency evacuation requirements. Rather, the DEIR explains that the County will evaluate all other developments "on a project-by-project basis" to determine consistency with applicable emergency response and evacuation plans. DEIR at 4.7-39 to -40.

The DEIR relies on Yorba Linda's October 2013 evacuation plan to prevent the evacuation gridlock that has occurred during past emergencies. DEIR at 4.14-70. But the DEIR provides no traffic analysis or modeling to support the argument that Yorba Linda's evacuation plan will somehow allow residents of the Project and the surrounding

areas to escape from a fire emergency. Past evidence points to the opposite conclusion. The DEIR even notes that during an evacuation, residents would be diverted by deputies and barricades from some main streets so that law enforcement and firefighting vehicles could use them. *Id.* If this is the case, it would only reduce the road capacity that evacuees could use.

The DEIR also fails to ensure that local and state fire and emergency service providers will be able to access the Project during a wildland fire emergency. The DEIR claims that "the function of the street system would remain and there would be available capacity to accommodate the projected traffic volumes, in addition to emergency service vehicles." DEIR at 4.12-11. But the DEIR provides no traffic analysis or modeling to support that claim. Therefore, the DEIR does not provide substantial evidence supporting its conclusion that the street system would provide available capacity to accommodate traffic volumes during a fire emergency. The Project's fire-related impacts remain significant.

The DEIR's failure to include an effective emergency evacuation plan also threatens the safety of Project and nearby residents in the case of an emergency related to oil production facilities on site. The DEIR simply does not ensure that current and future residents of the Project and surrounding developments will be able to safely evacuate the area in the event of an emergency related to on site oil facilities.

The DEIR admits that new and continued oil drilling operations, including consolidation of oil wells relocated from the rest of the project site and slant drilling of new wells below ground, may occur on the Project site. DEIR at 2-28. But the DEIR concludes that with compliance with applicable regulatory requirements and implementation of certain Project Design Features ("PDFs"), operation of oil facilities would not create a significant hazard to the public or the environment. DEIR at 4.7-23.

The DEIR relies on PDFs 7-2 to 7-7 to support this conclusion. But these PDFs do not remove the risk that Project and nearby residents will need to evacuate the area in the event of an oil-related emergency. PDFs -2 and 7-3 simply require buffer zones between wells and new residences. PDF 7-4 restates the requirements that all new wells must comply with applicable law and regulations. PDF 7-5 prohibits public access to the oil drilling pad, and PDF 7-6 prohibits new service roadways through open space areas. PDF 7-7 requires the Project developer to notify homeowners regarding the previous use of the site as an oilfield and the extent of continued oil production activities in the area.

An oil-related emergency, such as a fire or spill, could still occur, despite implementation of these PDFs. Despite this fact, the DEIR provides no traffic analysis or modeling to support any claim that the street system would provide available capacity to

accommodate traffic volumes during an oil-related emergency. The DEIR therefore provides no substantial evidence to support its claim that operation of oil facilities would not create a significant hazard to the public or the environment and that a less than significant impact would occur with regards to future oil operations.

3. The DEIR Fails to Adequately Analyze the Project's Consistency with the Orange County General Plan and Yorba Linda General Plan Regarding Public Safety and Fire Hazards.

Because the Project would expose current and future residents and structures in the area to a significant risk of loss, injury or death involving wildland fires, the Project is inconsistent with the Goals, Objectives, and Policies of the OCGP and YLGP regarding public safety and fire hazards. These plan inconsistencies constitute significant and unavoidable impacts that the DEIR has failed to recognize.

As described above, the Project's wildland fire hazards remain significant even with the identified mitigation. The Project is therefore inconsistent with OCGP Public Services and Facilities Element - Orange County Fire Authority Goal 1, to "Provide a safe living environment ensuring adequate fire protection facilities and resources to prevent and minimize the loss of life and property from structural and wildland fire damages."

For the same reasons, the Project is inconsistent with YLGP Safety Element Goal 4, to "Protect people and property from brush fire hazards." In the absence of a proven emergency evacuation plan, the Project is also inconsistent with OCGP Public Services and Facilities Element - Orange County Fire Authority Goal 2, to "Minimize the effects of natural safety hazards through implementation of appropriate regulations and standards which maximize protection of life and property," and OCGP Public Services and Facilities Element - Orange County Fire Authority Objective 2.1, "To create and maintain plans and programs which mitigate the effects of public hazards." The EIR must acknowledge that the Project's wildland fire hazards remain significant and grapple with the fact that Project is inconsistent with the OCGP and YLGP. Until it includes this analysis, the EIR's analysis of land use impacts is incomplete and invalid.

C. The DEIR Fails to Accurately Analyze the Project's Water Supply Impacts.

The DEIR fails to accurately analyze the Project's water supply impacts because it does not determine the extent of new water infrastructure facilities required for the Project nor analyze the impacts of those facilities.

1. The DEIR Fails to Ensure That the Project Will Have Sufficient Water Supplies and Wastewater Treatment Facilities.

The DEIR makes unsupported assumptions about the availability of water facilities for the Project. CEQA requires the County to perform a thorough analysis of the Project's planned water supply. The DEIR must determine whether the proposed water source is adequate to meet the Project's needs and whether tapping it will cause adverse environmental impacts. *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova*, 40 Cal. 4th 412, 432 (2007). If a project's proposed water supply is uncertain or unreliable, the DEIR must identify an alternative water source and consider the environmental impacts of using that source. *Id.*

The Yorba Linda Water District ("YLWD") completed the Northeast Area Planning Study in March 2013 to evaluate the capacity of existing distribution system facilities and describe new infrastructure required to provide water services to the Project. The Planning Study identified improvements that will be necessary to meet the anticipated water service and infrastructure demands within the YLWD's northeast area, including both the Cielo Vista and Esperanza Hills developments. DEIR at 4.15-17 to -18. Among these needed improvements, the Planning Study identified new pump stations, a pressure reducing station, pipeline upgrades, an increase in the capacity of existing pump stations, and other potential improvements. DEIR at 4.15-18.

But the DEIR fails to ensure construction of the necessary water facilities for the Project. The DEIR concludes that "final planning, buildout, and timing" of Cielo Vista and Esperanza Hills "cannot be accurately ascertained at this time." DEIR at 4.15-18. So the DEIR simply proposes a mitigation measure that would require the Project Applicant to work with the Yorba Linda Water District to ensure an adequate water supply for the area's future residents and for fire safety purposes. *Id.* (Mitigation Measure 4.15-1). This mitigation measure is simply too vague to ensure that existing and proposed infrastructure will accommodate the Project's estimated water demand, wastewater generation, and solid waste generation. The DEIR's analysis of the Project's water supplies is therefore inadequate. In fact, during the Freeway Complex Fire, YLWD facilities did not provide adequate firefighting water flow to effectively combat the spreading blaze. Freeway Complex Fire After Action Report, Exh. D, at 64-65. Until the County provides a detailed description of the water facilities that will serve the Project, neither the County nor the public can evaluate whether this infrastructure will be sufficient during a fire emergency. The DEIR therefore lacks the substantial evidence necessary to supports its claim that there will be an adequate water supply for the area's residents and for fire safety purposes.

2. The DEIR Fails to Adequately Analyze the Impacts of New Water Infrastructure That Must Be Built to Serve the Project.

The DEIR also fails to adequately describe or mitigate the impacts of new water infrastructure that must be built to serve the Project. Under CEQA, the "ultimate question" is whether an EIR adequately addresses the reasonably foreseeable impacts of supplying water to the project. *Vineyard Area Citizens*, 40 Cal. 4th at 434. The EIR must give decision makers sufficient facts to evaluate the pros and cons of supplying the amount of water that the Project will need. *Id.* at 430–31. This must include a description of the environmental impacts of necessary water facilities. *Id.* at 432.

The DEIR includes no analysis of the potential environmental impacts of the improvements necessary to meet the Project's anticipated water service and infrastructure demands This is impermissible. Construction and operation of the improvements necessary to meet the Project's anticipated water service and infrastructure demands would cause potentially significant environmental impacts. The DEIR must address the impacts of likely future water facilities. Unless and until it does so, it will remain incomplete and invalid. *See id.*

D. The DEIR Fails to Adequately Analyze the Project's Traffic and Transportation Impacts.

The DEIR fails to adequately analyze the Project's traffic and transportation impacts because it does not include the required analysis of transportation system management and demand management for the Project, and because it interferes with implementation of the Orange County Transportation Authority Commuter Bikeways Strategic Plan (2009) ("Bikeways Strategic Plan"). The DEIR also fails to acknowledge that the Project is inconsistent with the policies of the Orange County General Plan, Yorba Linda General Plan, and Bikeways Strategic Plan regarding transportation management and alternative transportation. These plan inconsistencies constitute significant and unavoidable impacts.

1. The DEIR Interferes With Implementation of the Bikeways Strategic Plan.

The DEIR mentions the Bikeways Strategic Plan, but at the same time prevents implementation of that plan. The Bikeways Strategic Plan includes an "Action Plan" that identifies the tasks that the Orange County Transportation Authority ("OCTA") will undertake to ensure the implementation of the Bikeways Strategic Plan." OCTA Bikeways Plan at 15. These tasks include:

- Promote that local jurisdictions to emphasize [sic] their consideration of bicyclists within environmental and planning documents;

- Facilitate bikeway planning coordination efforts between jurisdictions and other involved entities;

- Ensure that the needs for bicyclists and bikeways are considered in the development of projects and programs within OCTA; and

- Review development plans and environmental documents and provide comments, 1) to ensure that developers and local jurisdictions are complying with the [Plan]], and 2) to encourage these entities to add local supplemental routes that may not be on the regional bikeways plan, but would enhance the overall connectivity of the bikeway system.

The DEIR does nothing to facilitate these tasks. The Project does not include the addition of supplemental cycling routes to serve the Project or enhance the overall connectivity of the bikeway system. There is no evidence in the record to suggest that the County has encouraged the Project developers to do so. The DEIR even notes that no bicycling facilities are currently located or proposed adjacent to the Project site, but fails to encourage their incorporation into the Project. DEIR at 4.14-16. By failing to even discuss these elements of the Bikeways Strategic Plan, the DEIR gives OCTA nothing to work with as it seeks to represent the needs of cyclists and bikeways as part of the Project. Without more information about opportunities for cycling infrastructure and demand for such alternative transportation, the OCTA cannot fulfill its task of ensuring that the needs of bicyclists and bikeways are considered in the development of projects.

The County is required to ensure that OCTA can undertake the tasks included in the Action Plan discussed above. OCGP Transportation Element Policy 2.4 requires the County to "[a]pply conditions to development projects to ensure compliance with OCTA's transit goals and policies." Unless the County does more to assist the OCTA to implement the Bikeways Strategic Plan, the Project will be inconsistent with this policy.

2. The DEIR Fails to Adequately Analyze the Project's Consistency with the Orange County General Plan and Yorba Linda General Plan Regarding Traffic and Transportation.

The DEIR fails to provide the required analysis of transportation system management and demand management for the Project. OCGP Transportation Element Objective 6.7 requires developers of more than 100 dwelling units to submit a Transportation System Management/Transportation Demand Management plan that

"includes strategies, implementation programs and an annual monitoring mechanism to ensure a reduction of single occupant automobile travel associated with development." DEIR at 4.14-76.

The Yorba Linda General Plan also requires analysis of transportation system management and demand management for the Project. YLGP Circulation Element Goal 3 is to "Maximize the efficiency of the City's circulation system through the use of transportation system management and demand management strategies." YLGP Circulation Element Policy 3.7 requires "that new developments provide Transportation Demand Management Plans, with mitigation monitoring and enforcement plans, as part of required Traffic Studies, and as a standard requirement for development processing." The DEIR does not provide this analysis, and without it, the Project is inconsistent with these YLGP requirements.

E. The DEIR Fails to Accurately Analyze the Project's Noise Impacts.

The DEIR fails to accurately analyze the Project's noise impacts because it employs an impermissible standard of significance that conceals significant noise impacts. The DEIR acknowledges that there are three appropriate standards by which to judge the significance of noise impacts from the Project:

- Would the project result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

- Would the project result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?

- Would the project result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?

DEIR at 4.10-14. Appendix G of the CEQA Guidelines echoes these standards. But the DEIR later states repeatedly that the Project would result in a significant noise impact only if the noise level exceeds the 65 dBA CNEL limit in the Orange County Noise Ordinance *and* the Project generates a noise level increase of greater than 3.0 dBA. DEIR at 4.10-18. This actually represents a combination of the multiple separate thresholds of significance that conceals significant noise impacts.

Many of the Project's noise impacts would clearly exceed one of the three relevant significance thresholds. For example, the Project would increase the off-site traffic noise levels by 3.5 dBA CNEL on the segment of Via Del Agua south of "A" Street. DEIR at

4.10-18. And Project-related traffic noise impacts would exceed the Orange County Noise Ordinance's 65 dBA CNEL limit in numerous places. *See* DEIR at Table 4.10-6 and 4.10-7.

But by evaluating noise impacts using a combination of these separate thresholds of significance, the DEIR concludes that these impacts are not significant. According to the DEIR, the 3.5 dBA noise increase on Via Del Agua south of "A" Street is not significant because the ultimate noise level will not exceed 65 dBA. DEIR at 4.10-19. And noise levels that exceed 65dBA are not significant because they do not involve increases of 3.0 dBA. *See, e.g.*, DEIR at 4.10-19 ("since the noise levels would not be increased by greater than 3.0 dBA, off-site traffic noise impacts under Opening Year (2015) traffic conditions would be less than significant").

The amalgamated significance threshold paints a misleading picture of noise impacts. As shown above, many of the Project's noise impacts would be significant under the separate thresholds provided in Appendix G and articulated in the DEIR itself. This combined standard appears to have been invented solely to ensure that these impacts appear to be less than significant. Notably, the Esperanza Hills DEIR, also prepared by the County, uses separate thresholds as Appendix G intends. *See* Esperanza Hills DEIR at 5-470. It determines that certain noise impacts are significant solely because they result in an increase greater than 3.0 dBA CNEL. *Id.* at 5-482. The present Project's impacts would be significant, and would require mitigation, under the Esperanza Hills standards. The Cielo Vista DEIR has no explanation for the difference between the two documents' treatment of noise impacts. It is apparent that the DEIR's noise impact thresholds are not supported, or supportable, by substantial evidence. The Supreme Court recently emphasized that, although agencies have some discretion in choosing how to measure the significance of a project's impacts, they must select an approach "that will give the public and decision makers the most accurate picture practically possible of the project's likely impacts." *Neighbors for Smart Rail v. Exposition Metro Line*, 57 Cal. 4th 439, 449 (2013). An agency may not use compliance with a threshold as a shield to foreclose consideration of substantial evidence of an impact's significance. *See Protect the Historic Amador Waterways v. Amador Water Agency*, 116 Cal. App. 4th 1099, 1109 (2004); *see also Mejia v. City of Los Angeles*, 130 Cal. App. 4th 322, 342 (2005). The County must use the thresholds of significance contained in the Esperanza Hills DEIR to evaluate Cielo Vista's noise impacts.

F. The DEIR Fails to Accurately Analyze the Project's Consistency with the Orange County General Plan and the Yorba Linda General Plan.

The Project is inconsistent with applicable City of Yorba Linda General Plan land use designation for the site. As discussed above, the Project is also inconsistent with

applicable OCGP and YLGP goals, objectives, and policies regarding geologic hazards, public safety, fire hazards, and traffic and transportation.

Contrary to the claims made in the DEIR, and despite implementation of the prescribed mitigation measures, the Project would result in significant physical impacts on the environment. Therefore, significant impacts would occur due to inconsistencies with applicable land use plans and policies.

1. The DEIR Violates CEQA Because the Project is Inconsistent with the Orange County General Plan and the Yorba Linda General Plan and Would Result in Significant Physical Impacts on the Environment.

The DEIR explains that the Project would have a significant impact if it would conflict with applicable land use plans, policies, or regulations of an agency with jurisdiction over the project . . . adopted for the purpose of avoiding or mitigating an environmental effect." DEIR at 4.9-7. As discussed above, the Project is inconsistent with applicable OCGP and YLGP goals, objectives, and policies regarding geologic hazards, public safety, fire hazards, and traffic and transportation. The impacts in these substantive categories remain significant despite the DEIR's proposed mitigation measures.

The DEIR evaluates the Project's consistency with the YLGP because the Project may be annexed by the City of Yorba Linda. DEIR at 4.9-16. The annexation process would require the City to make certain discretionary approvals, including changes to the City's zoning designation for the Project area. The County's EIR would serve as the foundation for the City's required analysis of environmental project impacts resulting from such changes. *Id.* Even without the potential annexation, the Project is within the City's Sphere of Influence. The YLGP is thus an applicable land use plan, and the EIR must evaluate the Project's consistency with the plan.

The Project's proposed density is greater than the maximum density allowed for the Project site under Policies 1.2 and 7.4 of the Yorba Linda General Plan Land Use Element. The YLGP Land Use Element designation for the project site is Low Density residential with a range of 0-1.0 dwelling unit per acre. DEIR at 4.9-4. Including both Planning Areas, the Project's residential land uses would occur at a density of 1.3 dwelling units per acre. The gross density of the Project exceeds the City's permissible density range.

Because the Project conflicts with applicable land use plans and policies adopted for the purpose of avoiding or mitigating an environmental effect, the Project's

inconsistency with the General Plans is itself a significant and unavoidable impact. *See* Pub. Resources Code § 21100(b)(2)(A); CEQA Guidelines § 15126(b) (describing consequences of significant and unavoidable impacts). No amount of mitigation can change the fact that the Project is inconsistent with the Orange County and Yorba Linda General Plans. As discussed below, this inconsistency means that the Project also violates state planning and zoning law.

2. The Project Violates State Planning and Zoning Law Because it is Inconsistent with the Orange County General Plan.

The California Supreme Court has described the General Plan as "the constitution for all future developments within the city or county." *Citizens of Goleta Valley v. Board of Supervisors*, 52 Cal. 3d 553, 570–71 (1990). To effectively guide development, state law requires that general plans must "comprise an integrated, internally consistent and compatible statement of policies . . . ." Gov. Code § 65300.5. It also mandates that all subordinate land use decisions, including specific plans, must be consistent with the general plan. This requirement is known as the "consistency doctrine." *FUTURE v. El Dorado County*, 62 Cal. App. 4th 1332, 1336 (1998). It has been described as "the linchpin of California's land use and development laws" and "the principle which infuses[s] the concept of planned growth with the force of law." *Napa Citizens for Honest Government v. Napa County*, 91 Cal. App. 4th 342, 355 (2001); *Garat v. City of Riverside*, 2 Cal. App. 4th 259, 285 (1991) (disapproved on other grounds by *Morehart v. County of Santa Barbara*, 7 Cal. 4th 725, 743 fn. 11 (1994)) (general plan must be internally consistent).

A project cannot be found consistent with a general plan if it conflicts with a plan policy that is fundamental, mandatory, and clear, regardless of whether the project is consistent with other general plan policies. *FUTURE*, 62 Cal. App. 4th at 1341–42. Even in the absence of a direct conflict, a local agency may not approve a development project if it frustrates the general plan's policies and objectives. *Napa Citizens*, 91 Cal. App. 4th at 378–79. Amendments to the General Plan must maintain its internal consistency. Gov't. Code § 65300.5.

The Project violates these state law requirements because it conflicts with and frustrates clear policies within the Orange County General Plan regarding public safety, fire hazards, geologic hazards, and transportation.

The Project conflicts with clear, fundamental general plan directives regarding public safety. Section III.A. of this letter discuss these inconsistencies in detail. OCGP Public Safety Goal 1 is to "Provide for a safe living and working environment consistent with available resources." OCGP Public Safety Objective 1.1 is "To identify natural

hazards and determine the relative threat to people and property in Orange County." The Project is also inconsistent with OCGP Public Safety Goal 2, to "Minimize the effects of natural safety hazards through implementation of appropriate regulations and standards which maximize protection of life and property." These core principles of the County's General Plan articulate the County's fundamental duty to promote the safety of its residents during the land use planning process.

The Project is also inconsistent with important OCGP goals and objectives regarding public safety and fire hazards. Section III.B. of this letter discuss these inconsistencies in detail. OCGP Public Services and Facilities Element - Orange County Fire Authority Goal 1 requires the County to ensure adequate fire protection facilities to prevent and minimize the loss of life and property from structural and wildland fire damages. OCGP Public Services and Facilities Element - Orange County Fire Authority Goal 2 and Objective 2.1 require the County to minimize natural safety hazards and mitigate the effects of those hazards. These are clear, basic directives to protect the public from natural hazards, including fires.

Finally, the Project is also inconsistent with OCGP objectives regarding transportation system management and demand management. Section III.D. of this letter discuss these inconsistencies in detail. OCGP Transportation Element Objective 6.7 requires the Project Applicant to analyze transportation system management and demand management for the Project. This requirement is unambiguous and clearly applicable to the Project. It also represents an essential component of land use planning in a County that suffers from some of the worst traffic congestion in the country. But the DEIR simply fails to provide this analysis.

IV. The DEIR's Analysis of Project Alternatives is Inadequate.

The DEIR does not comply with the requirements of CEQA because it fails to undertake a legally sufficient study of alternatives to the Project. CEQA provides that "public agencies should not approve projects as proposed if there are feasible alternatives . . . which would substantially lessen the significant environmental effects of such projects." Pub. Resources Code § 21002. As such, a major function of the EIR "is to ensure that all reasonable alternatives to proposed projects are thoroughly assessed by the responsible official." To fulfill this function, an EIR must consider a "reasonable range" of alternatives "that will foster informed decision making and public participation." CEQA Guidelines § 15126.6(a). "An EIR which does not produce adequate information regarding alternatives cannot achieve the dual purpose served by the EIR . . . ." *Kings County Farm Bureau v. City of Hanford*, 221 Cal. App. 3d 692, 733 (1990).

As discussed above, the DEIR fails to adequately analyze the Project's environmental impacts. Had the County performed an adequate analysis, there is no doubt that the document would have determined that the Project would result in numerous significant environmental impacts, including impacts related to geologic hazards, public safety and fire hazards, traffic and transportation, and land use incompatibility. In light of the Project's extensive significant impacts, it is incumbent on the County to carefully consider a range of feasible alternatives to the Project. The DEIR fails to do so. In fact, it analyzes only two meaningful alternatives—a Planning Area 1 Only Alternative and a Large Lot/Reduced Grading Alternative—in addition to the No Project Alternative.

The Contested Easement Alternative is not a meaningful alternative because it is virtually identical to the proposed Project. The only differences between this Alternative and the Project would be the addition of a narrow access easement in Planning Area 1 and a slight change to the lot configurations in Planning Area 1. DEIR at 5-29. All other aspects of this Alternative would be the same as the Project. *Id.* The DEIR admits that all of the impacts of the Contested Easement Alternative would be the same as those of the Project, or closely similar. DEIR at 5-29 to -37. Therefore, it would not reduce or avoid any of the Project's significant impacts and is not an effective alternative. *See, e.g.*, *Watsonville Pilots Ass'n v. City of Watsonville*, 183 Cal. App. 4th 1059, 1089–90 (2010) (EIR was deficient for failing to include alternative that would avoid or lessen the project's primary growth-related significant impacts); *see also Citizens of Goleta Valley v. Bd. of Supervisors*, 52 Cal. 3d 553, 566 (1990) ("[A]n EIR for any project subject to CEQA review must consider a reasonable range of alternatives to the project . . . [that] offer substantial environmental advantages over the project proposal.").

To ensure that the public and decisionmakers have adequate information to consider the effects of the proposed Project, the County must prepare and recirculate a revised EIR that considers additional meaningful alternatives to the Project.

1. The DEIR's Failure to Adequately Describe the Project and Analyze Project Impacts Results in an Inadequate Range of Alternatives.

As a preliminary matter, the DEIR's failure to disclose the severity of the Project's wide-ranging impacts or to accurately describe the Project necessarily distorts the document's analysis of Project alternatives. As a result, the alternatives are evaluated against an inaccurate representation of the Project's impacts. The County may have identified additional or different alternatives if the Project impacts had been fully disclosed and Project setting had been accurately described.

The DEIR fails to adequately evaluate the severity and extent of impacts related to geologic hazards, public safety, noise, fire hazards, traffic and transportation, and land use incompatibility at the Project site. The DEIR's conclusions that the Project's impacts on these resources would be less than significant are erroneous. Proper analysis would have revealed that far more impacts were significant and unavoidable. The DEIR also fails to describe three of the most critical components of the proposed Project, including the adjacent Esperanza Hills development. An accurate accounting of the Project's impacts could significantly alter the substance and conclusions of the DEIR's alternatives analysis.

For example, a more accurate representation of the Project's impacts could change the DEIR's conclusion that the Large Lot/Reduced Grading Alternative is the environmentally superior alternative. Further geotechnical analyses could determine that construction in Planning Area 2 will lead to significant and unavoidable geologic hazards. The EIR could then determine, in light of these impacts, that the a Planning Area 1 Only Alternative, rather than the Large Lot/Reduced Grading Alternative, is actually environmentally superior. This revision could be necessary if additional analysis shows that Planning Area 2 will suffer from greater impacts related to fire hazards or obstacles to emergency evacuation.

The DEIR's failure to adequately describe the Project and its impacts also necessitates consideration of additional alternatives. Accounting for the various aspects of the Project left out of the EIR's consideration, a reasonable range of alternatives plainly includes an alternative that does not allow new oil drilling or one that does not provide access to the Esperanza Hills site. The EIR must be revised to analyze such alternatives.

Moreover, without sufficient analysis of the underlying environmental impacts of the entire Project, the EIR's comparison of this Project to the identified alternatives is utterly meaningless and fails CEQA's requirements. If, for example, the DEIR concluded that the Project resulted in significant wildland fire hazards, as it should have, the DEIR would be required to evaluate additional alternatives that did not pose these risks. These additional alternatives would necessarily be off-site locations away from the urban-wildland interface.

2. The DEIR's Narrow Project Objectives Prevent Consideration of Reasonable Alternatives.

The first step in conducting an alternatives analysis under CEQA is to define the project's objectives. This step is crucial because project objectives "will help the Lead Agency develop a reasonable range of alternatives to evaluate in the EIR." CEQA

Guidelines § 15124(b). Here, the County has identified eleven Project objectives. DEIR at 5-3.

The County may not define the Project's objectives so narrowly as to preclude a reasonable alternatives analysis. *Watsonville Pilots Ass'n*, 183 Cal. App. 4th at 1089. The "key to the selection of the range of alternatives is to identify alternatives that meet most of the project's objectives but have a reduced level of environmental impacts," rather than to identity alternatives that meet few of the project's objectives so that they can be "readily eliminated." *Id.*

The Project objectives listed in the DEIR violate this core CEQA principle. The DEIR states that one of the Project's objectives is to "[p]rovide a single family residential project with a sufficient number of units allowing for necessary infrastructure and open space in separate but related planning areas so that the property cannot be further subdivided." DEIR at 5-3. Another objective is to "[c]reate two planning areas that are responsive to the site's topography and that are consistent with adjacent single family neighborhoods." *Id.* Still another objective is to "[p]rovide for 36 acres of contiguous open space which can be offered for dedication to a public agency or to be maintained as private open space." *Id.* These objectives echo the design of the proposed Project so closely that the objectives of the Project are essentially *the Project itself*. CEQA forbids the use of this sort of circular logic to justify a project. *Watsonville Pilots Ass'n.*, 183 Cal. App. 4th at 1089.

Additionally, the Project objectives specify criteria that are essentially unique to the Project site. In this way, the DEIR ensures that only a limited range of alternatives could possibly satisfy all Project objectives. The DEIR's pursuit of these objectives is impermissible because it foreordains approval of the Project, or possibly the Planning Area 1 Only Alternative. This is because the Large Lot/Reduced Grading Alternative would fail to meet two of the Project's basic objectives and would only partially fulfill two others. DEIR at 5-28.

This one alternative alone does not constitute the "reasonable range" of alternatives that CEQA requires. By designing its objectives to make selection of the Project's site a foregone conclusion, the DEIR fails to proceed according to law.

3. The DEIR's Range of Alternatives is Not Reasonable Because None of the Alternatives Would Actually Reduce the Project's Impacts Overall.

The alternatives analyzed in the DEIR represent a false choice, because none reduces a majority of the Project's significant environmental impacts. In addition to the

No Project alternative, the DEIR offers only two meaningful alternatives: the Planning Area 1 Only Alternative and the Large Lot/Reduced Grading Alternative.

The DEIR itself concedes that both the Planning Area 1 Only Alternative and the Large Lot/Reduced Grading Alternative would have environmental impacts similar to, or even greater than, those of the Project. The Planning Area 1 Only Alternative would actually result in *greater* impacts than the Project in several areas, including air quality, geologic hazards, greenhouse gas emission, fire hazards, water quality, plan consistency, public services, traffic, and utilities. Many other environmental impacts would be the same under the Project and the Planning Area 1 Only Alternative.

The Large Lot/Reduced Grading Alternative might potentially reduce some impacts relative to the Project due to a decreased number of dwelling units. But the Large Lot/Reduced Grading Alternative would result in *greater* impacts than the Project in several areas, including aesthetics, biological resources, land use and planning, and wildland fire hazards. This Alternative would also result in less dedicated public open space on the Project site. In fact, paradoxically, the Large Lot/Reduced Grading Alternative would actually result in more extensive grading than the Project. DEIR at 5-23. The Large Lot/Reduced Grading Alternative would result in impacts that are similar to the Project's air quality, hazards and hazardous materials, hydrology, noise, and traffic impacts.

The DEIR thus requires County decisionmakers to choose between alternatives that, according to the DEIR, largely share the Project's environmental impacts. The County claims that the Large Lot/Reduced Grading Alternative is environmentally superior, but this option still yields similar or greater impacts in many impact issue areas. DEIR at 5-37 to -38. CEQA requires that "the discussion of alternatives shall focus on alternatives to the project or its location which are capable of avoiding or substantially lessening any significant effects of the project . . . ." CEQA Guidelines § 15126.6(b). None of the DEIR's alternatives meet this requirement.

Given the truly extensive impacts that this Project would have on the environment, the DEIR must include a rigorous, honest assessment of additional, less impactful, alternatives. Without this opportunity, the DEIR asks the public to accept on "blind trust" that the proposed Project is the best alternative. This approach is unlawful "in light of CEQA's fundamental goal that the public be fully informed as to the consequences of action by their public officials." *Laurel Heights*, 47 Cal. 3d at 494. Other feasible alternatives are discussed below.

4. Other Feasible Alternatives are Available and Must be Included in a Reasonable Range.

The DEIR's analysis of alternatives is inadequate, and necessitates development of additional alternatives for the Project. As discussed above, these alternatives must actually reduce or eliminate the bulk of the Project's significant environmental impacts. For instance, the DEIR should identify and evaluate an off-site alternative, as well as alternatives that reduce a majority of the Project's significant impacts.

The Notice of Preparation explicitly identified an "Alternative Location" as one of the alternatives to the Project, NOP at 13, but the DEIR does not include this alternative. The DEIR's reasons for determining that an alternative location is not a feasible alternative are unconvincing. The CEQA Guidelines advise that "only locations that would avoid or substantially lessen any of the significant effects of the project need be considered for inclusion in the EIR." CEQA Guidelines §15126.6(f)(2)(A). The DEIR contends that:

> "Selection of another parcel in the general vicinity of the project site would likely result in similar or greater impacts than the Project . . . . [b]ecause it is likely that another site would not substantially reduce significant environmental effects, this alternative was rejected from further consideration."

The EIR, however, is perfectly willing to consider other alternatives that do not substantially reduce significant environmental effects—the Planning Area 1 Only Alternative and the Large Lot/Reduced Grading Alternative. The EIR's dismissal of the concept of an alternative site effectively dismisses these alternatives as well, reducing its range well beyond the point of reasonableness.

Furthermore, the DEIR's basis for its dismissal is based on a faulty premise: contrary to the DEIR's implication, it need not limit its consideration to alternative locations "in the general vicinity of the project site." In fact, the County should not restrict its identification and evaluation of alternative sites to Orange County itself; it must assess alternative locations across the state. The revised alternatives analysis must also evaluate various other options for meeting housing demands, looking beyond the large-lot subdivision model presented by the Project. Infill sites and other non-sprawling solutions must be considered as alternatives.

The DEIR also justifies its failure to consider alternative locations because "the Project proponent does not own any other properties in the nearby local vicinity." The CEQA Guidelines do not support this reasoning. CEQA Guidelines section 15126.6

(f)(1) lists many factors that may be considered when addressing the feasibility of alternatives, including "whether the proponent can reasonably acquire, control or otherwise have access to the alternative site (or the site is already owned by the proponent)." The DEIR does not discuss whether or not the Project Applicant can reasonably acquire an alternative site, leaving its dismissal without the support of substantial evidence. And importantly, "[n]o one of these factors establishes a fixed limit on the scope of reasonable alternatives." *Id.* The Project Applicant's property portfolio, alone, cannot justify the DEIR's failure to consider alternative locations for the Project.

V. The DEIR Fails to Accurately Analyze the Project's Growth-Inducing Impacts.

CEQA requires an EIR to include a "detailed statement" setting forth the growth-inducing impacts of a proposed project. Pub. Res. Code § 21100(b)(5); *City of Antioch v. City Council of Pittsburg*, 187 Cal. App. 3d 1325, 1337 (1986). The statement must "[d]iscuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment." CEQA Guidelines § 15126.2(d). It must also discuss how projects "may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively." *Id.* The DEIR here does not meet these requirements in analyzing the impacts of the Project.

To the extent that the Bridal Hills and Yorba Linda Land parcels are not already planned for development and the County does not consider them part of the Project, the Project will induce growth on these parcels. Access to these parcels will be provided through Cielo Vista and Esperanza Hills. Development of these two parcels will undoubtedly utilize infrastructure improvements, such as water treatment and delivery facilities, that are planned to accommodate Cielo Vista and Esperanza Hills. The DEIR completely fails to analyze the extent or environmental impacts of such growth-inducing impacts.

At a minimum, the DEIR must analyze the additional population growth, new residential units, and other development that the Project would facilitate on the Bridal Hills and Yorba Linda Land parcels, as well as any other nearby development areas. The DEIR should identify the location and intensity of any such new development, and the environmental impacts resulting from that development.

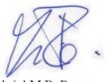
VI. Conclusion.

The DEIR for the Project fails to satisfy CEQA's requirements, and the Project violates state Planning and Zoning law. For these reasons, the County must not consider

the Cielo Vista Project further. The County must substantially revise the DEIR and incorporate the Esperanza Hills development, along with the other omitted aspects of the Project, into the Project and its environmental analysis. The County must then recirculate the DEIR for public review.

Very truly yours,

SHUTE, MIHALY & WEINBERGER LLP



Gabriel M.B. Ross

cc: Claire Schlotterbeck, Hills For Everyone
Todd Spitzer, Orange County Board of Supervisors
Steve Harris, Community Development Director, City of Yorba Linda

List of Exhibits:

Exhibit A: Esperanza Hills Draft Environmental Impact Report (December 2013)

Exhibit B: Yorba Linda Water District, Comments Regarding the Notice of Preparation (NOP) of EIR for Proposed Cielo Vista Project (Project No. PA100004), August 2, 2012

Exhibit C: Orange County LAFCO, Response to NOP for Cielo Vista Project, August 1, 2012

Exhibit D: Orange County Fire Authority, Freeway Complex Fire After Action Report (2009)

553228.5

EXHIBIT C

Yorba Linda Water District

Reliable and Trusted Service for More Than 100 Years

August 2, 2012

Ms. Channary Leng
OC Public Works/OC Planning
300 N. Flower Street
Santa Ana, CA 92702-4048

Subject: Comments regarding the Notice of Preparation (NOP) of EIR
For Proposed Cielo Vista Project (Project No. PA100004)

This is in response to the NOP for the subject project, dated July 5, 2012. Yorba Linda Water District (District) is the water service provider and sewer collection service provider for the proposed project area. On February 10, 2010 and June 6, 2012, the District provided Conditional Will-Serve Letters for water and sewer services, respectively, for the subject project. In those letters the following conditions were noted:

This letter is issued at the request of the developer for the entitlement process. Accordingly, this Conditional Will-Serve Letter is not a contractual offer or commitment to provide service, but a representation that the proposed development area is in, or may be annexed to the Yorba Linda Water District. The applicant must satisfy certain conditions specified by the District and agreed to by the applicant before service will be available to supply the project. Any future, binding commitment by the District to service this project will be subject to the availability of water and sewer facilities and the planning, design, and construction of adequate facilities to meet the demands of the project in accordance with (1) the terms and conditions of a Pre-annexation Agreement to be executed by the applicant and the District; and (2) the terms and conditions of an Application to an Agreement with the Yorba Linda Water District for Water and Sewer Service executed by the applicant and the District; both in accordance with the District's policies existing at the time such agreements are executed.

In addition to the conditions noted above, District staff has had recent meetings with representatives for the proposed Cielo Vista Project. Meetings have also taken place with representatives for another proposed single-family residential project referred to as the Yorba Linda Estates Project. This latter project would be located northeasterly of the Cielo Vista Project. These two proposed projects would develop the last major undeveloped parcels in the District's service area. The representatives for each of the two projects were advised that water and sewer services and facilities for the two projects must be planned and designed in concert to serve the combined area. That is, separate or piece-meal development of water and sewer services is not acceptable.

1717 E. Miraloma Avenue Placentia, CA 92870 714-701-3100 714-701-3108 Fax

Yorba Linda Water District

In this regard, they were advised that the District is proceeding with a project called the Northeast Area Water Service Planning Study. The study will be based on hydraulic modeling to determine the various alternative means to service the potential new residential developments as well as to meet the ultimate needs and goals of the District for this portion of the water service area. A critical element to be factored into the study will be the fire flow requirements, which we understand will be established in the near future by the Orange County Fire Authority. The planning study is expected to begin in August 2012, and may be completed by January 2013.

In Section 6 of the Cielo Vista Project Description Summary, Utilities and Infrastructure, Potable Water, it states that "Points of connection for water utilities that would serve the project exist in Aspen Way and Via del Agua." This is an assumption that has not been validated. Connection at these points assumes that water can be made available from the existing water facilities and infrastructure near the proposed project. This is yet to be determined; additional water facilities are likely necessary, the cost of which will be proportionately borne by the proposed project.

Concerning sewer services for the projects, the representatives for the two projects were advised that the District will require gravity-sewer service from all areas of the Yorba Linda Estates Project, with such service extending southerly and westerly downward to and through the Cielo Vista Project to connect to existing District sewers. Engineering studies by the project developers will be required to confirm the size of the sewer lines throughout the projects, and to confirm that the existing downstream sewers have adequate existing capacity for the additional flow.

Should you have any questions regarding this letter, please feel free to contact me at (714) 701-3102, or via email at sconklin@ylwd.com.

Sincerely,

Steve Conklin, P.E.
Engineering Manager

Copy: Andrew Keyworth, OCFA

EXHIBIT D

OC LAFCO partnering for innovative government Est. 1963

CHAIR
CHARLEY WILSON
Director
Santa Margarita Water District

VICE CHAIR
SUSAN WILSON
Representative of General Public

PAT BATES
Supervisor
5th District

JOE CARCHIO
Councilmember
City of Huntington Beach

PETER HERZOG
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2nd District

JOHN WITHERS
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ALTERNATE
BILL CAMPBELL
Supervisor
3rd District

ALTERNATE
JAMES FISLER
Director
Mesa Consolidated Water District

ALTERNATE
DEREK J. MCGREGOR
Representative of General Public

ALTERNATE
BOB RING
Councilmember
City of Laguna Woods

JOYCE CROSTHWAITE
Executive Officer

LOCAL AGENCY FORMATION COMMISSION
ORANGE COUNTY

August 1, 2012

Ms. Channary Leng
OC Public Works/OC Planning
300 N. Flower Street
Santa Ana, CA 92702-4048

SUBJECT: Notice of Preparation of an Environmental Impact Report

Dear Ms. Leng,

The Orange County Local Agency Formation Commission (LAFCO) has reviewed the County's Notice of Preparation of an Environmental Impact Report for the Cielo Vista project. The project raises several concerns and as a responsible agency, we appreciate this opportunity to comment on the project as described in the Notice of Preparation.

LAFCO's interest in the Cielo Vista project as it relates to CEQA is as follows:

1. LAFCO is a responsible agency under CEQA for the future annexation of the Cielo Vista project to the City of Yorba Linda.
2. The project raises a number of substantive issues that have significant implications to LAFCO, the City of Yorba Linda, and the County of Orange.

In summary, the proposed development of the Cielo Vista project in unincorporated Orange County without a definitive plan and process in place for annexation to the City of Yorba Linda raises issues about:

- Consistency with existing County policies for spheres of influence (SOI) and the creation of developed, inhabited unincorporated islands.
- The long-term delivery of reliable and efficient public services to future residents.
- The impacts to the City and its residents resulting from County service providers travelling through the City and adjacent residential neighborhoods to serve the Cielo Vista project.

12 Civic Center Plaza, Room 235, Santa Ana, CA 92701
(714) 834-2556 • FAX (714) 834-2643
http://www.oclafco.org

LAFCO AS RESPONSIBLE AGENCY
The Orange County Local Agency Formation Commission (LAFCO) is governed by the Cortese-Knox-Hertzberg Local Government Reorganization Act of 2000 ("Act," Govt. Code Section 56000 *et seq.*). Under the Act, LAFCO is required to make determinations regarding a proposal for changes of organization or reorganization (Govt. Code Section 56880). The Act also established the factors which LAFCO must consider in making its determinations, including any policies adopted by LAFCO to create planned, orderly and efficient patterns of development (Govt. Code Section 56668). Because of this role and pursuant to Section 21069 of the Public Resources Code, LAFCO is a responsible agency for the future annexation of the Cielo Vista project (also known as the Sage Property) to the City of Yorba Linda. Additionally and pursuant to Section 15086 of the California Environmental Quality Act (CEQA) Guidelines, LAFCO is responsible for reviewing and providing comments on this Notice of Preparation (NOP) and the subsequent Environmental Impact Report (EIR).

LAFCO has reviewed the NOP and provide the comments contained within this letter as the County begins preparation of the EIR.

LAFCO COMMENTS
The EIR should address the impacts and any necessary mitigation, including but not limited to the annexation process. In particular, the EIR should address the factors as identified in Government Code Section 56668. These factors include, but are not limited to, the following considerations:

1. ***Project Summary***

Annexation – Project Description
The "Project Description" in the Notice of Preparation references "the project is within the City of Yorba Linda Sphere of Influence (SOI)." The EIR should clearly identify the potential annexation of the Project area as part of the "whole of the project" and discuss the timing of annexation relative to the timing of the proposed development plans.

Annexation – Whole of the Project
CEQA Guidelines section 15378 states that a "project" means the whole of an action, which has a potential for resulting in either a direct physical changes in the environment, or a reasonably foreseeable indirect physical change in the environment."

In this case, the current development proposals of the Cielo Vista and the anticipated development of the Murdock properties together would result in direct physical changes in the environment. Actions that are part of one project and that are reasonably necessary to effectuate a single project (e.g. access through the Cielo Vista project to the Murdock property) are considered part of the "whole of the action." Accordingly, all aspects of both projects should be considered in one environmental document prepared

by the County. In performing its analysis of the project and the potential impacts of future applications for annexation, LAFCO requests that the County prepare a combined analysis of the environmental impacts of both projects (Cielo Vista and the Murdoch property). CEQA notes "that environmental considerations do not become submerged by chopping large projects into many little ones, each with a potential impact on the environment, which cumulatively may have disastrous consequences." (Burbank-Glendale-Pasadena Airport v. Hensler (1991) 233 CA3d 577.)

2. ***Public Services and Utilities***

Section 56653 of the Act requires that each application for a change of organization include a "plan for providing services within the affected territory." Among other things, the plan for services must indicate "when those services can feasibly be extended to the affected territory." (Govt. Code Section 56653(b)(3))

Although the focus of Subsection 56653(b)(3) is on the timing of the *initiation* of services, the point of this subsection, especially when considered with the remaining requirements of Section 56653, is on continuous, reliable service provision to the affected area. The EIR's discussion of impacts in the area of public services should be made with reference to and consistent with the plan for services submitted under the Act, in particular, Section 56668, containing the criteria for approval of the annexation. Similar discussion and references should be made in the analysis of Land Use/Planning and Population/Housing.

In addition to the services and utilities identified in the NOP, LAFCO is requesting the EIR include analysis and discussion of the environmental impacts of the following municipal services:

Water Availability
This section should include a discussion of water supplies as required under Subsection 56668(k) of the Act, including a discussion of the Project's consistency with relevant Urban Water Management Plans. The Cielo Vista project is within the boundary of the Yorba Linda Water District (YLWD) which is identified as the retail water service provider to the proposed Project territory, but the NOP omits discussion of the Orange County Water District (OCWD).

OCWD is responsible for maintaining the quality and availability of the groundwater for groundwater producers such as the YLWD. As the ground water "manager" OCWD restricts pumping by retail water providers to those within the boundary of OCWD. YLWD has proposed annexation of approximately 6,100 acres in the eastern portion of the District to OCWD. The Cielo Vista project is within the proposed annexation area. OCWD submitted a Notice of Preparation for an Environmental Impact Report in July, 2011. The agency is currently preparing the EIR and discussion

of the long-term availability of local groundwater supplies should be assessed and discussed in the EIR prepared for the Cielo Vista project. As lead agency, the County should consult with OCWD to determine the adequacy of groundwater supplies for the Cielo Vista project.

Additionally, the project alternatives should include consideration and discussion of the effects of annexation and no annexation to OCWD on the Cielo Vista project.

Water Quality
The EIR should address storm water permitting requirements, including the preparation of a Storm Water Pollution Prevention Plan, change in surface imperviousness due to the project, drainage basins, emergency response to spills, and general compliance with the regional storm water permit.

Fire Protection and Emergency Response Services
The EIR should discuss and potentially evaluate whether there are significant environmental impacts for the project area that result from fire and emergency response being provided through the City's contract (Yorba Linda contracts with OCFA for fire protection) or the County's contract.

Law Enforcement
The EIR should discuss and potentially evaluate whether there are significant environmental impacts for the project area that result from law enforcement being provided through the City's contract (Yorba Linda contracts for law enforcement with the Orange County Sheriff's Department) or directly from the Sheriff's Department.

Sewer
The EIR should identify and evaluate both local and regional wastewater service providers and the impacts the project may have on their system. This section should include discussion of local sewer service by the Yorba Linda Water District and regional collection and treatment of wastewater from the project area by the Orange County Sanitation District.

Solid Waste Disposal
The City of Yorba Linda is the logical provider of solid waste disposal to the project area. Orange County Waste Recycling currently administers contracts for solid waste disposal within unincorporated islands, such as the one proposed to be created by development of the Cielo Vista project. The Draft EIR should identify and evaluate the service levels and potential impacts to the environment by both of the public agencies capable of administering contracts for solid waste disposal services to the project area.

Street sweeping
The City of Yorba Linda is the logical provider of street sweeping services to the project area. The Draft EIR should identify and evaluate the provision of this service to the project area and identify any potential environmental impacts.

3. **Local Policies: Land Use & Planning**

The EIR should address any conflict with applicable environmental plans or policies of agencies with jurisdiction over the project including, but not limited to, the policies described below:

County, League, and LAFCO Sphere of Influence Policy Guidelines
The Cielo Vista project is located in unincorporated territory within the sphere of influence of the City of Yorba Linda. The Draft EIR should adequately discuss the County's adopted *Sphere of influence Policy Guidelines* (***Attachment A***) and the timing of the Cielo Vista project relative to the future or concurrent annexation of the project site to the City of Yorba Linda.

On July 27, 1999, the Orange County Board of Supervisors adopted the *Sphere of Influence Policy Guidelines*. These *Policy Guidelines* were also adopted by the Orange County Division of the League of Cities and by LAFCO. Pages 3 and 4 of the *Policy Guidelines* list a number of policy guidelines for development within spheres of influence, including the following policy statement:

> *"Urban development should occur within existing cities, Spheres of Influence, or planned cities. Initiation of annexation to the city should occur at the earliest time in the planning process consistent with these Policies. Initiation of annexation to a city should occur prior to the issuance of building permits."*

Creation of a Developed, Inhabited Unincorporated County Island
As part of its post-bankruptcy external restructuring program, the County has implemented changes in policy direction to:

- Shift the County away from the delivery of municipal services;
- Focus on the provision of regional services; and
- Work with Orange County cities to annex adjacent unincorporated areas and shift the responsibility of delivering municipal services to the cities.

As part of this change in policy direction, the County works with LAFCO and local cities to implement the Unincorporated County Islands Annexation Strategy (***Attachment B***). Development of the Cielo Vista project in unincorporated territory would create a developed, inhabited unincorporated area located adjacent to the City of Yorba Linda, and could create significant environmental consequences with respect to

Response to NOP for Cielo Vista project
Page 6 of 8

how municipal services will be provided to future residents. The Draft and Final EIRs should address any potential significant impacts to the future residents of the Cielo Vista project and adjacent City residents, as a result of developing the proposed 112 single-family residences in unincorporated County territory. Specifically, the Final EIR should address: (1) the ability and the capacity of the County to adequately provide the above mentioned municipal-level services to the Project and (2) the potentially significant environmental impacts to the City's residents resulting from County service providers travelling through the City's adjacent residential neighborhoods to serve the Cielo Vista project.

LAFCO Island Annexation Policy
Since 2000, LAFCO has worked with the County and cities to develop an islands strategy of aligning policies and practices. The LAFCO Island Annexation Policy (***Attachment C***) represents the current form of LAFCO's effort to align the interests and processes (e.g. municipal service alignment process) to ensure that unincorporated developments are built to city standards facilitating the eventual annexation of these areas to their adjacent city jurisdictions.

The County, as lead agency for the Cielo Vista project, should address any inconsistency in the development standards as currently proposed in County jurisdiction with those of the City of Yorba Linda to ensure the project can be annexed to the City without impacting future residents of the project or the City. Additionally, the EIR should explore the concept of municipal service agreements as discussed in the attached documents as an alternative to services provided by the County and should assess the comparative impacts to the environment.

City of Yorba Linda General Plan
In December 1993, the City of Yorba Linda adopted its current General Plan including the Land Use Element. The City identified a number of goals and policy statements as part of the 1993 General Plan. The County, as lead agency for the Cielo Vista project, should also address any inconsistencies with the policies identified by the City of Yorba Linda in the Final EIR. The policies that should be addressed include, but are not limited to, the following:

- Policy 7.1: *"Seek the annexation of Shell, Murdock and other undeveloped properties within the northern sphere of influence based upon development plans that ensure access, infrastructure and land use concepts which are acceptable to the City."*
- Policy 7.2: *"Require developers of undeveloped properties to complete improvements for required infrastructure and/or provide funds for required infrastructure (both on-site and related improvements) in accord with City determined service levels.*

Response to NOP for Cielo Vista project
Page 7 of 8

4. Mitigation Measures

As a responsible agency, LAFCO can also raise issues for potential mitigation for discussion in the Draft and Final Environmental Impact Reports (CEQA Guidelines 15126.4). As currently proposed all municipal services by the County would have to travel to through the City to serve the project. Additionally, all traffic to and from the project would impact adjacent City streets. The County, as lead agency, should address the cumulative impacts of the actions in the EIR and includes appropriate mitigation measures. LAFCO is requesting the following impacts to City services be considered and mitigation measures are included in the EIR:

- Traffic impacts to the City, specifically impacts to San Antonio Road and Yorba Linda Boulevard.
- The City, as the logical provider of municipal services may be impacted by the proposed development and should be addressed in the EIR.

5. Alternatives

The State CEQA Guidelines cite the importance of various alternatives in the EIR as critical for informed decision making: *"An EIR need not consider every conceivable alternative to a project. Rather it must consider a reasonable range of potentially feasible alternative that will foster informed decision making and public participation."* (CEQA Guidelines 15126.6)

LAFCO is requesting the EIR include a discussion of an "Annexation" alternative and adequately address the following significant impacts under the alternative:

- The development of a 112-unit residential project that is NOT in compliance with City standards.
- The potential impacts to the developer and/or the residents that would result from having to upgrade or otherwise improve street widths, sidewalks, and other infrastructure to bring up to City standards for annexation.

LAFCO is requesting the EIR include discussion of a "No Annexation" alternative and adequately address the following significant impacts under the alternative:

- The creation of a large, developed, and inhabited unincorporated County Island consisting of a 112-unit residential development project.
- Reduced levels of services to Cielo Vista residents for:
  - Law enforcement.
  - Fire protection and emergency response services.
  - Roads (maintenance, street lighting, landscaping, sweeping).
  - Code enforcement.

Response to NOP for Cielo Vista project
Page 8 of 8

  - Local representation and government accountability.
- The short-term and long-term fiscal impacts to the County of Orange of assuming responsibility of and service costs for providing the following municipal services to a 112-unit residential project in unincorporated County territory:
  - Law enforcement.
  - Fire protection and emergency response services.
  - Roads (maintenance, street lighting, landscaping, sweeping).
  - Code enforcement.
  - Local representation and government accountability.
- The impacts to the City and its residents resulting from County serviced providers travelling through the City and adjacent residential neighborhoods to serve the Cielo Vista project.
- The application of a municipal services agreement between the County and City for the City to provide services to the Cielo Vista project.

In summary, the Draft EIR should address *Orange County's Sphere of Influence Policy Guidelines* and the timing of the unincorporated development relative to future or concurrent annexation of the Cielo Vista project to the City of Yorba Linda.

The EIR should also describe the County's plan for public services (e.g. law enforcement, fire, water, sewer, parks, street sweeping, code enforcement, etc.) in the project area and identify and evaluate the alternative service providers for the project upon development and annexation of the Cielo Vista planned community to the City of Yorba Linda.

Thank you for this opportunity to respond to the Notice of Preparation. Please send one copy of the Draft EIR to me via email (jcrosthwaite@oclafco.org) or by mail at 12 Civic Center Plaza, Room 235, Santa Ana, CA 92701. If you have any questions or concerns regarding this response, please contact me or Ben Legbandt, Policy Analyst, either by email at blegbandt@oclafco.org or by phone at (714) 834-2556.

Sincerely,

Joyce Crosthwaite

Joyce Crosthwaite
Executive Officer

ATTACHMENT A

ORANGE COUNTY BOARD OF SUPERVISORS

MINUTE ORDER

July 27, 1999

Submitting Agency/Department: EXTERNAL RESTRUCTURING PROGRAM FOR THE COUNTY OF ORANGE

At this time Members of the Board of Supervisors may report on and discuss activities related to the External Restructuring Program for the County of Orange, including approval of the following:
1. Recommendations from Board City/County Subcommittee regarding proposed Sphere of Influence Policy Guidelines - All Districts (Continued from 6/2/99, Item 125)

The following is action taken by the Board of Supervisors:
APPROVED AS RECOMMENDED ☒ OTHER ☐

Unanimous ☒ (1) SMITH: **Y** (2) SILVA: **Y** (3) SPITZER: **Y** (4) COAD: **Y** (5) WILSON: **Y**
Vote Key: Y=Yes; N=No; A=Abstain; X=Excused; B.O.=Board Order

Documents accompanying this matter:

☒ Resolution(s) 99-301
☐ Ordinances(s)
☐ Contract(s)

Item No. 32
File 20883
Special Notes:

Copies sent to:
CEO
Board Offices
Auditor

I certify that the foregoing is a true and correct copy of the Minute Order adopted by the Board of Supervisors, Orange County, State of California.
DARLENE J. BLOOM, Clerk of the Board

By:_____
Deputy

COUNTY OF ORANGE
BOARD OF SUPERVISORS
ROBERT E. THOMAS HALL OF ADMINISTRATION
10 CIVIC CENTER PLAZA
P.O. BOX 687
SANTA ANA, CA 92702-0687

99 JUL 23 AM 11:23

Agenda Item No. 32
July 27, 1999 Meeting

Board of Supervisors
County of Orange
10 Civic Center Plaza
Santa Ana, CA 92701

Subject: Proposed Sphere of Influence Policy Guidelines

Fellow Board Members:

On June 29, 1999 the Board requested that the City/County Subcommittee return with recommendations regarding the proposed Sphere of Influence Policy Guidelines. Since then we have met with representatives of the League of Cities, Orange County Division and the Building Industry Association (BIA) in an effort to reach consensus on the Policy Guidelines.

Based upon our meetings the past few weeks, we are pleased to present a document which can be supported by the League of Cities, Orange County Division, and BIA, and which meets the goals of our overall long-term annexation strategy. In summary, the proposed Draft Resolution and Policy Guidelines reflect a careful balance between the need to respect the many months of effort spent developing Policy Guidelines which were unanimously approved by the League of Cities, while ensuring that the Board Resolution contained the necessary provisions with regard to our desire to not impact the timing associated with the processing of development applications. This balance has been achieved and we are jointly recommending full Board support of this item.

The enclosed Draft Resolution also contains additional language which recognizes that the Sphere of Influence Policy Guidelines are the first step toward our overall annexation strategy which includes County Islands. We feel it is important to stress the importance of County Islands to the full Board, and to support Supervisor Coad's efforts on behalf of this Board to develop specific strategies and programs for our County Islands. It should be noted here that both parties – the League of Cities representatives and the BIA – recognize the need to address the County Island issue.

CEO and County Counsel representatives will be available prior to or at the Board Meeting to address any technical or legal questions regarding the proposal.

RECOMMENDED ACTION

Adopt Draft Resolution approving Sphere of Influence Policy Guidelines.

Respectfully,

Thomas W. Wilson
Vice-Chairman

James W. Silva
Supervisor, Second District

RESOLUTION OF THE BOARD OF SUPERVISORS OF
ORANGE COUNTY, CALIFORNIA
July 27, 1999

On motion of Supervisor Wilson, duly seconded and carried, the following Resolution was adopted:

WHEREAS, representatives of the County, the cities and the Building Industry Association of Orange County have met to attempt to reach consensus on policy guidelines to guide private development and the provision of municipal services in city spheres of influence; and

WHEREAS, the proposed policy guidelines have been submitted to this Board for review and approval;

NOW, THEREFORE, BE IT RESOLVED THAT THIS BOARD HEREBY FINDS AND DETERMINES AS FOLLOWS:

1. Approval of these policy guidelines is not a project for purposes of the California Environmental Quality Act because the guidelines are not intended to direct or influence development, rather they serve solely as a framework for cooperation among affected agencies and landowners and only become a formal policy with regard to individual city spheres of influence when this Board and the City Council reach agreement on their adoption and implementation; and

2. This Board will consider application of these policy guidelines to individual city spheres of influence upon approval of these guidelines by the affected city, and

3. The guidelines will be considered in conjunction with future General Plan amendments within city sphere of influence areas, and

4. These guidelines are not intended to impact County regional facilities as they are applicable only to private development projects and the County has an adopted policy to oppose annexation and incorporation proposals that impact County regional facilities necessary for the County's core business functions, and

5. The County is the local agency with ultimate responsibility for review and approval of development projects in unincorporated territory whether or not they are located in city spheres of influence, and

6. This action does not confer any authority to delay or cause an increase in development application processing time, and

7. Private property rights shall not be abrogated as a result of interpretation or implementation of the Policy Guidelines as development applications are processed.

BE IT FURTHER RESOLVED that this Board hereby approves use of the proposed Sphere of Influence Policy Guidelines submitted by the County Executive Office subject to the matters set forth in this resolution.

BE IT FURTHER RESOLVED that this Board recognizes that the proposed Sphere of Influence Policy Guidelines are the first step toward an overall County Annexation Strategy which will also address County Islands. The CEO is directed to immediately undertake the necessary actions to complete a County Annexation Strategy in conjunction with LAFCO and the cities. This Board will review the progress of this work effort in ninety days in conjunction with a status report on the implementation of the Sphere of Influence Policy Guidelines.

BE IT FURTHER RESOLVED that this Board hereby directs:

1. The County Executive Office to work with affected cities towards the application of the policy guidelines in individual city spheres of influence for developing areas and report back within ninety days.

2. The Planning and Development Services Department to develop protocols and procedures for the processing of development applications within developing sphere of influence areas to implement the applicable policy guidelines. The procedures will be reviewed by affected parties, including the Development Processing Review Committee prior to approval by the Director of Planning and Development Services Department.

3. The County Executive Office and the Planning and Development Services Department to develop a report and recommendations regarding the long-term planning and governance assumptions

for unincorporated areas outside of existing spheres of influence and General Plan open space areas within existing spheres for consideration by LAFCO as part of its update of spheres of influence.

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The foregoing was passed and adopted by the following vote of the Orange County Board of Supervisors on July 27, 1999, to wit:

AYES: Supervisors: THOMAS W. WILSON, JAMES W. SILVA, TODD SPITZER
CYNTHIA P. COAD, CHARLES V. SMITH
NOES:
EXCUSED:
ABSTAINED:

Charles V. Smith
CHAIRMAN

STATE OF CALIFORNIA)
)
COUNTY OF ORANGE)

I, DARLENE J. BLOOM, Clerk of the Board of Orange County, California, hereby certify that a copy of this document has been delivered to the Chairman of the Board and that the above and foregoing Resolution was duly and regularly adopted by the Orange County Board of Supervisors.

IN WITNESS WHEREOF, I have hereto set my hand and seal.

Darlene J. Bloom
DARLENE J. BLOOM
Clerk of the Board
County of Orange, State of California

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Item No: 32

I certify that the foregoing is a true and correct copy of the Resolution adopted by the Board of Supervisors, Orange County, State of California

DARLENE J. BLOOM, Clerk of the Board of Supervisors

By: _____
Deputy

Sphere of Influence Policy Guidelines
(adopted July 27, 1999 by Board of Supervisors Resolution 99-)

Mission Statement

These policy guidelines are the product of a facilitated dialogue between the League of California Cities-Orange County Division, the County of Orange, the Local Agency Formation Commission (LAFCO), and the Building Industry Association of Orange County to address projected growth and the provision of municipal and regional services in developing areas, hereinafter Developing Spheres of Influence.

The intent of these policy guidelines is to clarify the relationship between cities and the County with respect to urban planning, to promote the efficient, effective, and equitable delivery of local and regional services for existing and future residents, and to define a collaborative process with respect to development standard determinations for Developing Spheres of Influence. These guidelines also recognize that urban development should occur within existing cities, Spheres of Influence, or new communities.

Nothing in these policy guidelines shall be interpreted to affect or change pre-existing approved entitlements or development agreements, nor does it apply to county islands, which will be subject to future policy development. These policies also are not intended to establish countywide development standards. Rather, they reflect recognition that each Sphere of Influence is unique and requires site specific planning and flexibility.

Definitions

"**Design Standards**" shall mean regulations pertaining to the location, height, bulk, density, intensity, setback and size of buildings and structures and local street widths.

"**Developing Spheres of Influence**" shall mean the Spheres of Influence to be established by LAFCO based on the considerations set forth in the Sphere of Influence Policy Guidelines for the following cities and, in the future, to existing cities where LAFCO establishes a new SOI boundary, and any newly incorporating cities:

Anaheim (Santa Ana Canyon)
Brea
Newport Beach (Newport Coast and Banning Ranch)
Huntington Beach
Irvine
Lake Forest
Orange (East Orange)
San Clemente
Yorba Linda (Chino Hills)

"**Development Standards**" shall mean standards for Infrastructure, Public Safety Regulations and Design Standards. Design Standards are not applicable to: 1) interim uses such as agriculture; or 2) public utilities.

"**Infrastructure**" shall mean standards for street alignments and grades and arterial and primary widths, drainage and sanitary facilities, public utilities, parks, public easements and other public facilities, or fees in lieu thereof, which will be operated and maintained by a city upon annexation.

"**New Communities**" shall mean areas designated as potential new cities through a joint LAFCO/County process.

"**Public Safety Regulations**" shall mean building codes and regulations adopted pursuant to the provisions of Health and Safety Code.

"**Sphere of Influence**" shall have the meaning as set forth in Government Code Section 56076.

"**Urban Level Municipal Services**" may include, but are not necessarily limited to, water, sewer, streets, street lighting, park and recreation services, building and zoning enforcement, animal control, law enforcement, fire protection, libraries, and crossing guards.

Policy Guideline Objectives

These Policy Guidelines will facilitate the orderly planning and development of Orange County by:

- Providing a framework for cooperative relations among cities, the County, and landowners by minimizing project by project controversy through advanced agreement on Sphere of Influence policy.
- Providing for urban development in a manner that results in annexations and new cities that are efficient, effective, and equitable to existing and new residents, landowners, and service providers.
- Conserving the resources of service providers within Orange County while recognizing the legitimate rights and interests of property owners.
- Assisting the general public in understanding the planning and service responsibilities of local governments providing urban municipal and regional services within Orange County.
- Assisting LAFCO to establish Spheres of Influence based upon a city's demonstrated ability to plan and serve the area.

July 22, 1999

- Furthering a successful and cooperative framework to promote flexibility, options, and incentives in the implementation of these policies.
- Discouraging the creations of new "unincorporated islands" within Developing Spheres of Influence.

Policy Guidelines

Spheres of Influence are established by the Local Agency Formation Commission, as required by state law, to identify the physical boundaries and service areas of cities and special districts. Current LAFCO policy calls for territory to be included within a Sphere of Influence if that area will need urban services within the next ten to fifteen years. Spheres of Influence are amended periodically and as conditions warrant.

The following policy guidelines concern development proposals within Developing Spheres of Influence. They do not apply to land covered by a pre-annexation agreement between a city and landowner.

1. Cities should have the option to provide Urban Level Municipal Services to areas within Spheres of Influence where the city has a demonstrated willingness and ability to provide Urban Level Municipal Services. This guideline is not intended to address the provision of services by independent special districts, which topic is subject to LAFCO jurisdiction.
2. Urban development should occur within existing cities, Spheres of Influence, or planned cities. Initiation of annexation to the city should occur at the earliest time in the planning process consistent with these policies. Initiation of annexation to a city should occur prior to the issuance of building permits.
3. Spheres of Influence reflect a city's demonstrated willingness and on-going ability to provide land use planning and to plan for and extend public services. This policy guideline acknowledges that LAFCO has the sole authority to determine spheres of influence, and LAFCO concurrence is necessary for implementation of this guideline.
   a) In conjunction with LAFCO review of a city's Sphere of Influence, the city must develop a plan of service consistent with the level of detail commonly found in General Plans for the proposed sphere area. The plan will include:
      1. Land Use Designations
      2. Location of existing services and infrastructure
      3. Capital improvement and funding plans
      4. Level and range of services proposed for the area

   b) It is anticipated that LAFCO would reevaluate a city's Sphere of Influence on a priority basis and determine if the sphere shall be maintained, revised or eliminated consistent with these policy guidelines if a city's actions significantly alter the need for urban services, or the provision of urban services within the sphere area.

4. The cities, the County, and LAFCO will periodically coordinate and complete Sphere of Influence updates so that responsible agencies can develop general plans, ordinances, and procedures consistent with these policy guidelines.
5. The public interest is served when the County acts to provide compatibility in land use planning and development standards in developing spheres areas. Development Standards applicable within Developing Spheres of Influence should allow consideration of the following:
   a) City standards for Infrastructure improvements, including public parks, and Public Safety Regulations should be utilized.
   b) City Design Standards will be the starting point of discussions between the city and the landowner for a development proposal. Cities and landowners will work cooperatively to achieve consensus by using flexibility, incentives, and other options to achieve agreement on the applicable Design Standards. In the event the city and landowner cannot agree on appropriate Design Standards, the County will make the final determination on the Design Standards which will apply based upon an evaluation of the legitimate objectives of the city and the landowner. Factors to be considered by the County shall include, but not be limited to, balancing the landowner's need for responsiveness to the marketplace with the city's need for consistency with the city's Design Standards.

   Sections 5(a) and (b) are intended to recognize that while the County will have ultimate responsibility for the application of Development Standards within a Developing Sphere of Influence area, compatibility with City Infrastructure and Public Safety Regulations facilitates the ultimate annexation of the development to the city. It is anticipated that each City will identify development standards to be addressed at the time formal policies are considered for individual Sphere of Influence areas.

Guidelines for Annexation Incentives

The following incentives are permissive options to address permit process time and cost and shall not be construed to apply to Development Standards and Design Standards, or negate a landowner's option to process all aspects of a development through the city or County.

1. Flexible Processing Options

   The County and the city may each submit a development processing time and cost proposal for landowner consideration. Should the landowner wish a development proposal to be processed through the city, the County and city will pursue a cooperative agreement allowing city processing prior to the effective date of annexation.

2. Pre-annexation agreements, which eliminate the need for the extension of Urban Level Municipal Services by the County will be considered a public benefit for the purposes of County development agreements.
3. To promote early annexation, the city will consider offering incentives, including but not limited to, the following:
   a) Pre-annexation planning and zoning
   b) Pre-annexation subdivisions
   c) Creative public financing opportunities
   d) Pre-annexation agreements
   e) Pre-annexation development agreements
   f) Financial incentives
   g) Phased annexations

Implementation

The Board of Supervisors directs:

1) the CEO to work with affected cities towards the application of the policy guidelines in individual city spheres of influence for developing areas and report back within ninety days.

2) the Planning and Development Services Department to develop protocols and procedures for the processing of development applications within developing sphere of influence areas to implement the applicable policy guidelines. The procedures will be reviewed by affected parties, including the Development Processing Review Committee prior to approval by the Director, Planning and Development Services Department, and

3) CEO and Planning and Development Services Department to develop a report and recommendations regarding the long-term planning and governance assumptions for unincorporated areas outside of existing spheres of influence or general plan open space areas within existing spheres of consideration by LAFCO as part of its update of spheres of influence.

ATTACHMENT B

WHITE PAPER

ORANGE COUNTY LOCAL AGENCY FORMATION COMMISSION (LAFCO)
COUNTY OF ORANGE AND
LEAGUE OF CALIFORNIA CITIES, ORANGE COUNTY DIVISION

UNINCORPORATED COUNTY ISLAND ANNEXATION STRATEGY

January, 2000

INTRODUCTION

The County of Orange recently completed an intensive restructuring of county government and an assessment of the regional, public services provided by the County. As a result of the assessment, the leaders of Orange County determined that the provision of municipal, city-level services to unincorporated islands is not a core county business. Therefore, a concentrated effort to identify, assess, revitalize and annex the unincorporated islands throughout Orange County has become a major priority for the County Executive Office, Strategic and Intergovernmental Affairs Department (CEO/SIA).

Thus began the coordinated effort with the County, the Orange County Local Agency Formation Commission (LAFCO), and the League of California Cities, Orange County Division to develop a comprehensive strategy to facilitate the annexation of the unincorporated islands throughout the county. The following is a description of previous actions taken in regard to County islands, the current status of the County islands, strategies to facilitate annexation to the adjacent city, an implementation strategy and the next steps required to reach the overall goal of transitioning municipal services from the County to cities.

The County Executive Office developed a comprehensive inventory of the County's unincorporated islands in August 1999. The Inventory is divided into the following three categories of unincorporated areas: small islands, redevelopment areas, and major unincorporated communities. Seventy-eight unincorporated areas are mapped and cataloged, and demographic, land use, and service data is provided for each area. The *Inventory of Unincorporated Areas* was distributed to County agencies, cities, special districts and interested parties and will serve as the baseline data for this unincorporated island annexation strategy.

On September 14, 1999 the Board of Supervisors approved the *Community Revitalization Program for Unincorporated Islands*. The purpose of the revitalization program is to coordinate Orange County agencies to revitalize unincorporated neighborhoods through community policing, community code enforcement and community based programs. The Board of Supervisors allocated $500,000 as part of the Fiscal Year 99/00 budget to implement the revitalization program in both small islands and major unincorporated communities.

Fourth District Supervisor, Cynthia Coad has taken the lead on the revitalization strategy and recently implemented an ongoing revitalization plan for the major unincorporated community in the El Modena area. The County's Probation Department, in coordination with the County Executive Office will continue to implement the revitalization strategy at up to seven additional sites that can include major unincorporated communities and small unincorporated island areas. A description of the revitalization program as an annexation strategy will be further defined in this report.

ANNEXATION STRATEGY

The following are annexation strategies that can be used to assist cities and/or provide incentives to annex the unincorporated areas within the city's sphere of influence. All the following strategies will not be applicable to every unincorporated area and should be considered on a case-by-case basis to meet the needs of the annexing city and the unincorporated community residents.

New Legislation – AB 1555/Longville Bill

On October 9, 1999 the Governor approved and signed AB 1555, a bill authored by Assemblyman John Longville, to promote the annexation and elimination of unincorporated county islands. The bill authorizes the Local Agency Formation Commission (LAFCO) to approve, without an election, the annexation or reorganization of an unincorporated island or unincorporated islands within city limits under specified conditions depending on whether the proceeding is initiated on or after January 1, 2000, or January 1, 2007. In summary, the conditions require that the island(s) can not exceed 75 acres, the annexation is proposed by resolution of the annexing city, the territory will benefit from annexation, or is already receiving benefits from the city and that the island was not created after January 1, 2000. A comprehensive description of AB 1555 and the conditions are described in the attached bill text.

LAFCO Fee Waivers for Small Islands

On November 2, 1999 the Orange County Board of Supervisors approved the *County of Orange FY 1999-2000 First Quarter Budget Report* which included the allocation of $50,000 to LAFCO to facilitate the annexation of small county islands. This net County cost item would offset the cost of processing small island annexations sponsored by the County or that have been determined to require a fee waiver by LAFCO.

Pre-Annexation Agreements

A pre-annexation agreement between the County and the annexing city will allow an opportunity to collectively define gaps between County and city standards and service levels to facilitate the

ultimate annexation of the island to the city. Ideally, the County and city will commit money and/or resources to respond to the specific, identified needs to bring the island to compatible city standards and service levels. The pre-annexation agreement will assure the city and island residents that certain needs will be met and/or land use uniqueness will be preserved, and will assure the County that the city will annex the island now or at some specified time in the future.

Pre-Annexation Development Agreements

Currently undeveloped islands are subject to the development standards established by the Orange County Planning & Development Services Department, which may be more, or less restrictive than the development standards of the annexing city. A Pre-Annexation Development Agreement between the County, the city and the landowner/developer will ensure that the development standards will not change when the property is annexed to the city. The County and the annexing city will agree to allow the landowner/developer the option of developing the property through the County process or the city process. On the condition that the County process is used, the County, the landowner/developer and the city will negotiate agreeable development standards that are the same, or comparable to the city's building codes and regulations.

Phased Annexation Strategy

The *Orange County Inventory of Unincorporated Areas* is a complete inventory of the developed unincorporated areas throughout the County. Several Orange County cities have multiple unincorporated islands within the city's sphere of influence which could be cost prohibitive to the city to annex them all in one annexation process. Therefore, the County will negotiate a pre-annexation agreement with a city that provides for phased annexations. Essentially, the city will have the option to annex portions of the unincorporated areas within the city's sphere of influence over a negotiated time period. The property tax transfer percentage between the city and the County will be proportional to the annexed areas. The full percentage as defined in the city/county property tax exchange agreement will be available to the city when the last

unincorporated area is annexed to the city. The city may choose to annex all the unincorporated islands within the city in one complete annexation process.

City/County Contract Service Agreements

Currently, the Board of Supervisors serves as the "city council" to the residents of unincorporated islands. It is the County's responsibility to provide municipal and regional services to the unincorporated island areas. However, due to the fragmentation of islands throughout the County, municipal service delivery is often uneconomical for the County and could be provided more efficiently by the adjacent city. In many cases cities already provide the first response for emergency services such as police and fire. Service contracts with adjacent cities to provide city-level services such as police, planning and street maintenance would address this inefficiency and contribute to an overall plan to ultimately annex the unincorporated island to the adjacent city.

First, where County service levels in an unincorporated island do not match those of the adjacent city, and thus need to be increased to facilitate annexation, service contacts with cities would preclude the need for temporarily increasing County staffing and resources to service the islands at a level commensurate to the services provided by the adjacent city. An example of this is street sweeping on neighborhood streets which is currently not done by the County, but may be done by the adjacent city in its neighborhoods. Second, the residents would have a local contact point for services such as building permits, code enforcement, public safety, etc. This creates an image for the island residents of belonging to the city (in turn improving community support for annexation), and allows the city to begin to have an influence on the character of the island.

In other words, until annexation, the County would operate under contract with the city as though the island is already annexed to the city. The County would give control of the islands to the city which would provide all of the needed services, including land-use decisions that comply with the city's general plan overlay for the island. Any deviations from the County's general plan overlay will require County approval. Where County and city land use restrictions deviate,

and residents prefer to retain the County land use, it may be appropriate to grandfather in certain land uses (e.g. density levels or existence of sidewalks).

Until annexation occurs, the County will continue to receive the revenue (sales and property taxes, etc.) which is generated from the County island property/uses unless the County agreed that the revenue could go to the city as full payment for the contract services provided by the city to the island. This would need to be studied on an island-by-island basis.

Revitalization Strategy

It has recently been brought to the forefront, by Supervisor Coad, that it is time to begin giving more attention to all County islands, some of which have become a haven for crime, gangs, blight, and an overall disengagement from the surrounding city whose sphere of influence they are within. Not only is there a variance in the size of these islands, but also the type of special attention they may need to have addressed. However, each island does have one thing in common with the others; they have not received the overall attention necessary to deal with their pressing needs.

Some of these islands have a distinct difference in appearance than that of the surrounding city whose sphere of influence it is within. It may be the type of land use, infrastructure needs, lack of services such as street sweeping, abandoned cars left on the streets, lack of code enforcement, undergrounding of utilities and other matters which tend to distinguish the island from the surrounding city. It is as much, and maybe more, in the city's interest to get the island cleaned-up and compatible with surrounding uses and image, as it is to the County.

At the direction of Supervisor Coad, the County Executive Office and the Orange County Probation Department are coordinating a comprehensive revitalization strategy that includes the participation of the following County departments: Sheriff-Coroner, Planning & Development Services, Health Care Agency, District Attorney, Social Services Agency, and Housing & Community Development. The purpose for the revitalization strategy is to demonstrate the County's interest in revitalizing unincorporated neighborhoods through community policing,

community code enforcement and community programs. The specific components of the Revitalization Strategy are defined in a separate report. The County and city can use the strategy to improve qualifying unincorporated islands as a condition of annexation.

IMPLEMENTATION STRATEGY

There are several components necessary to facilitate the annexation of the unincorporated islands throughout Orange County. The components defined in this strategy include developing a partnership between the annexing cities, the County and LAFCO as a first step. The partners will then identify specific islands for annexation, define a timeline to annex the islands, prepare a comprehensive fiscal and service level analysis, prepare a community outreach plan, and coordinate with affected agencies. As a final step, the partners will jointly notify the affected agencies and departments regarding the completed annexation(s).

1. *City/County Partnership*

The success of an annexation strategy and policy is contingent on the partnership between the cities and the County of Orange. It is important to create a partnership between each city and the County so that we are all going in the same direction, and know what each of the partners is responsible to provide/contribute. The League of California Cities, Orange County Division recently convened an Annexation Task Force comprised of elected leaders and city managers to coordinate with the County of Orange and LAFCO to develop an annexation policy for Orange County. Upon approval of a final annexation policy the partnership will continue to promote and market annexations to cities, implement the annexation policy, convene community outreach forums, and offer technical assistance on annexation issues on a countywide basis.

2. *Schedule & Timeline for Annexation*

The *Inventory of Unincorporated Areas* is the most comprehensive study of the unincorporated islands throughout the County. The City/County/LAFCO partnership will proactively coordinate a list of small islands from the Inventory that are considered non-controversial and can use one or more of the strategies defined in the previous section. The partners will focus on uninhabited islands first, followed by the smallest islands that are currently considered part of the adjacent city and will not be subject to resident opposition. The partners will also reactively identify the islands that have been requested by cities for

annexation and assist with the annexation of those areas by obtaining the information listed in the following section, *Inventory of Unincorporated Areas*.

3. *Inventory of Unincorporated Areas*

Expand the data in the *Inventory of Unincorporated Areas* to include the following information for the islands identified by the partners. The data will assist with the facilitation of annexations by providing a comprehensive analysis of the economic impact of the unincorporated island to the annexing city: (not listed in order or priority of importance)

1. Cost to Provide Services
2. Current Service Levels
   - Street sweeping
3. Code Enforcement
   - Abandoned vehicle removal
4. Public Protection/Safety
   - Crime statistics
   - Gang related activity & gang prevention programs
   - Service calls
   - Current staffing levels
   - Community-based policing program
5. Infrastructure & Roads
   - Maintenance schedule
   - Future capital improvement projects
   - Age of infrastructure
   - Sidewalks, curbs, gutters, etc. consistent with City standards
6. Demographic and housing data
7. Number of registered voters
8. Number of commercial establishments and annual sales tax revenue generated
9. Annual turnover/resale rate of existing property (commercial and residential)

10. Parcel tax or assessments – County Service Areas, street lighting districts, special purpose taxes
11. Service level unit of measurements
12. Current allocation of CDBG funds for projects within the subject County islands.
13. Actual and projected property tax increment generated in the island that is currently within a County redevelopment project area (RDA). Projects currently funding by RDA funds.
14. Sewer/septic
15. Land use planning and zoning information
16. School Districts

4. *Community Outreach*

It is important to create city/county partnerships to collectively develop community outreach programs in coordination with LAFCO. The unincorporated island residents are integral to the overall annexation process. Therefore, public community forums in the affected unincorporated island areas will be convened to discuss proposed annexations, respond to residents' concerns regarding annexation, and solidify the united approach between the city and the County regarding the annexation of the area.

Historically, one of the formidable barriers to annexation, has been that the residents of the island do not want to change the status quo. There is a fear, whether real or perceived, that annexing to a city will result in a different lifestyle imposed through the city's general plan, zoning, restrictive building/other codes, costly sewer connection fees or possibly a difference in the amount of taxes they will be required to pay (utility user fees, special taxes, annual sewer fees and assessments, etc.).

Furthermore, it is important to understand, that even though the city and County would like to facilitate the annexation of the County islands, the residents will continually resist if they think they will lose these perceived benefits/independence as a result of annexation. The residents must be educated regarding any differences in services, including direct benefits

that would result from annexation such as increased city-level services, increased public safety, lower taxes, access to city facilities, and the potential to "grandfather" land use standards in some cases.

5. *Sanitation District Coordination*

The data gathering process for the inventory will identify the number of properties that are currently on septic systems within the island. The annexing city will determine if the property must be converted to sewer as a condition of the annexation. However, in light of the environmental impacts of septic systems, it is doubtful that any city, or the County for that matter should continue to allow septic systems. There may need to be both city and county policies providing for the sunsetting of septic systems. If so, the city and county representatives will coordinate with the Sanitation District to transition the property from septic to sewer, determine the costs and payment for services.

6. *Orange County Fire Authority Coordination*

The unincorporated islands/areas currently are serviced by the Orange County Fire Authority, and to pay for those services a portion of the property taxes which are paid by the property owners in the unincorporated island/area goes into the County Structural Fire Fund to pay for these services. When a County island is annexed into a city, the portion of the property tax that historically went into the County Structural Fire Fund needs to be addressed.

If the Orange County Fire Authority is the service provider to the annexing city, then OCFA will thereafter continue to be the service provider to the service provider and the share of the property taxes which goes into the County Structural Fire Fund should continue unchanged. However, if the annexing city has its own fire department or is a contract city with OCFA or another city, then it seems that the portion of the property taxes which historically have gone into the Structural Fire Fund should then go directly to the city.

This is a matter which the Board of Supervisors and OCFA need to address. The Structural Fire Fund is under the jurisdiction and control of the Board of Supervisors, but pursuant to the terms of the Joint Powers Agreement, which established the OCFA, all Structural Fire Fund revenue was pledged to OCFA to cover operational costs for the unincorporated areas.

7. *Notification of Annexation to Affected Departments*

The LAFCO process currently provides notification to the County, Assessor, Auditor and Surveyor when an annexation is complete. The implementation strategy will also require a final notification of annexation to all impacted departments and agencies to include, but not limited to the following:

- Orange County Board of Supervisors
- Affected City Council
- League of Cities Task Force Members
- County of Orange Departments:
  - CEO/Budget Department
  - Health Care Agency
  - Housing & Community Development
  - Planning & Development Services Department
  - Public Facilities & Resources Department
  - Registrar of Voters
  - Sheriff-Coroner

NEXT STEPS

The *Unincorporated County Island Annexation Strategy* is the first step in a comprehensive approach to annex the unincorporated islands throughout Orange County to the adjacent cities. Transitioning the provision of municipal services to the cities will allow the County to begin focusing on core County businesses at a regional level. However, as a follow-up to the annexation strategy, addressing the following issues will move the County towards completing the overall goal.

Revitalization Strategy

Expand the Revitalization Strategy and develop a comprehensive approach to reinvest County resources into the unincorporated areas. The revitalization will include all unincorporated areas of the County, and will not be limited to islands.

Fiscal & Service Level Analysis

Expand the analysis to all unincorporated areas identified in the Inventory. The analysis is currently limited to those islands or unincorporated communities that have been identified for annexation by the League/County/LAFCO partnership or the annexing city.

Service Contracts

Facilitate contracts with cities adjacent to unincorporated communities to provide municipal services. Contract with the city to provide land use services, permits, code enforcement, etc. to begin eliminating the County's responsibility to provide city-level services on an on-going basis in unincorporated islands.

ATTACHMENT C

Policy & Procedural Guidelines for Annexation of Small Islands (Gov't Code 56375.3)

IV. SMALL ISLAND ANNEXATION PROCEDURAL GUIDELINES

The following shall serve as procedural guidelines for processing small island annexations pursuant to Government Code §56375.3.

The Commission may approve small island annexations, and order the annexation of territory without protest or an election, if it determines that all of the following conditions apply:

A. The annexation is initiated on or after January 1, 2000 and before January 1, 2014.

B. The annexation is proposed by resolution adopted by the affected city.

C. The annexation does not exceed 150 acres in area, and that area constitutes the entire island.

D. The territory is surrounded in either of the following ways: surrounded, or substantially surrounded, by the city to which annexation is proposed or by the city and a county boundary or the Pacific Ocean, or surrounded by a city to which annexation is proposed and adjacent cities. An unincorporated island is "substantially surrounded" if: (1) more than 50 percent of the island's boundary is contiguous to the annexing city, or (2) more than 50 percent of the island's boundary is contiguous to the annexing city and the Pacific Ocean.

E. The territory is not located within a gated community where services are currently provided by a community services district.

F. The territory is substantially developed or developing based upon one or more factors, including, but not limited to, the following:

- The availability of public utilities
- The presence of public improvements
- The presence of physical improvements upon the parcel or parcels in the area

G. It is not prime agricultural land.

H. The territory will benefit from the annexing city.

I. The Commission may offer incentives such as reduced fees for cities annexing small islands.

ATTACHMENT C

Original Adoption Date: 11/19/2001
Date of Last Review: 2/9/2011
Date of Last Revision: 3/11/2005, 2/9/2005

ATTACHMENT C

ITF Guiding Principles, Best Practices and Municipal Services Alignment Process

❖ ITF Purpose: To develop island annexation and alternative service guiding principles and best practices.

❖ Guiding Principles

1. The purpose of cities and the County unincorporated islands within their sphere of influence is the same - to provide "community" for the residents.
2. Communities need to be whole and healthy from a municipal service perspective.
3. It is the role of government to provide municipal services in a manner that makes communities whole and healthy.
4. Annexation and Municipal Service Agreements are different from one another and both are tools for government to make communities whole and healthy from a municipal service perspective.
5. Currently there are disparities of municipal services and their associated costs among cities and County unincorporated islands.
6. The goal for County and City government is to align cities and the unincorporated islands within their spheres of influence from a municipal service, capital improvement investments, and associated costs perspective in order to foster healthy and whole communities.
[Note 1: The above guiding principles shift LAFCO's focus away from securing annexations and onto aligning government leadership, municipal services and associated costs
[Note 2: "Alignment" is defined as "matching the city's existing codes and standards unless otherwise agreed upon by County and city."]

❖ Best Practices

1. Inventories
   - County inventory of costs associated with unincorporated islands
     - Identify methodology
     - Conduct inventory
   - City Island infrastructure inventory
     - Conduct inventory
     - Each city on a case-by-case basis identifies a "reasonable" and specific timeframe (or lifespan, e.g. number of projected years) for costs associated with the infrastructure improvements and maintenance required to achieve infrastructure alignment.
   - INVENTORIES ARE A BEST PRACTICE BECAUSE THEY:

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- Provide objective data for decision-making for both the county and cities
- Provide data that is viewed as credible because it is gathered by the county and cities
- Align the county and city financial interests in defining a "fair," equitable cost-sharing burden

2. Alignment practices
   - Specific plans to bring land use and planning among islands and cities into alignment
   - Municipal service agreements for police, fire and code enforcement alignment to eliminate disparity in services and associated costs
   - Affordable housing alignment agreements, including development, parking and traffic standards to address affordable housing issues and impacts
   - Annexation as a tool for achieving alignment is possible at any point that the city and county agree on annexation
     - ALIGNMENT IS A BEST PRACTICE BECAUSE:
     - It reduces the disparity of municipal services offered among communities in islands and communities in cities; thus making them whole from a municipal services perspective
     - It eliminates the need for island residents to choose between disparate county and city standards and levels of service
     - It eliminates city residents paying for portions of island resident services
     - It ensures island residents pay their fair share for the municipal service they receive
     - It provides factual data for island residents that is not manipulated or distorted by outside interests
     - It eliminates the major issues contributing to resident opposition to annexation without the disruption of proposing annexation. [e.g. police, fire, code enforcement, land use]
     - It eliminates city government issues associated with land use planning compatibility and code enforcement.
     - It [through Municipal Service Agreements] is a financial incentive for cities to engage with the county to align municipal services

3. Pilot Projects
   - Conduct pilot projects.
     - PILOT PROJECTS ARE A BEST PRACTICE BECAUSE:
     - They provide a "safer" environment and opportunity for all parties to test, refine and learn from the alignment process

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- They provide an opportunity to demonstrate the effectiveness of the alignment process
- The project and the respective cities and players participating in the pilot project can be used to educate and promote the process to other cities

4. Fiscal Model Template
   - Use the Fiscal Model Template as the basis for fiscal impact studies
     - THE FISCAL MODEL TEMPLATE IS A BEST PRACTICE BECAUSE:
     - It generates and results in fiscal impact studies that are viewed as more "credible" because they identify and represent the fiscal perspectives of the County, city, and residents (ALL THAT ARE IMPACTED)
     - It identifies available funding.
     - It clearly defines and standardizes the data and information required for the study analysis which helps simplify the time and work effort required to produce the data; i.e. It increases data collection efficiency.
     - It has the support of City Manager and the County CEO to ensure that accurate, timely data collection is a priority.
     - It generates "credible" fiscal impact studies that all parties – County, cities, residents – can rely upon for decision-making
     - [Note 3: For Fiscal Model Template see Attachment A]

❖ Island/City Alignment Process

1. Supervisor affirms that he/she wants the island communities in their respective districts to be aligned from a municipal service and associated cost perspective. [Comment: These alignment messages may be much easier for supervisors to deliver to constituents than messages trying to justify annexation.]
2. Supervisors that want their communities aligned identify and prioritize the islands that will be aligned
   - 2a: LAFCO notifies the cities with the prioritized islands in their Sphere of Influence that the Supervisor is interested in aligning municipal services, explains the process, answers questions and factors any city concerns into the process going forward.
3. Supervisors that want their communities aligned initiate alignment best practices
   - CEO's Office initiates cost inventory for priority islands
   - Specific plans initiated for priority islands
   - MSA discussions initiated
4. LAFCO invites city managers associated with priority islands to conduct infrastructure inventory; informs city that county is inventorying costs of serving the island; informs city that specific plan is being completed

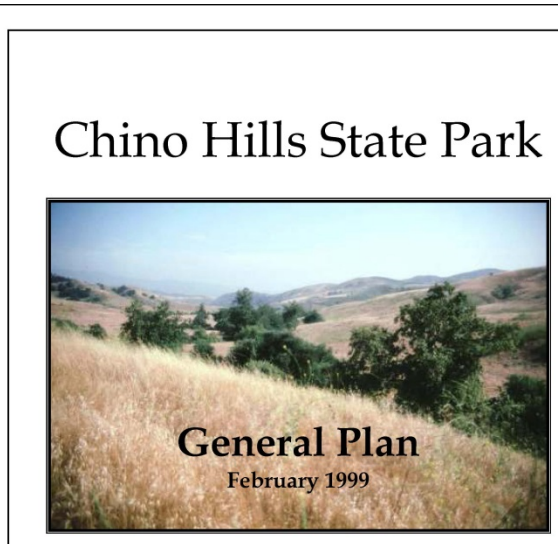
LAFCO ITF Guiding Principles Best Practices Process REV 7-18-11.doc 3

ATTACHMENT C

5. LAFCO convenes meeting with county and city to review/discuss cost inventory to serve islands and island infrastructure inventory
6. City Manager determines if city is "comfortable" engaging in informal talks about aligning municipal services among the city and island
7. City Manager recommends to city council that informal discussions commence
8. City Council agrees to informal discussions [Comment: Similar to the Supervisors, the alignment messages may be much easier for City Council members to deliver to their constituents than messages justifying annexation.]
9. City Manager, County CEO and LAFCO design a plan to align MS and associated costs using MSA's for police, fire, and code enforcement. . Plans designed on a case-by-case basis and may include:
   - Any all or a combination of the alignment practices [e.g. MSA's, affordable housing agreements, redevelopment agreements, community outreach and education agreements.]
10. City Council and County agree on plan to align municipal services and associated costs.
11. Alignment plan implemented and completed.
12. Alignment Process Outcomes:
    - Cities and islands aligned from municipal service and associated cost perspective; aligned in a manner that is agreeable to county and city; City-County cost burden equally shared; residents not asked to make a decision about municipal services and level of service;
    - Islands are as aligned as much as possible and thus optimally positioned for eventual annexation
    - Most reasons for residents to oppose annexation are "address" and/or cost of municipal services and possibly police/sheriff service.
    - The only decisions for residents are the cost they want to pay for municipal services and how much they want to pay to maintain "address."
    - County and city positioned to jointly communicate to island residents the costs of their municipal services and to offer them the choice of annexing for a specified cost and address change or to maintain their island status. [This is a much simpler communication task; reduces and defines the issues for residents to consider or oppose; less resources required…dollars and staff…to implement the communication plan; achieves healthy and whole communities from the municipal service perspective either way…through alignment best practices or annexation.]

LAFCO ITF Guiding Principles Best Practices Process REV 7-18-11.doc 4

EXHIBIT E



CALIFORNIA
STATE PARKS

GRAY DAVIS
Governor

MARY D. NICHOLS
Secretary for Resources

RUSTY AREIAS
Director of Parks and Recreation
P.O. Box 94286
Sacramento, CA 94296-0001

General Plan Inquiries

The Chino Hills State Park General Plan was prepared by the California Department of Parks and Recreation Southern Service Center. For general information regarding the document contact the service center at (619) 220-5300, or direct correspondence to:

California Department of Parks and Recreation
Southern Service Center
8885 Rio San Diego Drive, Suite 270
San Diego, California 92108

Publication Price and Order Information

Additional Copies of the approved Chino Hills State Park General Plan can be obtained for $6.00 each, plus $5.00 per copy for postage and handling. California residents must add 7.75% sales tax. Make checks payable to California Department of Parks and Recreation, and send your order to:

California State Parks Store
P.O. Box 942896
Sacramento, California 94296-0001

STATE OF CALIFORNIA - RESOURCES AGENCY GRAY DAVIS, Governor
DEPARTMENT OF PARKS AND RECREATION
STATE PARK AND RECREATION COMMISSION
P.O. BOX 942896, SACRAMENTO, CA 94296-0001
(916) 653-6524

Resolution 13-99
adopted by the
CALIFORNIA STATE PARK RECREATION COMMISSION
at its regular meeting in Brea on
February 23, 1999

WHEREAS, the Director of the Department of Parks and Recreation has presented to this Commission for approval the proposed General Plan for Chino Hills State Park; and

WHEREAS, this document reflects long-range development plans to provide for optimum use and enjoyment of the unit as well as the protection of its quality, resources, and diversity;

NOW, THEREFORE, BE IT RESOLVED that the California State Park and Recreation Commission hereby approves the Department of Park and Recreation's Chino Hills State Park Preliminary General Plan, dated October 1998, subject to such environmental changes as the Director of Parks and Recreation shall determine advisable and necessary to implement the provisions of said plan.

STATE OF CALIFORNIA - RESOURCES AGENCY GRAY DAVIS, Governor
DEPARTMENT OF PARKS AND RECREATION
STATE PARK AND RECREATION COMMISSION
P.O. BOX 942896, SACRAMENTO, CA 94296-0001
(916) 653-6524

Resolution 14-99
adopted by the
CALIFORNIA STATE PARK RECREATION COMMISSION
at its regular meeting in Brea on
February 23, 1999

WHEREAS, the Director of the Department of Parks and Recreation has proposed a 1425-acre Natural Preserve be established within Chino Hills State Park to provide for the recognition and protection of the important natural resources of the unit; and

WHEREAS, the proposed Natural Preserve is located in the hills and wooded canyons that encompass the Water Canyon and Brush Canyon watersheds; and

WHEREAS, the proposed Natural Preserve consists of rare plant communities, including coastal sage scrub, southern California black walnut woodland, and coast live oak woodland that support a wide variety of sensitive wildlife; and

WHEREAS, the proposed Natural Preserve is the northern extension of the Coal Canyon Biocorridor—a vital linkage between the wildlife habitats of the Puente-Chino Hills and the Santa Ana Mountains; and

WHEREAS, the proposed Natural Preserve offers an opportunity for the scientific study of wildlife movement in a rare regional biocorridor;

NOW, THEREFORE, BE IT RESOLVED pursuant to Section 5019.50 of the Public Resources Code, and after proceedings in accordance with the Administrative Procedures Act, that the California State Park and Recreation Commission hereby classifies 1425 acres in Chino Hills State Park as a Natural Preserve and names the unit Water Canyon Natural Preserve.

CHINO HILLS STATE PARK

GENERAL PLAN

FEBRUARY 1999

CALIFORNIA
STATE PARKS

State of California.....Gray Davis, Governor
The Resources Agency.....Mary D. Nichols, Secretary
California Department of Parks and Recreation.....Rusty Areias, Director

i

Mission Statement

The Mission of the California Department of Parks and Recreation is to provide for the health, inspiration, and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high quality outdoor recreation.

Chino Hills State Park General Plan

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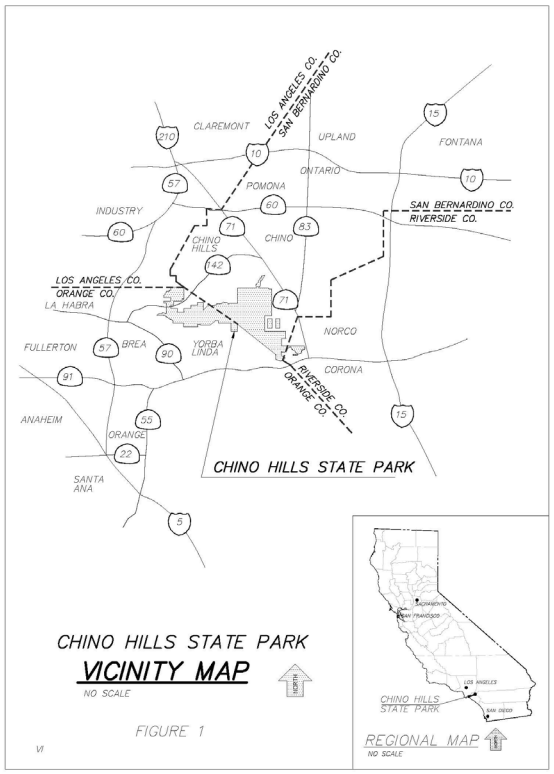


Chino Hills State Park General Plan

INTRODUCTION

Sycamore trees in Lower Aliso Canyon

INTRODUCTION TO THE PARK

LOCATION

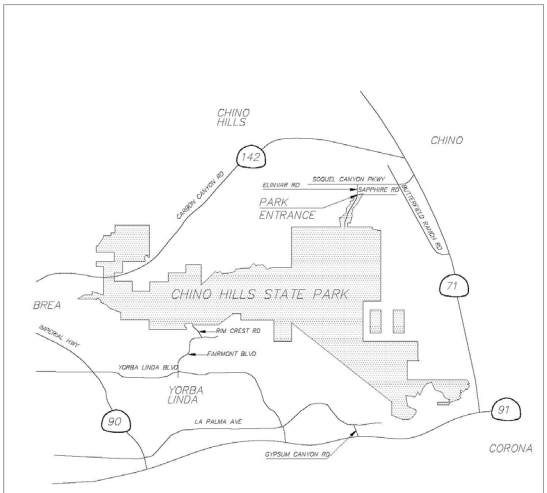
Chino Hills State Park is situated in the counties of Orange, Riverside, and San Bernardino (see Figures 1 and 2). Nearby transportation corridors include the Riverside Freeway (State Highway 91) to the south, State Highway 71 to the east, and Carbon Canyon Road (State Highway 142) to the north and west. The Sonome Canyon Area is just north of Carbon Canyon Road and is adjacent to Los Angeles County. The park is bordered on the north by the City of Chino Hills, on the south by the City of Yorba Linda, on the west by the City of Brea, and is close to the communities of Chino, Olinda Village, Sleepy Hollow, and Corona. Riverside is approximately 16 miles to the east of the park along Highway 91.

Chino Hills State Park lies within the densely populated urban communities of the southern California metropolitan complex. Approximately 15 million people live within a one-hour drive of the park. This number will escalate, as rural communities in the vicinity of the park are rapidly transformed into subdivisions.

Chino Hills State Park is within the Puente-Chino Hills, which are at the northern end of the Peninsular Ranges Geomorphic Province. The Cleveland National Forest in the Santa Ana Mountains is just 2 miles south of the park boundary on the opposite side of Highway 91. It is biologically connected to Chino Hills State Park via the Coal Canyon biocorridor, which is the only remaining viable link between them. Other parks in the vicinity include Carbon Canyon Regional Park to the west, Prado Regional Park to the east, Featherly Regional Park to the south, and Yorba Regional Park to the southwest.

The nearest State Park System units are California Citrus State Historic Park, 13 miles to the east; Pio Pico State Historic Park, 18 miles to the northwest; Bolsa Chica and Huntington State Beaches and Crystal Cove State Park, all 24 miles to the southwest; and Lake Perris State Recreation Area, 29 miles to the east.

As of November 1998 the park encompassed approximately 11,770 acres, most of which is made up of rolling hills. The dominant vegetation type in the park is non-native annual grassland. However, walnut woodlands, coastal sage scrub, coast live oak woodland, sycamore woodland, chaparral, and riparian scrub are also important components. In addition, a one-mile-long section of the Santa Ana River and its associated Fremont cottonwood riparian woodland are within park boundaries. This is the only remaining natural stretch of the Santa Ana River in Orange County.



CHINO HILLS STATE PARK

LOCATION MAP

NO SCALE

FIGURE 2

2

Chino Hills State Park General Plan

PURPOSE ACQUIRED

Chino Hills State Park was acquired primarily for the purpose of preserving its natural landscape features, its biological diversity, and the opportunities for solitude and recreation that open space provides for people in densely populated areas. In June 1977, the California Legislature passed Concurrent Resolution No. 17 directing the California Department of Parks and Recreation (the Department) to undertake a study of the feasibility of acquiring land in the Chino Hills for State Park System purposes:

> *WHEREAS, The Chino Hills is an almost undeveloped island of unspoiled land surrounded by the urban sprawl and freeways of the Counties of Los Angeles, San Bernardino, Riverside, and Orange and is presently threatened with major development that is incompatible with its wildlife, aesthetic and recreational values; and WHEREAS, Securing the Chino Hills for park purposes would assure the preservation of those values to the benefit of residents of the state; now, therefore, be it resolved by the Assembly of the State of California, the Senate thereof concurring, That the Department of Parks and Recreation is requested to undertake, in cooperation with the Counties of Los Angeles, San Bernardino, Riverside, and Orange on a shared cost basis, a study of the feasibility of acquiring lands in the Chino Hills for park purposes and to report thereon to the Legislature on or before March 1, 1978…*

In April 1979, the Department issued the Chino Hills Feasibility Study that identified 30,000 acres of the Chino Hills as suitable for inclusion into the State Park System. The acquisition of 2,237 acres in November 1981 initiated the project.

A local conservation organization called Hills For Everyone initiated the Chino Hills Project and worked closely with the Legislature and the Department to make Chino Hills State Park a reality. In 1982, Hills For Everyone entered into a lease agreement with the Department of General Services to manage the land involved in the early acquisitions until the Department of Parks and Recreation was ready to assume management responsibility. Hills For Everyone opened the area to the public on a limited basis in the spring of 1983 and managed the property until 1984, at which time the Department of Parks and Recreation took over its management.

Chino Hills State Park General Plan

SPIRIT OF PLACE

Chino Hills State Park gives those who visit it a sense of being transported back in time to an earlier and more undeveloped California. Upon entering the park, the transition from the human-made environment to the natural environment is abrupt; housing tracts quickly give way to open hills, and once inside, the sights and sounds of modern intrusions are minimal and one feels many miles away from cities and freeways. The park interior is enveloped by its ridgelines, and one perceives the land as being secluded, protected, and still. Without city noises and visual obtrusions, visitors become aware of the park's subtle movements, natural smells, and variations in microclimate, vegetation, and topography. Many endearing values of the park are intangible. The qualities of open space, natural sounds, and fresh air cannot be quantified like physical resources can, but they allow visitors to be aware of and reconnected with the natural world.

Coast live oak forest in Telegraph Canyon

The forces of nature that have shaped the land are evident by the steeply cut valleys, landslides, and rolling hills of the park. These places mark the passage of time through their variation of seasonal colors. The park's landscape changes over the course of a year from one that is dry and dusty to one that is moist and lush. These variations can also be discovered while moving from the exposed ridgetops to the dense shade under riparian tree canopies.

The park is one of few in the Los Angeles Basin that offers opportunities for tranquility, solitude, and relief from the hectic urban life that surrounds it. It gives visitors a place to explore and recreate at their leisure. As the pace of life in this area quickens and the size of the population adjacent to the park grows, these values will become increasingly precious to many park visitors.

One comes away from Chino Hills State Park feeling refreshed. But the effect of one's experience at the park is most apparent when one returns to the urban environment. The park leaves visitors with a feeling of compassion for the disappearing values of California's past landscapes and a sincere appreciation for the remaining open space that is available for today's enjoyment.

Chino Hills State Park General Plan

PURPOSE OF THIS GENERAL PLAN

This general plan provides guidelines for long-term management, development, and operation of Chino Hills State Park. It replaces the original Chino Hills State Park General Plan approved in August 1986. After a review by the Department, it was determined that an amendment to the 1986 general plan should be developed. However, due to the extensive nature of the amendment, the planning team decided to completely revise and replace the original document.

This document is prepared by the California Department of Parks and Recreation to satisfy the requirements of Public Resources Code (PRC) Section 5002.2. The PRC specifies that a general plan be prepared prior to development of any new facilities and will consist of elements that will evaluate and define the proposed management of resources, land uses, facilities, concessions, and operation of the park. In addition, the plan serves as a first-tier environmental impact report (as defined in Section 15166 of the California Environmental Quality Act [CEQA] Guidelines). The Chino Hills State Park General Plan must be submitted to, and approved by, the State Park and Recreation Commission.

The proposals in this general plan are conceptual in nature. They are intended to provide vision for the park rather than make detailed recommendations. Separate management and project plans will be developed that will provide the necessary details for specific actions. These plans are required to assess the potential environmental impacts of specific proposals made.

This general plan also discusses the potential for future acquisitions. Areas of interest extend beyond present Department of Parks and Recreation ownership for the purposes of long range planning. This does not constitute a commitment for acquisition nor portray an ultimate park boundary.

Telegraph Canyon Trail

Chino Hills State Park General Plan

EXISTING CONDITIONS AND ISSUES

Eastern view from Telegraph Canyon Trail

Chino Hills State Park General Plan

PARK SUMMARY

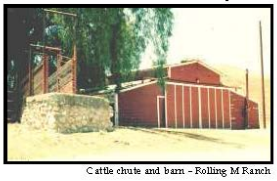
The Park Summary highlights and summarizes the existing land use, facilities, and significant resource values at Chino Hills State Park necessary to understand the goals and guidelines noted in the Plan Section of this document.

EXISTING LAND USE

Chino Hills State Park is a large area of relatively undeveloped land. One of the principal appeals for visitors is the natural character of the landscape. Most of the land is natural open space, cut occasionally by roads, trails, pipelines, and power lines. In a few locations, this land use changes to accommodate recreational and operational needs.

ROLLING M RANCH

For visitors, park staff, and volunteers, the Rolling M Ranch is the most actively used area of the park (Figure 3). It is at the end of the entrance road and offers a place for visitors to park their vehicles and access the trail network. Here, visitors can picnic, use the restroom, get water, and find park information. Park volunteers often use this area to meet and conduct business. The Rolling M Ranch is also a hub for park operations. It is a residential area for park staff as well as the operations center. The area is used for equipment and supply storage as well as a workspace for maintenance and ranger staff.



Cattle chute and barn – Rolling M Ranch

OTHER VISITOR-USE AREAS

There are additional visitor-use areas near the Rolling M Ranch that offer structured-type recreation. The equestrian staging area is used for large groups and special events. The campground area allows for night use of the park. Picnic areas and scenic overlooks are nearby. Panorama Point near the Rolling M Ranch offers a scenic viewpoint, parking, and interpretive information. There are no formal group-use areas in the park; however, the campgrounds can accommodate small groups as needed. Other visitor-use areas include pedestrian access points along the park boundary. Some visitors access the trail network via these access points after parking offsite on residential streets.

Chino Hills State Park General Plan

Lemon Grove Area

The Lemon Grove Area is located in Carbon Canyon on the far-western end of the park (see Figure 3). This trailhead area can be reached from Carbon Canyon Road by entering through Carbon Canyon Regional Park (County of Orange) and provides the only access from the western side of the park. Visitors can reach the park's interior by traveling through Telegraph Canyon from this area. The Lemon Grove Area contains significant riparian habitat as well as approximately 40 acres of trees that represent the only extant remnant of the historically significant citrus industry that once surrounded the park.

Sonome Canyon Area

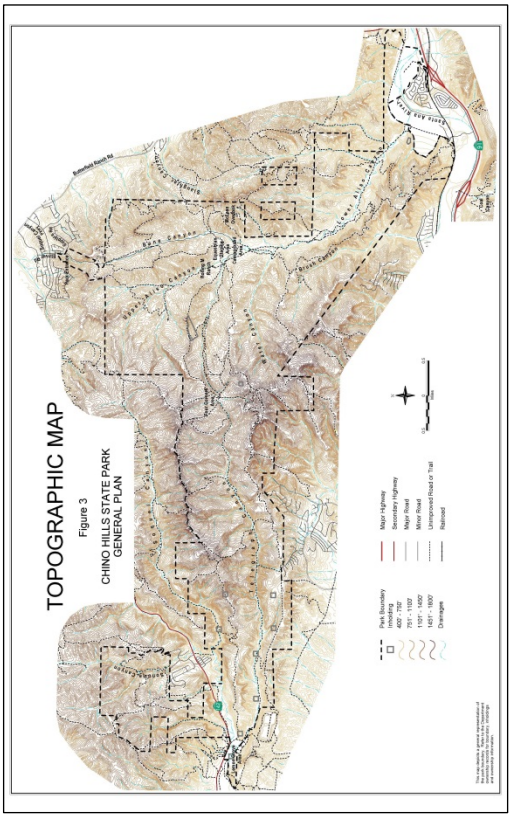
In November 1996, The Department of Parks and Recreation purchased the Sonome Canyon Area from Shell Western E&P Inc. This 965-acre property is north of Carbon Canyon Road (State Route 142) (see Figure 3). A Habitat Conservation Plan (HCP) was developed and funded by Shell Western E&P Inc. as part of mitigation for nearby Shell Western E&P Inc. developments. Also in 1997 an additional 19 acres was added to the Park as part of an HCP mitigation obligation for Metropolitan Water District of Southern California (MWD). The intent of the HCP is to protect and enhance habitat on a 2,600-acre Study Management Area that includes the Sonome Canyon Area as well as other areas in the western portion of the park. As of 1998, the property had no developed facilities and was accessed by trail from the south.

Sub-Classifications

There are currently no sub-classifications or formal land-use designations within Chino Hills State Park. Three land-use zones, however, were identified in the original (1986) general plan. These are Primitive, Park Land, and Developed Park Zones. All uses in these zones fall within the State Park classification of the Public Resources Code (Section 5019.53). The land use for the Primitive Zones is limited to trails and trail camping. The Park Land Zones include trails and trail camping as well as walk-in camping, family picnicking, and vehicle access limited to park personnel. The Developed Park Zones, in addition to the above, offer parking, day use, overnight use, administrative and operational use, and public vehicle access. The management zones described in this Chino Hills State Park General Plan supersede the land-use zones identified in the original general plan.

Inholdings

Several property inholdings occur at Chino Hills State Park (see Figure 3). These inholdings are, in general, owned in fee by public agencies and privately held companies such as Metropolitan Water District of Southern California, Shell Western E&P Inc, and Southern California Edison. The Department of Parks and Recreation cannot make substantial improvements in these areas. Refer to the Department Land Ownership Record for complete information about these inholdings.



Chino Hills State Park General Plan

EXISTING FACILITIES

Chino Hills State Park has few facilities (see Figure 4). In general, existing facilities in the park were constructed during three different periods: the historic ranching period, the Hills For Everyone management of the park, and the initial development by the California Department of Parks and Recreation.

Most of the existing structures at the Rolling M Ranch were constructed prior to ownership by the California Department of Parks and Recreation. These include two residences, a barn, and a shed. As of 1998, the smaller of the two residences was condemned due to structural damage. Some of these structures are over 50 years old, and are considered historic resources. Also, many of the existing park roads were built during this ranching period.

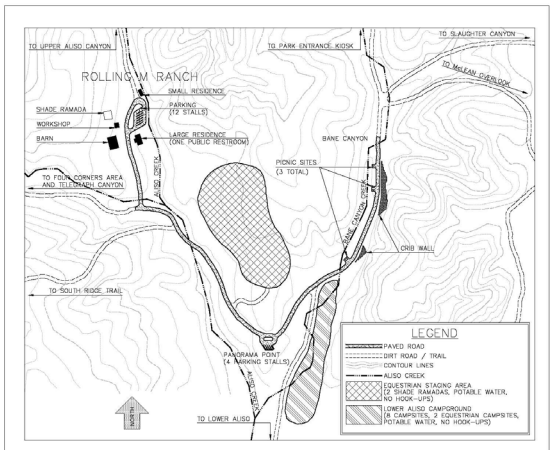
Hills For Everyone established some of the existing facilities during its management of the parkland from 1983 to 1984. These include a trailhead and trail, a viewpoint, an equestrian camping area, family camping and picnicking sites, parking areas, and signs. These facilities were established with volunteered labor and materials.

Initial development of the park by the Department consisted of building an entry station; paving portions of the entrance road; constructing retaining walls; family picnic sites with parking, a scenic overlook, and paved parking at the Rolling M Ranch; and installing water and underground electric utilities. The residences at the Rolling M Ranch use propane gas from tanks. Water is supplied by the City of Chino Hills and power is supplied to the Rolling M Ranch by Southern California Gas and Electric. No telephone service is available at the park.

Panorama Point looking south down Aliso Canyon

The park contains approximately 50 miles of roads and trails (see Figure 3), including single and double track trails, and dirt roads. The three-mile long entrance road is mostly unpaved, except for a three-quarter-mile paved section between the Rolling M Ranch and the road to McLean Overlook.

As of 1998, no concessions existed within the park.



CHINO HILLS STATE PARK
EXISTING FACILITIES MAP
NO SCALE

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FIGURE 4

PARK SUPPORT

Volunteers

Three groups of organized park volunteers are involved in recreation, land use, resource management, and interpretation issues and play an important role in the operation of the park. The volunteer groups include a Natural History Unit, Mounted Assistance Unit, and a Bicycle Assistance Unit. In 1997, these volunteer groups logged 3,960 hours of service. Typical volunteer activities include trail patrols and maintenance, interpretive programs, facility maintenance and construction, and habitat restoration projects.

Cooperating Association

The Chino Hills State Park Interpretive Association, a non-profit cooperating association operating under a contract with California State Parks, provides funds to the park to assist with interpretive and educational activities. This association raises funds through membership fees, donations, and fundraising efforts.

Hills For Everyone

Hills For Everyone is a citizen advocacy group dedicated to the preservation of the local hills for people and wildlife. Hills For Everyone was instrumental in preserving land in the Chino Hills for park purposes and they work closely with Department staff on planning and conservation issues.

Interpretive panel – Hills For Everyone Trail

SIGNIFICANT RESOURCE VALUES

Physical Resources

Topography

The Chino Hills are part of a group of hills that also includes the Puente Hills to the northwest. The Chino Hills and the Puente Hills form a roughly triangular area of approximately 35 square miles of valleys, canyons, hills, and steep slopes. The hills are bounded on the northwest by the San Gabriel Valley, on the northeast by the San Bernardino Valley, and on the south by the Santa Ana River Canyon and the Los Angeles Basin.

Telegraph Canyon running east to west and Aliso Canyon running north to south are the principal stream drainage areas in the park. Slopes are generally steeper in the Telegraph drainage than the Aliso drainage. The most level areas in the park are near Aliso Creek, adjacent to the Santa Ana River, and at the mouth of Telegraph Canyon. The highest elevations in the park are San Juan Hill (1,781 feet) and Gilman Peak (1,865 feet). The lowest elevations occur along the Santa Ana River (430 feet).

Meteorology

The climate at Chino Hills State Park is typically Mediterranean with cool, moist winters and warm, dry summers. Local weather conditions are greatly influenced by wind patterns. Westerly breezes bring in moist marine air, which moderates temperatures and frequently brings in low clouds or fog. Easterly breezes bring in dry desert air, which accentuates temperature extremes (raising maximums and lowering minimums). Occasionally, strong (35 to 50 miles per hour) easterly winds may blow for several days, sometimes raising temperatures over 100 degrees Fahrenheit. These Santa Ana winds produce low humidity and reduce fuel moisture, which, with the high wind speeds, create extreme fire hazard conditions.

Average annual precipitation in the Chino Hills area ranges from 15 to 18 inches. Typically, the summer months are dry. Late winter and early spring rains (December through March) usually produce 75 percent of the annual precipitation. These rains produce high runoff, which initiates the period of stream flow. The dry summer period typically leads to depletion of soil moisture, cessation of vegetative growth, and termination of stream flow in the creeks.

Air pollution is a significant environmental problem that restricts visibility and poses health hazards in the Chino Hills area.

Hydrology

The Chino Hills are part of the divide between the Los Angeles and Santa Ana Hydrologic Basins. Most of Chino Hills State Park is in the Carbon Canyon and Aliso Canyon watersheds. Bane Canyon and Water Canyon are part of the Aliso Canyon watershed and are completely within the park, as is 87 percent of Aliso Canyon. The Carbon Canyon Watershed includes Carbon Canyon, Soquel Canyon, Sonome Canyon, and Telegraph Canyon. The first three canyons are in private ownership outside the park, however, 96 percent of Telegraph Canyon is located within park boundaries. A majority of the headwaters is currently used for grazing, but significant upstream portions of the Carbon Canyon, Soquel Canyon, and Sonome Canyon watersheds are residential.

Several roads that cross streams exist in Bane, Aliso, Telegraph, and Soquel Canyons. In some areas, increased soil erosion, turbidity, and damage to aquatic habitat has occurred because of road use through stream channels.

Geology

The Chino Hills are made up of a thick sequence of middle to upper Miocene marine sedimentary rocks of the Puente Formation, deposited from five to fifteen million years ago. The Puente Formation has been divided into four members from oldest to most recent: the La Vida, Soquel, Yorba, and Sycamore Canyon members.

Petroleum and associated gas have been extracted from oil fields in the region since the late 1800s. In 1885 the first commercial production of oil in the Los Angeles Basin was at the old Puente oil field west of the park. Although numerous oil wells have been drilled in the Chino Hills, there is no record of commercial production in the park.

The hills are a result of uplift and folding along the Whittier fault zone and the Chino fault. Both the Whittier fault zone and the Chino fault may be branches of the Elsinore fault, which is a major structural feature of the Peninsular Ranges Geomorphic Province to the south. The state geologist classifies the Whittier fault zone as active. A branch of the Whittier fault cuts through the park in the vicinity of Telegraph and Carbon Canyons. Damage to structures or facilities could result from seismic shaking. Landslides could also be generated, especially if the slopes are saturated.

Chino Hills State Park has major geologic hazards and sensitivities. The Chino Hills are prone to frequent landslides. In fact, the area around and including the park has been identified as the most landslide-prone area in southwestern San Bernardino County. Even though many of the landslides occurred long ago by human standards, they must still be considered as areas of instability, because the landslide deposits are generally perched precariously on hillslopes, awaiting only the proper climatic, hydrologic, and perhaps seismic conditions to become activated.

Soils

Chino Hills State Park is located in Soil Region VII – Southern California. In this region, upland soils have clay or clay-loam surfaces, neutral to basic reacting, and often-calcareous subsoil. Alluvial soils are mostly sandy loam, light brown in color, and have neutral reactions. The Chino Hills area soils are primarily upland soils, formed in place with only minor occurrences of alluvial soils.

In Chino Hills State Park, the Soil Conservation Service has mapped 39 soil units representing 20 soil series. These soils vary widely in depth, fertility, permeability, and other important characteristics. Two important characteristics of the soils in the park, which may affect potential land uses, are erosion hazard and shrink-swell potential.

The steepness of watershed lands, past land-use practices, and the rapid surface runoff create a high potential for erosion throughout Chino Hills State Park. The park is riddled with a network of roads, fences, transmission easements, power lines, and gas lines. In some places livestock have created linear paths along steep fence lines, leading to development of gullies, loss of soil and vegetative resources, and potentially contributing to development of new landslides. The roads promote gullying, mass wasting, and loss of vegetative resources. Increased water runoff results from water concentration through culverts, removal of vegetation, and diversion from natural watercourses. Ditches, berms, and improperly constructed water bars also lead to erosion of the roads and adjacent lands in the park.

Natural Resources

Connectivity

The Southwest Ecoregion, of which Chino Hills State Park is a part, is recognized worldwide as a significant area of biodiversity. Biodiversity refers to the variety of species occurring within a given area. The Southwest Ecoregion extends roughly from San Diego to Santa Barbara, as far east as the crest of the Transverse Ranges and west to the coast. This area contains a greater number of biological resources than any other area of comparable size in the United States (E.O. Wilson, *Biodiversity*, National Academy Press, Washington D.C., 1988). As land in southern California becomes more developed and open space dwindles, the importance of Chino Hills State Park to the preservation of biodiversity in the Southwest Ecoregion will greatly increase.

Even with continued protection, the biodiversity of the park is at risk. The Puente-Chino Hills, including the park, have become increasingly isolated by the conversion of the surrounding landscape to urban uses. Scientific studies have shown that the isolation of habitat can lead to ecosystem collapse. Small, isolated areas of habitat simply cannot support as many species as larger areas. In order for the biodiversity of

the park to be maintained at or near current levels it must remain connected to other protected open space in the region.

Without the ability to protect the entire landscape, biocorridors are the best known way to counteract the effects of the isolation of parks and their habitat areas. Biocorridors, like hallways between rooms, are extensions of habitat that connect one core habitat area to another. A core habitat is an area of high resource sensitivity because it supports habitat that is crucial for a majority of wildlife species in the park. Biocorridors provide for plant and animal movement between core habitat areas. The exchange of plants and animals between habitat areas is critical to the maintenance of healthy ecosystems for several reasons. These include the maintenance of genetic variation, the ability of species to shift their ranges over time in response to environmental change, and as a source of repopulating after a natural catastrophe. Without plant and animal exchange with other protected areas, many species populations within Chino Hills State Park will not be able to perpetuate and will eventually die off.

The habitat linkages important to the biological survival of Chino Hills State Park are: 1) Coal Canyon which links the park to the Cleveland National Forest and the Santa Ana Mountains; 2) the Sonome Canyon Area which links Chino Hills State Park to Tonner Canyon and other open space to the northwest; and 3) the Prado Basin area that links the park to the Prado Basin, and thereby to the Dairy Preserve, the Santa Ana River watershed, and open space east of State Route 71. Roads with heavy traffic bisect these linkages and are barriers to wildlife attempting to cross them. When future improvements to these roads are undertaken, including capacity increases planned for the regional transportation system, the construction or enhancement of suitable bridges, culverts or other acceptable structures are necessary to maintain corridor function and biological viability.

Mountain lion tracks (photo by Connie Spenger)

Biocorridor Areas

Coal Canyon

The most important biological linkage between Chino Hills State Park and adjacent, protected open space is the Coal Canyon biocorridor which connects the park and surrounding Puente-Chino Hills on the north to the Cleveland National Forest and the Santa Ana Mountains on the south. The biocorridor provides for the dispersal of plants and the movement of animals between the two areas. The much larger Santa Ana Mountains support the diversity of the Puente-Chino Hills by allowing animals to disperse into the area thereby bolstering populations, providing new genetic material, and helping to prevent local extinctions.

The Coal Canyon biocorridor extends within park boundaries through Brush and Water Canyons to the interior of the park. These two canyons constitute an important natural resource area that supports high quality examples of California walnut woodland, oak woodland, and riparian habitat. The area provides for the movement of special status species such as the mountain lion, as well as habitat that is crucial to the California gnatcatcher and the nesting success of a pair of resident golden eagles. All of Water Canyon and a large portion of upper Brush Canyon are within the park's boundary.

The Riverside Freeway (State Route 91) bisects the Coal Canyon biocorridor outside of park boundaries. Terrestrial animals attempting to cross the freeway are forced to either cross under it via a relatively small double box culvert or over it across multiple lanes and a freeway divider. Because the culvert crossing is small relative to its length, many animals do not use it. Deer, for example, typically will not use the 91 Freeway culvert crossing because they require a view of the opposite end of the crossing and the culvert does not provide this need. A freeway underpass at this location, which is currently fenced off from the wildland area, holds the potential to allow for the movement of many animals that cannot currently overcome the impediment of the freeway.

As of 1998, portions of the Coal Canyon biocorridor remained in private ownership and may be developed. If development occurs, the Puente-Chino Hills, including Chino Hills State Park will be biologically isolated. Eventually, this will result in local species extinction on a large scale and may result in the biological decline of the park and the Puente-Chino Hills because this area is too small to support many of the existing plant and animal populations.

Sonome and Tonner Canyons

The Sonome Canyon biocorridor lies within the Sonome Canyon Area. It links Chino Hills State Park with two adjacent open space areas in the Puente and Whittier Hills via the Tonner Canyon biocorridor on the north and west. This important connection

ties three significant core habitat areas together and allows for the passage of species between them.

The Sonome and Tonner Canyon biocorridor is bisected by Carbon Canyon Road (State Route 142). There are several culverts that pass under the road but they are very small and are, therefore, of limited value for wildlife passage. Larger mammals such as deer and mountain lions are unable to pass through and must cross the road in order to enter and leave Chino Hills State Park through this corridor. If Carbon Canyon Road is widened to accommodate greater vehicle usage, wildlife losses will increase unless adequate mitigation measures are enacted.

Prado Basin

The Prado Basin biocorridor links Chino Hills State Park with the high quality habitat within the basin and with the upper reaches of the Santa Ana River to the east. The State Endangered western yellow-billed cuckoo and the State and Federally Endangered least Bell's vireo have been documented within the Prado Basin. This corridor offers an important opportunity for exchange of these species between the park's Fremont Cottonwood habitat along the Santa Ana River and that of the Prado Basin. As with the other corridors connecting Chino Hills State Park to adjacent open space areas, this one is bisected by a major highway. As mitigation for the widening of State Highway 71, the California Department of Transportation installed fences in an attempt to direct wildlife into culverts and away from at-road crossings of the freeway.

Plant Life

Vegetation Types

At first look, Chino Hills State Park may appear to be simply composed of rolling hills covered with non-native grassland. Although these grasslands are truly the dominant vegetation type in the park, a closer look reveals a significant diversity of plant community types. In fact, Chino Hills State Park supports 14 different vegetation series as defined in the California Native Plant Society's (CNPS) classification, *A Manual of California Vegetation* by John O. Sawyer and Todd Keeler-Wolf (1995). A Draft Vegetation Map has been delineated for the park following this classification scheme (see Figure 5). The vegetation type series mapped for Chino Hills State Park are listed in the following table:

Series

California Grassland Series	California Walnut Series
Purple Sage Series	California Sagebrush Series
Sumac Series	California Buckwheat Series
Coast Prickly Pear Series	Coast Live Oak Series
California Sycamore Series	Arroyo Willow Series
Fremont Cottonwood Series	Mulefat Series
Purple Needlegrass Series	Cattail Series

Of these 14 vegetation types, 9 are considered unique or significant in southern California because their acreage is rapidly dwindling and because of their importance as habitat to both sensitive and common wildlife species. These 9 are the California Walnut Series, California Buckwheat Series, California Sagebrush Series, Purple Sage Series, Coast Prickly Pear Series, Sumac Series, Arroyo Willow Series, Fremont Cottonwood Series, and California Sycamore Series.

California Walnut Series
The southern California black walnut (*Juglans californica* var. *californica*) has a range limited to the Los Angeles Basin and surrounding foothills. Some of the largest remaining woodlands in southern California can be found in Chino Hills State Park, particularly throughout Water Canyon, on the south side of Telegraph Canyon, and in the Sonome Canyon Area. Walnut trees are found typically on north-facing slopes and in canyon bottoms and are often in association with coast live oak (*Quercus agrifolia*).


Southern California black walnut woodland – Water Canyon

Coastal Sage Scrub Habitats: California Buckwheat Series, California Sagebrush Series, Purple Sage Series, and Coast Prickly Pear Series
The coastal sage scrub habitats have declined rapidly in southern California due to increased open space development. Remaining patches of habitat in the state have become crucial to the survival of many animal species, including the California gnatcatcher (*Polioptila californica*), a Federally Threatened bird species. Even the coastal sage scrub habitat types that are not ideal for California gnatcatcher nesting sites are important for the species dispersal into nearby habitats that are more suitable.

California Buckwheat Series is a type of coastal sage scrub habitat that is dominated by California buckwheat (*Eriogonum fasciculatum*) in association with California sagebrush (*Artemisia californica*), white sage (*Salvia apiana*), purple sage (*Salvia leucophylla*), and black sage (*Salvia mellifera*). This habitat type is important to California gnatcatcher survival. The California Buckwheat Series is well represented in various parts of Chino Hills State Park, with excellent examples in Telegraph Canyon.

California Sagebrush Series is another type of coastal sage scrub habitat. This vegetation series differs from the California Buckwheat Series in that it is dominated, sometimes entirely, by California sagebrush (*Artemisia californica*) and may also include California buckwheat (*Eriogonum fasciculatum*), black sage (*Salvia mellifera*), bush monkeyflower (*Mimulus aurantiacus*), purple sage (*Salvia leucophylla*), white sage (*Salvia apiana*), or lemonade berry (*Rhus integrifolia*). This habitat type is as important to California gnatcatcher survival as the California Buckwheat Series. As of 1998, the California gnatcatcher had been documented as nesting within park boundaries only in the California Sagebrush Series habitat along the park's southern boundary.

Purple Sage Series, another type of coastal sage scrub habitat, is different from the others in that it is dominated by purple sage (*Salvia leucophylla*). Purple sage may be the sole component in this series, but typically California sagebrush (*Artemisia californica*) occurs in the canopy as well. Examples of this series can be found in the Sonome Canyon Area.

Coast Prickly Pear Series is dominated by the coast prickly pear (*Opuntia littoralis*). This habitat is found as small patches in various locations within the park. Some good examples can be found on the south-facing slope in Telegraph Canyon and in Upper Aliso Canyon. The cactus wren (*Campylorhynchus brunneicapillus*), a California Species of Concern, is dependent upon this habitat and is found in many of the park's cactus patches.


Coast Prickly Pear – Upper Aliso Canyon

Sumac Series
Sumac Series is dominated by relatively tall shrubs such as laurel sumac (*Malosma laurina*), toyon (*Heteromeles arbutifolia*), and lemonade berry (*Rhus integrifolia*). This series is well represented in Chino Hills State Park particularly along the north ridge of Telegraph Canyon. Because the understory is composed of several coastal sage scrub species such as California buckwheat and California sagebrush, this series could provide habitat for the California gnatcatcher.

Riparian Habitats: Arroyo Willow Series, Fremont Cottonwood Series, and California Sycamore Series
Riparian habitat in general is uncommon in southern California. It is important habitat for many wildlife species that use it for nesting, foraging, perching, and cover from the hot sun. It has decreased dramatically over the years and continues to decline due to development and habitat degradation.

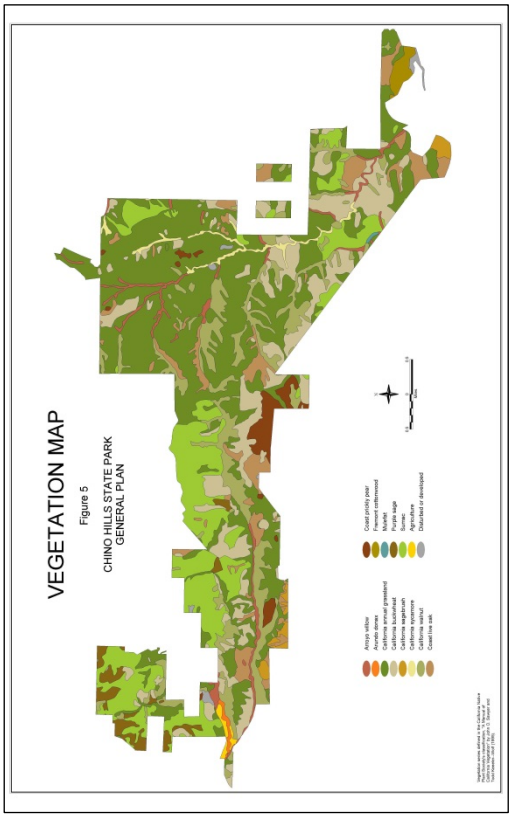
Arroyo Willow Series is a type of riparian habitat that is represented in several of the canyons in the park by thickets dominated by the arroyo willow (*Salix lasiolepis*). Some examples of this habitat are found in Upper and Lower Aliso Canyon and Telegraph Canyon. It is excellent habitat for wildlife such as herpetofauna (reptiles and amphibians), birds, and mammals. Within the park, this habitat supports the existence of the State Endangered willow flycatcher (*Empidonax traillii*) and least Bell's vireo (*Vireo bellii pusillus*).

Fremont Cottonwood Series is another type of riparian habitat that is found in the park only within a small area along the Santa Ana River. This type of habitat is extremely limited in southern California and is of crucial importance for two bird species. These species are the State Endangered western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), which has been documented in adjacent habitat within the Prado Basin, and the State and Federal Endangered least Bell's vireo (*Vireo bellii pusillus*), which has been documented within this habitat at Chino Hills State Park.

California Sycamore Series is a type of riparian woodland dominated by the California sycamore (*Platanus racemosa*). This habitat within Chino Hills State Park is well represented in Aliso Canyon. Dominated by mature sycamore trees, the woodland is valuable for various bird- perching and nesting sites and is habitat for various arboreal wildlife species. Sycamore tree seedlings are uncommon in the park, as well as elsewhere. This is due, in part, to competition with non-native annual grasses and forbs.


California sycamore – Bane Canyon

Cattail Series
Three livestock ponds, McDermott Spring, Windmill, and Panorama Ponds were constructed by previous land owners and offer year-round water for wildlife as well as suitable conditions for the establishment of aquatic plants and emergent wetland vegetation.



Purple Needlegrass Series
Small stands of the native bunchgrass called purple needlegrass (*Nasella pulchra*) are recovering in some areas within Chino Hills State Park. Prior to heavy grazing and other disturbances in the Chino Hills, purple needlegrass and other native perennial bunchgrasses dominated the grasslands. Currently, the extent of native bunchgrass patches in the park is minimal compared to the coverage of non-native annual grassland.

Sensitive Plant Populations
There are three sensitive plant taxa known to occur within the boundaries of Chino Hills State Park (see below). One is a Federal Species of Concern, but all three are listed in the California Native Plant Society - Inventory of Rare and Endangered Vascular Plants of California.

There are several other sensitive taxa that have a potential to occur within the park (see below). One of these, Braunton's milk-vetch (*Astragalus brauntonii*) is documented as occurring on property adjacent to the park and is likely to occur within park boundaries, as well. This species is currently listed as Federal Endangered. Seven other listed sensitive plant taxa have the potential to occur within park boundaries.

Catalina Mariposa Lily

1998 Sensitive Plant Taxa Known To Occur Within Chino Hills State Park

Taxon	Common name	CNPS List*	State/Federal List*
Dudleya multicaulis	many-stemmed dudleya	1B	FSC
Calochortus catalinae	Catalina mariposa lily	4	
Romneya coulteri	Coulter's matilija poppy	4	

1998 Sensitive Plant Taxa For Which Potential Habitat Exists Within Chino Hills State Park

Taxon	Common name	CNPS List*	State/Federal List*
Astragalus brauntonii	Braunton's milk-vetch	1B	FE
Calochortus weedii var. *intermedius*	intermediate mariposa lily	1B	
Atriplex coulteri	Coulter's saltbush	1B	
Brodiaea filifolia	thread-leaved brodiaea	1B	CE/FSC

Hemizonia pungens ssp. *laevis*	smooth tarplant	1B	
Chorizanthe parryi var. *fernandina*	San Fernando Valley spineflower	1A	
Dodecahema leptocera	slender-horned spineflower	1B	CE/FE
Eriastrum densifolium ssp. *sanctorum*	Santa Ana River woollystar	1B	CE/FE

*Listing status codes: CNPS 1A = Presumed extinct in California; CNPS 1B = Rare and Endangered in California and elsewhere; CNPS 4 = Plants of limited distribution; FSC = Federal Species of Concern (formerly candidate species); CE = State of California Endangered; FE = Federally Endangered

Exotic Plant Populations
For over 100 years, livestock grazing occurred within the boundaries of what is now Chino Hills State Park. This grazing, along with fire suppression, disrupted natural ecological processes and allowed the introduction and rapid expansion of many non-native plant pest species to occur. The most noticeable disturbance has occurred in the many acres of open grassland which are now heavily dominated by non-native annual grasses and mustards. However, riparian areas have been adversely affected as well. Heavy grazing in riparian areas has disturbed habitat and degraded water quality thus paving the way for the proliferation of such exotic plant pests as the tree-of-heaven (*Ailanthus altissima*).

The giant cane (*Arundo donax*) is an invasive, exotic plant that is found in the Santa Ana River and Carbon Canyon Creek. Giant cane is currently manageable in the portion of the Santa Ana River within park boundaries, but has overrun Carbon Canyon Creek. Efforts will be necessary to further control and eradicate this species from park property.

Animal Life

The great diversity of vegetation types and habitat supports the existence of a wide variety of animal species. Some of the taxa occurring in the park are considered threatened, endangered, or species of special concern by the U.S. Fish and Wildlife Service and/or the California Department of Fish and Game.

Sensitive Animal Populations

Mammals
Two California Mammal Species of Special Concern are known to occur within Chino Hills State Park. These are the western mastiff bat and the mountain lion (also a California Fully Protected Species). In addition to these, 22 special status mammal species have been recorded with the California Natural Diversity Database (CNDDB) of the California Department of Fish and Game as occurring in the vicinity of the park. Although they have not been documented within the park as of 1998, suitable habitat exists within the park to support their existence (see Appendix A).

Birds
Chino Hills State Park provides suitable habitat for numerous bird species. Of the 15 sensitive bird species documented using the park, one is on the Federal Threatened list, two are listed as Federal Endangered, two as California Fully Protected, two as California Endangered, eight are California Species of Special Concern, and three are of local or regional concern even though they don't appear on current sensitivity lists (see Appendix A). Several of these taxa occur on more than one sensitivity list. Suitable habitat exists within the park for an additional 28 bird species that have special status although they had not been documented there as of 1998 (see Appendix A).

Golden Eagle – Brush Canyon (photo by Rick Jackson)

Reptiles
Six sensitive reptile species occur within the boundaries of Chino Hills State Park: the southwestern pond turtle, San Bernardino ringneck snake, San Diego (coast) horned lizard, northern red-diamond rattlesnake, coast patch-nosed snake, and coastal western whiptail. All of these are considered California Species of Special Concern, but the pond turtle and the horned lizard are also listed as California Fully Protected. Suitable habitat for eleven other sensitive reptile species occurs within the park boundaries (see Appendix A).

Amphibians
There are nine special status amphibian taxa that could occur in the park (see Appendix A). Three of these, the arboreal salamander (a species of local concern), the western spadefoot (California Fully Protected, California Species of Special Concern), and the Monterey salamander have been documented as occurring within park boundaries.

In all, 23 wildlife taxa with some level of sensitivity have been documented utilizing the habitats and resources of Chino Hills State Park. Also, suitable habitat exists to support 65 additional sensitive animal taxa. These numbers are very large for a park the size of Chino Hills State Park.

Aquatic Life

Fish habitat in the Santa Ana River and in most of its tributaries has been significantly reduced from its original extent. Stream channelization, dams, and other projects related to urbanization of the Los Angeles plain have contributed to this habitat loss. As a result, steelhead and Pacific lamprey, two anadromous fish species that once inhabited the river, are no longer present. Of the native freshwater fish species, only the arroyo chub still can be found in the Santa Ana River. The Santa Ana sucker, Santa Ana speckled dace, and unarmored three-spine stickleback no longer exist in this river system. Currently, the unarmored three-spine stickleback is listed as both State and Federal Endangered and a recovery team is inspecting the possibility of appropriate sites for reintroduction within the park (see Appendix A).

Lower Aliso Creek

Chino Hills State Park includes a one-mile-long unchanneled section of the Santa Ana River. Also within park boundaries, Aliso Creek, which provides suitable habitat for the four freshwater fish native to the area, is the only unchanneled tributary with access to the river downstream of the Prado Dam. It also contains a perennial reach that supports populations of the arroyo chub. Aquatic habitat in Aliso Creek has become increasingly important to the regional conservation of the arroyo chub. The introduction of pollutants and exotic animal species has reduced habitat quality in the Santa Ana River. Introduced crayfish, two species of non-native fish, and African clawed frogs are present in Aliso Creek. They are both a competitive and predatory threat to the arroyo chub.

Paleontology

Chino Hills State Park has not been systematically surveyed for paleontological resources. However, many fossils have been found in the Chino Hills area. The Puente Formation, present throughout the park, is well documented to contain abundant fossil deposits. Fossil specimens known to be present in that geologic formation include whales, porpoises, fish, shark teeth, leaves, marine invertebrates, and others. The Puente Formation is particularly well recognized for its fossil fish remains, especially near-shore species. Unique Pliocene-age fossil deposits may also be present in the southeastern portion of the park. Microscopic foraminifera are also contained in the marine sandstone members. A thorough paleontological survey may reveal that important fossil deposits exist within the park.

Cultural Resources

Native American Ethnographic Overview

Chino Hills State Park is located in the inland southern portion of the traditional Gabrielino territory in close proximity to the Juaneño, Luiseño, Serrano, and Cahuilla Indian groups. The Gabrielino were occupying lands in and around the park at the time the Spaniards arrived in southern California.

The Gabrielino are reported to have been the wealthiest, most populous, and most powerful ethnic nationality in aboriginal southern California, other than the Chumash. The Gabrielino possessed a material culture reflecting sophisticated knowledge of the working qualities of natural materials and elaborate artisanship. They were particularly known for their tool, utensils, and ritual objects. The Gabrielino traded their creations, food products, and animal skins over a broad region in present-day southern California.

San Gabriel Mission baptism records list village names and an occasional note concerning village locations. These location notes and the number of individuals baptized suggest that four large villages were situated in the Santa Ana River Basin near Chino Hills State Park. The Indians of these villages are hypothesized to have regularly exploited the natural resources of the Chino Hills.

Historic Overview

The historic period of the Park dates from the first recorded Euroamerican explorations along the Santa Ana River in the late-eighteenth century and continues through ranching endeavors of the mid-twentieth century.

This area was originally part of the extensive grazing lands granted to the San Gabriel Mission, which was established in 1771. During the Mexican Republic era, the area served as spillover grazing land for Rancho Santa Ana del Chino to the north, Rancho La Brea to the west, and Ranchos Cañon de Santa Ana and La Sierra Yorba to the south. In 1848, when Mexico ceded California to the United States, it became part of the United States public domain lands. Documented legal acquisition of public land in the park began during the last three decades of the nineteenth century.

Throughout its recorded history, the area served primarily as grazing land, although some late-nineteenth and early-twentieth century agriculture, horticulture, oil exploration, and mining activities occurred in parts of the park. Historic activity left only one complex of historic buildings (Rolling M Ranch) and scattered historic features. However, stock grazing had a significant effect on the park. Cattle and sheep grazing eliminated native grasses and grains once used by Native Americans as food sources, and ranchers introduced non-native grasses to feed stock herds.

Hispanic Period (1771-1848)
Although exploration occurred both north and south of the park, there is no documented evidence indicating the park was formally surveyed by Euroamericans during the eighteenth or early-nineteenth century, nor legally acquired prior to the 1830s. Mission San Gabriel was established just 20 miles northwest of the park, so stock grazing may have occurred on park land as early as the 1770s.

Early American Period (1848-1920)
In contrast to the surrounding region, there is no evidence of permanent activity other than grazing in the present-day park prior to the U.S. Surveyor General's public domain surveys. These surveys began in 1853 and were not completed until 1894. The deputy surveyor's field notes do not note any structures, fences, or wagon roads in the park, although much of the land was obtained and used for grazing during this period.

Legal acquisition of public domain land within Chino Hills State Park by private individuals did not begin until the early 1870s. Many of those filing were associated with the small ranching community of Rincon just east of the park boundary along the Prado Basin. Local ranchers such as Fenton Slaughter, who had purchased Raymundo Yorba's home and property in 1868, established successful sheep and cattle ranching operations that extended into the eastern limits of Chino Hills State Park. Activity and ownership increased during the Great Land Boom of the mid-1880s. Those who purchased Chino Hills land for ranching use included the founder of the town of Chino, Richard Gird. By 1895 much of the future park property was under absentee ownership, such as that of the San Francisco based Chino Land and Water Company.

Although most of the Chino Hills land was in ownership by 1900, the first published USGS quadrangle map of 1902 indicates only three miscellaneous structures and a wagon road running within current park boundaries. These structures were likely associated with various ranching and mineral extraction activities. Although no large deposits were located or exploited within the park, several oil wells and mines have been documented from this period.

Twentieth Century Development Period (1920s-1980)
During the inter-war years of the 1920s to the 1940s, the ranching industry reached its most active period at Chino Hills. In 1921, local dairy rancher Frank Pellissier purchased most of the Chino Land and Water Company holdings for his dairy herds, including the area of the future Rolling M Ranch. The first aerial photographs of the region in the late 1930s indicate numerous cleared areas that had obviously received regular grazing activity along almost all the watershed canyons of the park, including near the Santa Ana River and Carbon Canyon.

The 1940s would also see the increased development of the Rolling M Ranch complex. Aerial photographs show several structures and cleared areas on the site by 1940. In

1948, the Mollin Investment Company acquired 1,720 acres, subsequently giving the area the name of the Rolling M Ranch. The company enlarged and improved the corral system and rehabilitated and enlarged the main house. Mollin owned the property until the establishment of the State Park in the 1980s.

Cultural Resources Within The Park

Archaeological Resources
Archaeological resources within Chino Hills State Park include those from both the prehistoric and historic periods. Some areas of the park have not been surveyed for archaeological resources, so, the full extent of archaeological resources occurring in the park is not known. Descriptions and locations of recorded sites are found in the park Resource Inventory, as well as in other Department files.

Prehistorical Archaeology
The Native American sites located in Chino Hills State Park indicate that the Indians of the Santa Ana River Basin used the area for hunting and gathering. To date, two Native American camp sites and many isolated artifacts have been identified and recorded in the park. The range of site types recorded within the park includes one site with occupational debris and appreciable depth, one with sparse occupational remains, an outcrop with one cupule petroglyph, numerous isolated metates and manos, and two isolated projectile points. Archaeological surveys of limited scope within the Sonome Canyon Area have yielded no archaeological sites to date.

The most recent dates for sites in the Prado Basin and Chino Hills are not well defined, but fall around 1,000 years before present (BP). Mission baptismal records indicate the former presence of aboriginal villages near Chino Hills State Park, however, archeological data on these villages is lacking. One site within Chino Hills State Park yielded dates between 1,070 and 2,380 years BP.

Historical Resources
The park's historic period resources include various structures, features, and cultural landscapes. Most are associated with ranching, the dominant historical land use. Other historic resources are associated with mineral and oil extraction, transportation and other public utilities, and varied agricultural and horticultural uses.

Only some of these resources are inventoried and identified. Most of these were evaluated as individual features. Those sites identified as locally or regionally significant include the Rolling M Ranch complex (seven structures) and four windmills, circa 1900-1930. Twenty other historic-period sites have been recorded. Most of these lack individual significance, but when evaluated collectively as features of the larger landscape, their historical significance is apparent. Such features include corrals, stock ponds, water troughs, water tanks, cross fencing, structure and equipment remains, and small, miscellaneous structures.

Cultural Landscapes

The most significant historic resource at Chino Hills State Park is the historic ranch landscape, a vernacular landscape that reflects the lives and activities of those occupying the land in the late-nineteenth and early-twentieth centuries. This remnant, rural landscape provides a rich contrast to the dense urban development fast enveloping the park. The historic character is defined by patterned relationships of cultural features to the land – its inherent topography, soils, vegetation, and water sources – and also to climate patterns. Landscape components (old trails, ranch roads, fields, orchards); water system features (windmills, stock ponds, water troughs, tanks, pipes); and individual elements, such as the barn, sheds, stock fences, chute, scale, and other ranching equipment, remind us of this historic "working landscape".

Cattle chute at Rolling M Ranch

The park contains several sites associated with the history of the local oil industry and small-scale mining efforts. Research available at this time does not indicate that any of these sites is individually significant. However, they do represent locally recognized historic land uses within Chino Hills State Park.

Of six livestock ponds that were constructed in the park during the ranching era, four are still present. Three of these, McDermott Spring, and Windmill and Panorama ponds, have stable earthen dams, are not interfering with fish migration routes, and are deep enough to provide positive wildlife habitat values. These ponds represent a significant example of the historic ranching landscape.

Approximately 40 acres of lemon trees in the Lemon Grove Area represent the only extant remnant of the historically significant citrus industry that once surrounded the park. This area is located off Carbon Canyon Road at the far-western end of the park. It offers trailhead parking and access to Telegraph Canyon.

Collections

The most notable collection currently housed at the park is a collection of historic ranching artifacts once used at the Rolling M Ranch and surrounding ranchlands. These artifacts represent a prime resource for interpreting the events of the historic ranching era.

Aesthetic Resources

Aesthetic value is attributed by park visitors to experiences, features, and qualities in harmony with natural, unmanipulated conditions and is perceived through the senses, by seeing, hearing, touching, smelling, and tasting. In addition to the tangible natural and cultural features such as plants, animals, waters, geologic features, buildings, and archaeological sites, Chino Hills State Park also offers many intangible qualities. These include natural quiet, solitude, space, scenery, a sense of history, sounds of nature, and clear night skies that are important components of people's enjoyment of the park.

The appearance of the landscape in Chino Hills State Park is relatively unaltered by the works of humans, especially when compared to the surrounding urban landscape. Long distance views of natural terrain and vegetation are available from selected locations. The acquisition plans for this park have emphasized the value of acquiring ridgetops to protect the viewsheds within the park. As a result, the relative pristine views of the hills from Telegraph and Aliso Canyons and from selected panorama points have been mostly protected from urban encroachments. Viewpoints of particular interest are San Juan Hill, Gilman Peak, and McLean Overlook.

A wide variety of more intimate natural scenes are available throughout the park. Densely wooded canyon bottoms offer dark shade, lush vegetation, and running water. Many species of wildflowers provide scenes of great beauty during the spring. The grassy hills are brilliant green during the spring and golden brown in the summer.

Due to the proximity to urban environments, the hills are interlaced with utility easements, roads, and other human-made works that are significant negative visual features in the park. By far the most prominent negative visual features are the many high-voltage electrical transmission lines that traverse the park. Other negative visual features include partially buried natural gas pipelines and the many unsurfaced roads. Also, some modern facilities such as a large cribbed retaining wall along the entrance road and modern site amenities at the overlook area near the Rolling M Ranch are not compatible with the rural scenery and detract from the visitor's experience of the natural landscape.

Electrical transmission lines – Telegraph Canyon

Recreational Resources

The proximity of its natural open space to urban populations and extensive trail network make Chino Hills State Park a popular and valuable recreational resource. Visitors enjoy both active and passive forms of recreation that focus primarily on trail use. People frequently visit the park from adjacent communities to walk, jog, bike, or ride horses. The park is also a popular spot for family and equestrian campers, as well as picnickers.

Trail Use

Trails are used by a majority of visitors for their recreational pursuits (see Figure 3). The trail network gives access to many of the park's special places, including wooded riparian areas, open grasslands, and scenic viewpoints. The variety of trails available at the park offers a wide range of difficulty and recreational experience. Many visitors use the trails for active-types of recreation such as jogging, hiking, mountain biking, and horseback riding. Other visitors use the trails for passive-type activities such as bird watching, photography, and nature study. Some hiking-only trails occur in the park to accommodate these activities.

Hiking trail in Water Canyon

Conflicts between trail users have occurred on multi-use trails in the park. These conflicts have resulted when trail users perceive their trail experience to be negatively affected by the behavior or activity of another. Trail users with different activity styles, modes of travel, or expectations sometimes perceive other trail uses to be incompatible with their use.

Camping and Picnicking

The shaded campground area near Aliso Creek offers a comfortable and appealing camping location. The site is suitable for families, small groups, and equestrians. The equestrian staging area is a large, flat area with scenic vistas of the park. This area is suitable for large equestrian groups as well as individuals and families with horses. Both sites are along the interior of the park, offering a quiet location and dark nighttime skies suitable for stargazing (see Figure 4).

Several family picnic sites occur along the interior of the park (see Figure 4). The most popular of these is at a shade ramada located at the Rolling M Ranch.

PLANNING INFLUENCES

The goals and guidelines established in the *Plan Section* of this document are the result of many factors. The existing conditions of the park; the natural, cultural, and aesthetic resources; and the public use of the park all shape general planning. In addition, there are other factors that influence long-range planning. The influences of system-wide planning, regional planning, and public concerns are summarized in this section.

SYSTEM-WIDE PLANNING

Some regulations, policies, and plans address issues that cross park and regional boundaries. Appendix B (Page 96) shows system-wide planning influences that may affect planning decisions at Chino Hills State Park. Any system-wide plans developed in the future that contain specific recommendations pertaining to the use, operation, or management of the State Park may also effect future planning decisions at Chino Hills State Park.

REGIONAL PLANNING

Certain plans and programs address regional issues and events. The following regional influences may affect planning decisions at Chino Hills State Park.

Natural Communities Conservation Program (NCCP)

The Department of Parks and Recreation has signed a Memorandum of Agreement (MOA) with the California Department of Fish and Game (DFG) outlining each agency's responsibilities in the implementation of the Coastal Sage Scrub Natural Communities Conservation Program (NCCP).

In cooperation with the U.S. Fish and Wildlife Service (USFWS), the NCCP is designed to provide for regional protection and conservation of sensitive species habitat at the natural community level and at the same time to allow for compatible development and urban growth. The program is attempting to do this by acquiring and protecting large parcels of adjoining quality habitat and by restoring adjacent habitat of lower quality within an interconnected core habitat system. California State Parks, as a leader in the conservation and management of the natural habitats, is playing an important role in the formulation of regional preserves for the NCCP.

Southern California, with its fast urban growth rate and urgent need to preserve rapidly declining natural habitats, is the first area of the state to implement the NCCP. The focus is on coastal sage scrub habitat, crucial to the survival of the Federal Threatened California gnatcatcher and an important habitat for species of concern such as the coastal cactus wren and the orange-throated whiptail.

Chino Hills State Park has a considerable amount of high quality coastal sage scrub habitat within its boundaries. Its lands have been enrolled as a reserve in the NCCP program, and its contribution to a regional NCCP Habitat Conservation Plan (HCP) is imminent. The park's inclusion in the NCCP program necessitates that management of the park should be consistent with NCCP long-term plans and management goals.

Biocorridors

Biocorridors, or habitat linkages, are imperative to the biological survival of Chino Hills State Park and the Puente-Chino and Whittier Hills. These biocorridors cross several jurisdictional and private property boundaries. To effectively manage them for the facilitation of wildlife movement requires cooperation and a regional perspective.

The Wildlife Corridor Conservation Authority (WCCA) is a local joint powers authority (JPA) represented by city and state agencies, as well as members of the public. California State Parks is currently represented as a Governing Board member of the JPA. The mission of WCCA is to provide for the proper planning, conservation, environmental protection, and maintenance of the habitat and wildlife corridor between the Puente Hills in the west and the Chino Hills in the east, which connects to the Cleveland National Forest to the south. WCCA encourages the Department to pay special attention to the areas that are ecologically sensitive such as the north-south connection between the park and the Cleveland National Forest, and the east-west connection between the park and the Prado Basin. It is the responsibility of Chino Hills State Park to manage identified wildlife movement corridors within the park's boundaries in a manner consistent with the conservation and perpetuation of the species that use them and to facilitate their movement.

The results of resource studies undertaken by WCCA are available to Department managers for use at Chino Hills State Park.

Santa Ana River

A small area of Chino Hills State Park is in the Santa Ana Canyon and Santa Ana River Flood Plain. This area between the Green River Golf Course and State Route 71 is subject to the *Lower Santa Ana River Canyon Resource, Floodplain, and Habitat Management Plan*. The Department was a part of the Study Group that developed the plan. Flowage easement rights are also required in this portion of the park for the Santa Ana River Mainstem Project, per an agreement between the Riverside County Flood Control and Water Conservation District (RCFC&WCD) and the Department.

Trails

Many regional riding and hiking trails and bikeways exist in the vicinity of Chino Hills State Park. Because the park borders four counties and three cities, there are numerous opportunities to link regional trails with those at the park. The cities of

Anaheim, Brea, Chino Hills, and Yorba Linda, as well as the County of Orange, for example, currently show trail linkages to the State Park in their general plans. The following agencies have regional trail plans: City of Chino Hills, City of Anaheim, Orange County Transportation Agency, County of Orange, and City of Yorba Linda.

Park Access

The cities adjacent to the park, Yorba Linda, Brea, and Chino Hills, have expressed concerns about providing adequate park access and trailhead parking. This is a result of problems associated with visitors parking on residential streets to access the trail network.

Wildfire Management

The City of Brea is concerned about park activities that may affect adjoining wildlands in the jurisdiction of the City of Brea. In addition, the Metropolitan Water District of Southern California (MWD), because of their operation of a water filtration plant adjacent to the park, as well as water feeder lines and easements within the park, is concerned about any wildfire management planning occurring at the park. Parties to the Habitat Conservation Plan (HCP) also are concerned about wildfire management planning at the park.

Habitat Conservation

The Metropolitan Water District of Southern California (MWD) and Shell Western E&P Inc., adjacent property owners to the park with planned future activities that will have impacts on habitat, have developed a Habitat Conservation Plan (HCP) with the Department and other agencies (U.S. Fish and Wildlife Service, California Department of Fish and Game, the County of Orange, the Cities of Yorba Linda and Brea, and Hills for Everyone) in accordance with Section 10(a)(1)(B) of the Federal Endangered Species Act. The HCP is a plan to protect and restore coastal sage scrub habitat and the species that utilize it. The HCP was required as mitigation for the development by Metropolitan and Shell Western E&P Inc. of coastal sage scrub habitat used by the Federally listed California gnatcatcher. The HCP covers a 2,600-acre Study/Management Area in the western portion of Chino Hills State Park and results in the preservation of more than 1,200 acres, including the Sonome Canyon Area.

The HCP is a major component of the Natural Communities Conservation Program (NCCP) because it provides crucial habitat protection and enhancement for some of the last remaining coastal sage scrub habitat in the region. The HCP includes resource management objectives for the area that are consistent with Department goals and also provides for a resource ecologist to implement and monitor results of the program for a period of fifteen years.

Utility Easements and Roads

Metropolitan Water District of Southern California (MWD)

The Metropolitan Water District of Southern California (MWD) operates the Robert B. Diemer Water Filtration Plant at its 200-acre facility adjacent to the southern boundary of the park in Orange County. MWD's Yorba Linda Feeder tunnel and pipeline system traverses the park in a north-south direction to connect with the Diemer plant. In addition, MWD's Lower Feeder pipeline traverses the park in San Bernardino County in an east-west direction.

MWD's *Guidelines for Development in the Area of Facilities, Fee Properties, and/or Easements of the Metropolitan Water District of Southern California* was developed to assist other agencies, including the Department of Parks and Recreation, in preparing plans that are compatible with MWD's facilities and easements.

In addition, MWD Operations personnel use several dirt roads, including those along the Lower Feeder and Yorba Linda Feeder rights-of-way and to miscellaneous substructure facilities associated with pipelines. Any of the Department's maintenance activities, land uses, or planning efforts that affect MWD's access is a concern of MWD.

MWD has an Emergency Response Plan. This plan addresses public safety issues associated with nearby storage areas of hazardous chemicals. These chemicals are currently used in the water treatment process and stored in bulk at the Diemer plant. Any public uses planned for park areas adjacent to the plant are a concern of MWD.

Heavy trucks must routinely travel through the park to access the solids drying ponds near Telegraph Creek. Any activities or planning that affect this access is a concern of MWD.

Southern California Edison

Southern California Edison (SCE) Operations personnel use several dirt roads in the park to access gas pipelines and electric transmission lines. Any of the Department's maintenance activities, land uses, or planning efforts that affect safe access to SCE facilities is a concern of SCE.

Regional Transportation

The Southern California Association of Governments (SCAG) is the authority for the Regional Transportation Plan (RTP) that incorporates Chino Hills State Park and communities in the region. The 1998 RTP is known as *CommunityLink 21*, which covers the period from 1998 to 2020. This plan addresses mobility, economic, social, and environmental goals and objectives for transportation planning for the region.

The Orange County Transportation Agency and the Southern California Association of Governments are lead agencies of the Four Corners Policy Committee. This committee is made up of representatives from county, city, and local government agencies, as well as regional transportation agencies and private organizations in the affected area. The area that surrounds Chino Hills State Park is named for the four corners of the Counties of Los Angeles, San Bernardino, Orange, and Riverside, which come together at this location and includes State Routes 57, 90, 142, 71, 91, 60, 83, and Interstate 15. Knowledge of proposals made in the RTP and by the Four Corners Policy Committee, as well as other potential regional transportation authorities, is crucial to understanding potential impacts to resources and operation of the park.

POPULATION TRENDS

The proximity of Chino Hills State Park to the intensely developed metropolitan areas of Los Angeles, Orange, Riverside and San Bernardino Counties potentially offers an open-space retreat to 15 million people. By the year 2020, the California Department of Finance projects that the resident population of these counties will grow by 32 percent and exceed 22 million people. This means that approximately 45 percent of the state's population will live within 40 miles (a short driving distance) of the park. The estimated resident population of the three bordering communities of Brea, Yorba Linda, and Chino Hills is expected to exceed 225,000 people by the year 2025. These local populations will create the highest demand for park use.

The regional population is unparalleled in its cultural and ethnic diversity and includes a growing number of single-parent households. It is important to note that in the next twenty years there will be a population explosion of senior-aged citizens. To accommodate these citizens, Chino Hills State Park will need to provide for a wider range of recreational interests and abilities than it does now.

Visitor attendance at Chino Hills State Park steadily increased between the opening of the park in 1984 and 1995. There were an estimated 9,845 visitors to the park in 1990. This amount increased to an estimated 193,891 visitors in 1995. Attendance from 1995 through 1997 decreased slightly to an average 171,835 visitors per year.

PUBLIC CONCERN

Public input was solicited at several steps in the general plan process. Several meetings were held to familiarize the public with the planning process and park issues. The first public meeting, held in the City of Brea, was informative and provided an opportunity to describe the significant resources and unique features that make Chino Hills State Park a special place. The meeting was opened to public comments, and all comments were noted. In addition, a questionnaire was distributed to those attending to gauge what issues and concerns were considered most important. Responses from the questionnaires indicated that the primary interest in

Chino Hills State Park was for natural resource preservation, interpretation, and recreational activities. The majority of respondents thought that the park should be left natural and undeveloped. Trails and public access were important concerns as well.

The second public meeting, held in the City of Chino Hills, was a workshop where participants noted specific concerns and commented on proposed general plan guidelines. A similar workshop was held in the City of Yorba Linda to expand opportunities for public involvement to surrounding communities. After each workshop proposed guidelines were reevaluated and, where appropriate, rewritten to incorporate these comments and suggestions. The overriding concerns were public use of the proposed Core Habitat Zone, the need for improved public access points into the park, and the desire to restrict future developments and concessions within park boundaries.

A final public meeting, describing plan alternatives and the preferred plan, was held in the City of Corona. At the end of the meeting, the public was invited to ask questions. These were again noted and reviewed after the meeting.

Throughout the course of public involvement in the general plan process for Chino Hills State Park, it was clear that the primary issues of concern for park users are those related to park access, trail use, and maintaining the wildness of the park by restricting further developments and concessions.

In addition to the meetings held for the general public, the Chino Hills State Park General Plan team held a meeting with public agency representatives. Concerns were voiced about public access points and parking, continued access to utility company structures and maintenance of utility roads, and the need for more interpretive programs, including campfire programs, designed to increase public awareness of the park's resources.

Residential subdivision adjacent to park entrance at Bane Canyon

ISSUES

The *Issues Section* highlights the important issues derived from the *Park Summary* (beginning on Page 9) and from the *Planning Influences* (beginning on Page 37). The goals and guidelines of the *Plan Section* address these issues.

RESOURCE MANAGEMENT AND PROTECTION

Biocorridors and Core Habitat Areas

Urbanization within and surrounding the Puente-Chino Hills has resulted in the near biological separation of Chino Hills State Park from adjacent open-space areas. The remaining biological connections to these adjacent areas are tenuous. They are bisected by roads and reduced in size by the conversion of surrounding open space urban uses. In some cases, portions of remaining, viable habitat linkages are privately owned and unprotected. Development of these private parcels will jeopardize the diversity and integrity of the park's biological resources by eliminating or reducing wildlife movement through these corridors. The identification and management of areas containing representative, sensitive, or otherwise important habitats within the park and the biocorridors that link these habitats to those outside of the park, are essential to the maintenance of the park and regional ecosystems.

Natural Resources

Increased awareness of the diversity and fragility of sensitive plant and animal species, as well as their supporting habitats has created greater need to protect and interpret these resources. Further guidance to direct resource management and conservation efforts at the park is needed to ensure the perpetuation of these values for future generations.

Historic Resources

Information acquired since the original general plan places new emphasis on the park's historic resources, particularly the historic ranching landscape and features associated with the Rolling M Ranch. Greater protection and interpretation of these historic resources is needed in order to preserve California's heritage and for the education and enjoyment of park visitors.

Aesthetic Resources

Aesthetic qualities of the park can be adversely impacted by man-made intrusions such as developments, activities, or land uses that are incompatible with the park's natural character. Increasing development and more intensive land uses surrounding the park place increased emphasis on protecting scenic features and preserving the visitor's experience of the park's aesthetic qualities.

INTERPRETATION

Current knowledge of natural and cultural resources at Chino Hills State Park places new emphasis on habitat connections, native plant and animal diversity and fragility, Native American involvement in the area, and historic ranching. Interpretive topics need to reflect this current knowledge and emphasis.

VISITOR USE AND DEVELOPMENT

Visitor-Use Facilities

The original (1986) general plan proposed the development of a large number of campgrounds, picnic areas, and trailhead parking areas in the park, specifically within Lower Aliso Canyon and the Santa Ana River floodplain. Continuing resource inventory work within the park has increased the Department's understanding of the sensitivity of the resources located at these proposed campground sites. Also, the current demand for camping at the park places question on the need for many large, developed campgrounds. The placement of facilities at these sites is no longer considered appropriate, yet additional facilities to enhance the visitor's park experience may still be needed. Guidance for the development of both visitor-use and operations facilities is needed to accommodate new recreational opportunities and at the same time protect park resources.

Park Access

Public vehicle access into the park is limited to the Bane Canyon entrance. This entrance is accessed through a residential area. The location makes it difficult to access the park and causes off-site parking conflicts. Furthermore, the access into the park from this point is on a one-lane, steep, dirt road. This road cannot be upgraded to an acceptable condition because of the steepness of the grade and adjacent slopes.

The emergency vehicle access at Rim Crest Road (see Figure 2) is being used as a pedestrian access point and certain problems have developed because of it. There are no developed parking, restroom, or trash facilities at this location, and visitors are parking on residential streets. This situation points to the need for coordination with local jurisdictions in addressing access. Also, information on sensitive park resources indicates that some of the park's access points proposed in the original general plan may be inappropriate.

Acquisitions

Acquisition plans for the park have, among other things, emphasized the value of acquiring ridgelines to protect the viewsheds within the park. However, additional guidelines are needed to help Department staff evaluate the desirability of proposed land acquisitions at Chino Hills State Park.

Chino Hills State Park General Plan

PLAN SECTION

Riparian vegetation – Lower Aliso Canyon

INTRODUCTION TO THE PLAN SECTION

The long-range vision for Chino Hills State Park is depicted in the *Plan Section*. The purpose here is to portray both the desired resource condition and visitor experience of the park and to provide goals and guidelines that will direct future management efforts toward achieving those desires. The *Plan Section* does not designate detailed facility improvements with specific sizes and capacities. Over the next 5, 15, or 30 years there will be different technologies, different recreational needs, and new opportunities that can not be foreseen with the writing of this document. In short, there will be many ways to achieve the desired conditions within the parameters provided by the *Plan Section's* goals and guidelines.

The following planning hierarchy provides direction for the future of Chino Hills State Park. Items in bold boxes were created as part of this general plan effort.

Classification: Along with all units that have been designated as "state parks", Chino Hills State Park is managed under the direction of Public Resources Code Section 5019.53.

Declaration of Purpose: A broad statement of direction, unique to Chino Hills State Park (Page 48).

Management Zones: A land-use zoning plan for the park that links four general levels of desired resource conditions and visitor experience to geographic areas depicted on a map (Page 49).

Park-wide Management Goals and Guidelines: Topical guidance whose scope is relevant for the entire park (Page 57).

Specific Area Goals and Guidelines: Management goals and guidelines that clarify goals for a specific area (Page 75).

DECLARATION OF PURPOSE

The Declaration of Purpose defines the purpose of the park and is the broadest statement of management goals. A declaration of purpose is required by the Public Resources Code, Section 5002.2 (b), "setting forth specific long-range management objectives for the park consistent with the park's classification..." The Declaration of Purpose for Chino Hills State Park will be as follows:

Purpose

The purpose of Chino Hills State Park is to preserve the natural, cultural, and scenic resources of the rolling hills, wooded canyons, and riparian forests that are representative of the early California landscape, and make them available for public enjoyment and education.

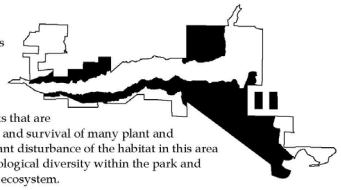
California State Parks will endeavor to preserve and restore native habitats in the park for their intrinsic natural values, to promote biological diversity, and to support the integrity of regional ecosystems. California State Parks will endeavor to protect the cultural and scenic resources, promote an understanding of the park's unique features, and provide recreation opportunities in a manner consistent with the protection of natural and cultural values.

MANAGEMENT ZONES

Management zones spatially define the management scheme for the unit (see Management Zones Map – Figure 6). The management zones for Chino Hills State Park are based primarily on the degree of natural, cultural, and aesthetic resource value and sensitivity. Secondarily, they are based on recreational, visitor service, and management needs, and ecological and geographical parameters. Four management zones for Chino Hills State Park are presented below, along with goals and guidelines for visitor activities, resource management, and facility development within the management zones. The management zones are the Core Habitat Zone, Natural Open Space Zone, Historic Zone, and Recreation and Operations Zone. The Management Zone Matrix on Page 55 further defines the vision for these four management zones.

CORE HABITAT ZONE

The Core Habitat Zone is the area of highest biological resource sensitivity in the park. The area includes very sensitive wildlife habitats that are crucial to the movement and survival of many plant and animal species. Significant disturbance of the habitat in this area could seriously affect biological diversity within the park and throughout the regional ecosystem.



WATER CANYON NATURAL PRESERVE

Statutes for classification of units of the State Park System are contained in Article 1.7 of the Public Resources Code. Based on these statutes and an evaluation of the park's resources it is proposed that a portion of the Core Habitat Zone be sub-classified as the **Water Canyon Natural Preserve**, as described in Public Resources Code Section 5019.71. The natural preserve will incorporate the entire Water Canyon watershed as well as the entire upper Brush Canyon watershed. The boundary of the natural preserve is generally delineated by the watershed boundaries of Water and Brush Canyons up to the southern park boundary and existing park trails in Lower Aliso Canyon (see Figure 6).

The Water Canyon Natural Preserve contains the northern extension of the Coal Canyon biocorridor, thereby preserving habitat crucial to the movement of sensitive wildlife and providing an important connection to the park's interior. The natural preserve also contains large stands of coastal sage scrub habitat which is necessary for the success of the California gnatcatcher, as well as fine examples of California Walnut Woodland and Coast Live Oak Woodland.

The creation of the Water Canyon Natural Preserve within Chino Hills State Park will provide the highest level of protection for the sensitive resources found in the preserve and will protect wildlife movement within the park and throughout the region. This sub-classification is necessary to ensure that development, inappropriate land use, or improper management decisions do not adversely affect the resources contained within the natural preserve boundary.

The sub-classification of the area to a natural preserve will require some adaptation from current land uses and management for this area. Currently, this area is governed by the state park classification as stated in Public Resources Code, Section 5019.53. The change to a natural preserve status will amend the primary goal for the area from balancing resource protection with recreational opportunities, to resource protection taking precedence over recreational opportunities. The Public Resources Code, Section 5019.71 governs the intent, management, and use of natural preserves:

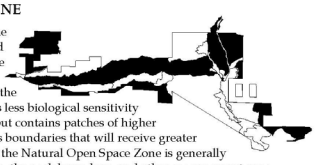
> PRC Section 5019.71: *Natural Preserves consist of distinct areas of outstanding natural or scientific significance established within the boundaries of other state park system units. The purpose of natural preserves shall be to preserve such features as rare or endangered plant and animal species and their supporting ecosystems, representative examples of plant or animal communities existing in California prior to the impact of civilization, geological features illustrative of geological processes, significant fossil occurrences or geological features of cultural or economic interest, or topographic features illustrative of representative or unique biogeographical patterns. Areas set aside as natural preserves shall be of sufficient size to allow, where possible, the natural dynamics of ecological interaction to continue without interference, and to provide, in all cases, a practicable management unit. Habitat manipulation shall be permitted only in those areas found by scientific analysis to require manipulation to preserve the species or associations which constitute the basis for the establishment of the natural preserve.*

The Water Canyon Natural Preserve will be managed according to PRC, Section 5019.71, the *Management Zones Section* of this general plan, and applicable Departmental policies as outlined in *System-wide Planning* of this general plan. Furthermore, the natural preserve will be managed according to the *Resource Management Directives for the California Department of Parks and Recreation*, Section 1812.2, which states that:

> *Boundaries of wildernesses and natural preserves will be established to give full protection to environmental and ecological integrity, from the standpoints of watershed influences, scenic and visual unity, cultural values, and other appropriate environmental factors.*

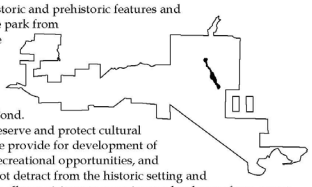
Developments in natural preserves are limited to trails and interpretive facilities required to make possible the visual and sensory enjoyment of the resources by visitors. Vehicle access and parking are not appropriate; visitor centers, restrooms, structures, and facilities other than signs shall be placed outside natural preserves.

NATURAL OPEN SPACE ZONE



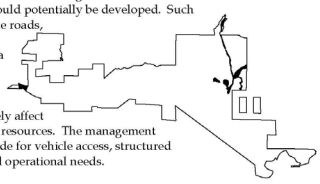
The Natural Open Space Zone protects natural, cultural, and aesthetic resources, and at the same time allows for recreational opportunities at the park. The zone generally has less biological sensitivity than the Core Habitat Zone but contains patches of higher resource sensitivity within its boundaries that will receive greater protection. The boundary of the Natural Open Space Zone is generally delineated by roads and trails, the park boundary, and other management zone boundaries.

HISTORIC ZONE



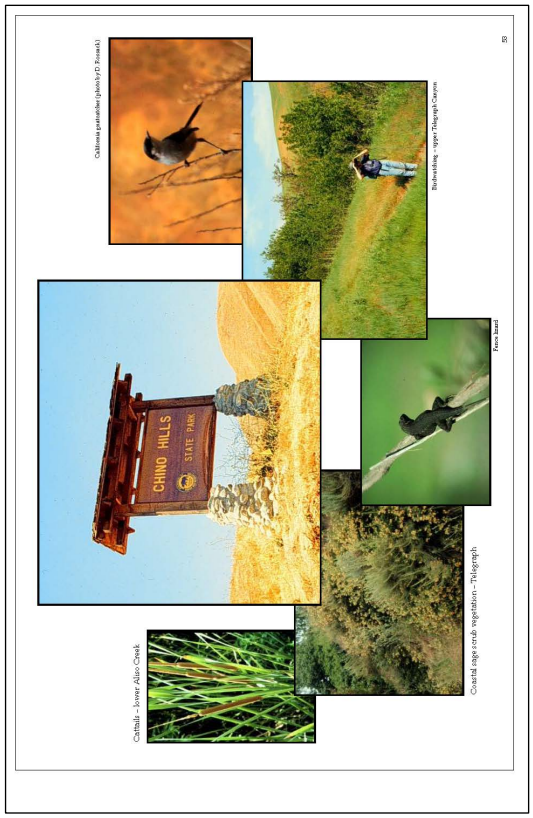
The Historic Zone protects historic and prehistoric features and cultural landscapes within the park from impacts that may compromise their integrity. The zone incorporates the Rolling M Ranch complex, the windmill area west of the campground, and Windmill Pond. The intent of the zone is to preserve and protect cultural resources and at the same time provide for development of appropriate visitor services, recreational opportunities, and operational facilities that do not detract from the historic setting and experience. The Historic Zone allows visitors to experience a landscape from a past era. Management efforts and land use decisions will be based on the preservation of this value. The Historic Zone boundary includes significant historic landscape features, important views from the Rolling M Ranch, and other cultural resources.

RECREATION AND OPERATIONS ZONE



The Recreation and Operations Zone is designated where visitor services and operations facilities exist or could potentially be developed. Such facilities include public vehicle roads, maintenance structures, a visitor center, campgrounds, a campfire area, and employee housing. This zone is already developed or future development will not adversely affect significant natural or cultural resources. The management intent for this zone is to provide for vehicle access, structured recreation, visitor service, and operational needs.

The boundary of the Recreation and Operations Zone is generally delineated by existing roads, and campground and staging areas. The zone incorporates the current entrance road up to the Historic Zone, a proposed entrance road through Slaughter Canyon, the road leading to and including the McLean Overlook, the area currently used for equestrian staging, an area west of the Rolling M Ranch, and the Lemon Grove Area. In the event of a developed park entrance road through Slaughter Canyon, the Bane Canyon entrance road will be included in the Natural Open Space Zone.



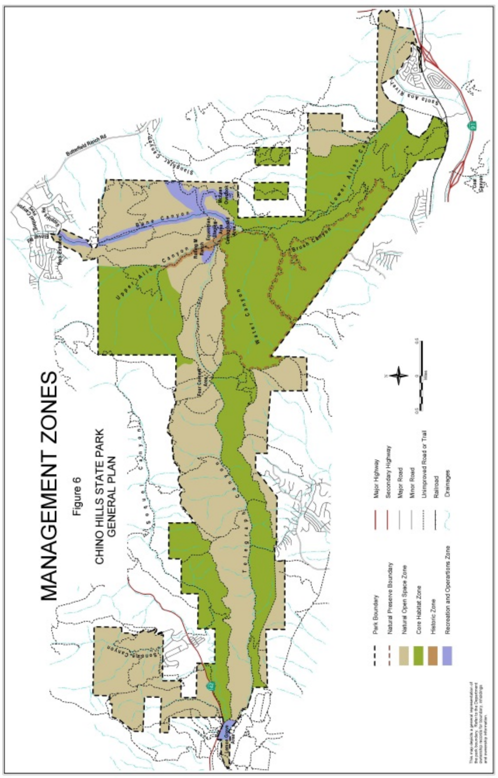


Figure 7 **Management Zone Matrix** Figure 7

	Core Habitat Zone	*Natural Open Space Zone*	*Historic Zone*	*Recreation and Operations Zone*
PRIMARY GOAL	The primary goal of the Core Habitat Zone is to preserve and protect sensitive plant and animal species and their supporting habitats, as well as to protect the movement of plants and animals within the park and throughout the region. Resource protection will be the foremost consideration for all land use and management decisions.	The primary goal for the Natural Open Space Zone is to preserve and protect the resources and at the same time to provide for quality recreational opportunities.	The primary goal of the Historic Zone is to protect the cultural resources and at the same time to provide for quality recreational and educational experiences.	The primary goal of the Recreation and Operations Zone is to provide for vehicle access, structured recreation, visitor service, and operational needs.
RESOURCE MANAGE-MENT	Visitor and management activities within the zone will have no significant adverse impact on resources. Patrol and utility company vehicles and motorized equipment use is permitted on designated park roads and trails.	Visitor use and management activities will not have more than minimal impacts on resources. Patrol and utility company vehicles and motorized equipment use is permitted on designated park roads and trails.	Visitor use and management activities will not have more than minimal impacts to natural and aesthetic resources, and will include only those that do not detract from the historical setting and experiences. Vehicles and motorized equipment will be allowed on designated park roads and trails and will be managed to minimize impacts. Protection of cultural sites will include preservation of the surrounding cultural and natural landscapes by the elimination and exclusion of modern intrusions that adversely affect the cultural landscapes.	Visitor use and management activities will be mitigated to reduce significant impacts to resources. Activities may include the movement of vehicles, and intense visitor use. Vehicles and motorized equipment will be allowed on designated park roads and trails.
CARRYING CAPACITY	Visitors will experience a sense of remoteness and calm. The sights and sounds of nature will be more prevalent than those of human use. The chance of encountering other people will be low, and there will be extensive opportunities to experience natural quiet and solitude. Encounters with others should be less than 2/hour during peak use periods. Human uses will not disrupt or compromise sensitive resources.	The social environment will be leisurely and uncrowded with occasional sights and sounds of people. During some seasons, days, and times of day, there will be a good chance of encountering other people or groups of people. Opportunities for natural quiet and solitude will be variable depending upon the park location and season, day, and time of day. Encounters with others should be less than 6/hour during peak-use periods.	The social environment will be active and communal. At times, the sights and sounds of human use and activities will be more prevalent than those of nature. There will be frequent encounters with vehicles, other people, and groups of people. The chance of interacting with others will be high.	The social environment is active and communal. At times, the sights and sounds of human use and activities are more prevalent than those of nature. There are frequent encounters with vehicles, other people, and groups of people. The chance of interacting with others will be high.
TYPICAL VISITOR ACTIVITIES	Acceptable uses of the Core Habitat Zone include approved scientific research that increases our knowledge of the resources and improves management strategies. Conducted and self-guided interpretive programs are acceptable in the Core Habitat Zone. Visitor activities will be confined to daylight hours only.	Conducted and self-guided interpretive programs are acceptable in the Natural Open Space Zone. Visitor activities will be confined to daylight hours only.	Acceptable activities include interpretational and educational programs, exhibits, and historic structure museums. Opportunities for other interpretive programs and appropriate visitor services also exist. Overnight use is limited to educational and environmental living programs.	Acceptable activities include vehicle circulation, interpretation, camping, picnicking, and other forms of recreation suitable in the park. Overnight uses will be permitted only in specific areas designated for such use.
PUBLIC ACCESS	Public access through the zone includes hiking, biking, and horseback riding. Bikers and horseback riders are restricted to designated trails only.	Public access through the zone includes hiking, biking, and horseback riding. Bikers and horseback riders are restricted to designated trails only.	Public access through the zone includes hiking, biking, horseback riding, and driving (highway legal vehicles). Bikers and horseback riders are restricted to roads and designated trails only.	Public access through the zone includes hiking, biking, and horseback riding on designated trails and driving (highway legal vehicles). Bikers and horseback riders are restricted to roads and designated trails only.
RANGE OF APPROPRIATE FACILITIES	Multiple-use trails, trailhead features, and trailside rest stops are appropriate.	Multiple-use trails, trailhead features, trailside rest stops, and day-use parking along boundary (see *Park Access Points,* Page 70) are appropriate.	Only those facilities that support the visitor's use, understanding, and appreciation of the historical landscape and that are visually compatible with the historical scenery are appropriate.	Any visitor service and support facilities that are consistent with Parkwide and Specific Area Goals and Guidelines are appropriate. These could include but are not limited to: - Overnight Accommodations (camping, lodging) - Concession Facilities - Restrooms - Park Operations Buildings - Roads and Trails

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Chino Hills State Park General Plan

PARKWIDE MANAGEMENT GOALS AND GUIDELINES

This section presents the broad goals and guidelines developed for managing parkwide resources, interpretation, visitor uses, and development. It addresses related planning issues that are not tied to a specific geographic area of the park.

RESOURCE MANAGEMENT AND PROTECTION

NATURAL RESOURCES

Biocorridors

Protecting biocorridors and facilitating the movement of animals and dispersal of plant seed within Chino Hills State Park, and between the park and other wildland areas, is imperative to maintain ecosystem health and support regional conservation.

Mountain Lion
(Photo by Mountain Lion Foundation)

Goal: Maintain and enhance the movement of native animals through the park and regional ecosystem. Visitors will gain an understanding of the importance of biocorridors and management efforts at the park aimed at supporting wildlife movement in the region.

Guidelines:

- Biocorridors within Chino Hills State Park that interconnect the park and its core habitat areas to other protected lands are of the highest priority for protection.
- The collection of baseline information and the monitoring of the health and function of core areas and biocorridors are high management priorities for the park. An emphasis should be placed on measuring the effects of human uses on the integrity of the system.
- Biocorridors will be recognized when there is enough information to indicate the necessity or importance of these connections to the movement of wildlife between Chino Hills State Park and other wildland areas. The adequacy and effectiveness of these habitat linkages will be monitored by tracking and documenting the presence, distribution, movement, and habitat associations of the representative species using them.

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- The Department will actively work with local jurisdictions, transportation agencies, and regulatory agencies in the planning of future transportation projects. The Department will discourage the fragmentation and isolation of habitat by such projects and ensure that adequate mitigation measures are incorporated into all road improvement and construction projects. The Department will advocate measures that consider known information on wildlife use of biocorridors, principles of conservation biology, and other professionally accepted design criteria. An emphasis should be placed on the maintenance of habitat linkages and construction of under-crossings and bridges that allow full wildlife movement between the affected areas.

- The Department will support and work towards the preservation, protection, and enhancement of the lands that make up the Coal Canyon, Sonome and Tonner Canyons, and Prado Basin biocorridors. Efforts will be directed towards enhancing wildlife habitat linkages so as to accommodate as many different native species as possible. Enhancement tools may include:
  - restoring or expanding native habitat to facilitate wildlife movement.
  - installing fencing to direct wildlife into underpasses or culverts and away from roads and freeways;
  - limiting vehicular use of underpasses to daytime use by land management agencies and emergency vehicles only;
  - widening of underpasses;
  - removing lighting in underpasses to make crossing more conducive to wildlife;
  - removing all or some of the pavement in underpasses;
  - reducing noise impacts by erecting structures to block freeway noise

Buffers

Land uses outside park boundaries can cause significant impacts on parklands. Possible impacts include exotic plant infestations, chemical pollution, predation and competition from domestic pets, wildfire, artificial light and noise, and loss of foraging or nesting habitat. Buffers, such as dedicated open space and agricultural lands, are low-intensive-use areas between the park's boundary and adjacent developments that help to separate conflicting land uses and protect natural habitats from destructive impacts.

Goal: Establish, maintain, and protect buffers adjacent to Chino Hills State Park.

Guidelines:

- The Department will work with adjacent landowners, neighbors, and local jurisdictions to provide for necessary buffers adjacent to park boundaries.

- The Department will assist local jurisdictions in the development of plant palettes for proposed projects in the vicinity of the park.

Vegetation Management

Past management practices, including livestock grazing and fire suppression, changed the ecological conditions under which native plant communities flourished at Chino Hills State Park. Current conditions favor the existence and continued domination of non-native annual grasses and forbs over much of the park, effectively eliminating native perennial bunch grasses. Changes such as these alter the ecological dynamics of the system and reduce wildlife values.

Goal: Restore and protect the native vegetation within Chino Hills State Park through active resource management programs. Planning and conservation efforts will address unique or important plant and wildlife resources at the community level and provide for their continued health and protection.

Guidelines:

- Vegetation management will be directed toward reestablishing the natural ecological processes that are essential for the development of native plant communities, expansion of these native communities, and the removal or reduction of exotic plant taxa. These objectives will be met through various studies, updates to the park's Unit Data File, and the preparation of comprehensive management plans.

- Management actions will minimize and, where possible, prohibit activities that further the spread of non-native plants.

Native Plant Communities
Chino Hills State Park supports a number of important native plant communities such as the California Walnut Series, California Buckwheat Series, Coast Prickly Pear Series, Arroyo Willow Series, Fremont Cottonwood Series, California Sycamore Series, and the Purple Needlegrass Series. These plant communities are essential habitat for both rare and locally important wildlife species and communities.

Guidelines:

- The Department will actively work to restore native plant communities and the natural processes that ensure their perpetuation.
- All seedlings and saplings used in habitat restoration projects will originate from seed collected from native plant taxa within park boundaries or from a

nearby area, with the exception of plants used for historic restoration within the Historic Zone. Only non-native plant taxa that are considered to be non-invasive are allowed within the Historic Zone.

Sensitive Plant Populations
The park offers open space that is vitally important to the continuation of several sensitive plant taxa occurring within or adjacent to Chino Hills State Park.

Guideline:

- All current, professionally recognized lists will be used to determine sensitivity. Current lists include state taxa of special concern; the California Native Plant Society's (CNPS) Lists 1A, 1B, 3, and 4; taxa of local concern (including endemic species); and taxa that are State or Federally listed or are candidates for listing. The Department will protect all sensitive plant taxa to the degree necessary to maintain or increase populations.

Wildlife Management

The protection and perpetuation of native wildlife populations will be accomplished, in part, through restoration and enhancement of native plant communities, removal of exotic plant taxa, and perpetuation of aquatic habitats.

Goal: Protect, perpetuate, and restore native wildlife populations and native aquatic species at Chino Hills State Park.

Guidelines:

- All sensitive wildlife species and their habitats will be protected. Include all taxa that are locally important (including endemic species), whether or not they appear on any endangerment list, as well as those protected by Federal and/or State law. Management and protection of sensitive species is dependent upon adequate maps and other data regarding species presence within, movement through, and uses of the park.

- Avoid ecological imbalances resulting from human-caused activities. If it is necessary to regulate animal populations, use methods based on sound principles of ecosystem management and consistent with Department Resource Management Directives. Avoid disturbance to other natural values of the park.

- The Department will work with surrounding property owners and jurisdictions to reduce numbers of non-native animals such as feral cats, starlings, and cowbirds that enter the park. This can be most effectively accomplished by developing a program to monitor and control non-native pests.

- Regular monitoring of medium and large mammals is necessary to gauge the effectiveness of biocorridors and to identify declines or increases in wildlife populations.

- Re-introduction of extirpated species will be appropriate only if historical documentation exists to confirm the presence of the species of interest within the Chino Hills at some time in the past and if suitable habitat exists to support its survival. Re-introduction of a species will be conducted using sound ecological methods and will not negatively affect populations of other native species. Animals to be re-introduced will come from a nearby area.

- Specific management programs using sound ecological principles and professionally accepted methods are necessary to protect and restore sensitive animal populations and their habitats.

Wildfire Management

Wildfire is a threat to structures and human safety in the dry hills of southern California. The prescribed use of fire can simulate a more natural fire regime for the Chino Hills and reduce the risk of catastrophic fires. In addition, controlled fires provide the added benefit of enhancing conditions for the expansion of native plant communities. However, extremely dry and windy conditions along with a high incidence of human-caused ignition dictates that wildfires will continue to occur in these hills. It is, therefore, prudent to plan for such an emergency.

Planning for wildland fires can considerably reduce damage to natural and cultural resources, particularly that caused by the activities of fire suppression. For example, adverse impacts can be caused by the hasty bulldozer construction of fire-control lines. These lines have the potential to remove roots and upper organic soil horizons, thereby increasing erosion and slowing the re-establishment of vegetation. Damage to resources can also occur from improper applications of chemical fire retardant that affect aquatic systems.

Goal: Plan for the occurrence of wildfires in order to preserve sensitive park resources and protect human lives and structures.

Guideline:

- The Department will work with appropriate agencies such as the California Department of Forestry and Fire Protection, county and city fire Departments, and Metropolitan Water District of Southern California to develop and implement a wildfire management plan for Chino Hills State Park. This plan will address all aspects of wildfire planning, including prevention, pre-suppression, and suppression. The plan will identify modified fire suppression methods and ways to protect sensitive park resources.

Prescribed Fires

Since the early 1900s, fire suppression practices have effectively reduced the occurrence of wildfires in southern California. Over time, fire plays an important role in the development of native plant communities. The near-elimination of wildfires has stressed the ecological balance, thereby allowing non-native plant pest species to establish and, in some cases, dominate the landscape. Fire suppression also results in the increased build-up of dry fuels, which can then lead to large-scale, catastrophic fires.

Goal: Restore the role of fire in the natural ecological processes of Chino Hills State Park.

Paleontological Resources

The presence of a Miocene-age marine geologic formation within Chino Hills State Park, which is known to yield abundant fossils in adjacent land, suggests that important fossil resources may exist within park boundaries.

Goal: Document and protect paleontological resources that are found within the park.

Guideline:

- As fossil remains are discovered during the course of a survey or if new resources are uncovered, professional measures will be taken to protect the resources found at the site.

Cultural Resources

Archaeological Sites (Prehistoric and Historic)

Chino Hills State Park includes significant archaeological resources. Prehistoric sites located in Chino Hills State Park indicate that the area was used for hunting and gathering by Indians of the Santa Ana River Basin. Several historic archaeological sites are also found within the park and reflect examples of historic land use of the area.

Goal: Protect the archaeological resources at Chino Hills State Park.

Guidelines:
Management guidelines for protecting archaeological resources can be found in the *Visitor Use and Development Section* (see Page 68).

Historic Resources (Structures, Sites, and Landscapes)

Chino Hills State Park includes a number of locally significant historic resources, including buildings and structures, features, and cultural landscapes. Windmills, water troughs, tanks, and water piping are scattered throughout the park. These features are visible reminders of the ranching landscape and reflect historic land uses over the past two hundred years. The semi-rural landscape, a remnant of nineteenth and early twentieth century southern California, is rapidly being eliminated by urbanization. The non-renewable historic resources of Chino Hills State Park, in juxtaposition with its significant natural resources, offers a revealing view of past cultural patterns to future generations.

Goal: Protect the significant historic sites at Chino Hills State Park.

Guidelines:

- All historic resources identified within the Historic Zone (i.e. structures, sites, and landscapes) will be preserved and protected through implementation of applicable Department policies and the application of professional standards.
- Recognized historic resources or sites outside of the Historic Zone should be removed based on the determination that they create physical or visual impacts to natural resources. Of those chosen for removal, the ones with historic integrity and interpretive value should be considered for relocation to the Historic Zone or another interpretive facility.

Windmill near Rolling M Ranch

Historic Ranching Landscape
The most historically significant land use associated with the lands of Chino Hills State Park is that of cattle ranching. From the early days of the Spanish missionaries and their Native American neophyte workforce, through Mexican Californio vaqueros and American ranchers and settlers, the grazing of stock represents one of the most profound human impacts upon the land.

Goal: Preserve and interpret the historic ranching landscape within the Historic Zone for the education and enjoyment of park visitors.

Guidelines:

- Preservation treatments will be based on primary research to identify historic fabric of features.
- Ranch buildings and structures can be utilized for appropriate operational and interpretive functions.

Oil Industry and Mining Sites
The park contains several sites associated with the history of the local oil industry and small-scale mining efforts.

Goal: Allow oil and mining sites to remain in place.

Guideline:

- Oil and mining sites will be passively managed with onsite interpretation, restoration, or reconstruction discouraged.

Historic Roads and Trails
Portions of several historic roads and trails, some dating to the nineteenth century, are located within the boundaries of the park. Many are currently in use as transportation and circulation routes for park visitors, utility companies, and staff.

Goal: Preserve historic roads and trails and at the same time provide for visitor, Department, and utility company use.

Historic Electrical Towers and Utility Lines
The first electrical towers to be erected on the parkland were completed in the late 1930s. A few of these historic towers still exist within the park. Additionally, many more modern towers and utility lines also exist within the park. Efforts are being made to remove the modern towers because they adversely affect both the natural and cultural landscapes of the park. Historic towers are not considered to be individually eligible historic resources, however, they may be compatible with the historic ranching landscape of the park.

Goal: Preserve the historic electrical towers within the Historic Zone that are considered to be contributing elements of the historic landscape.

Guideline:

- Placing electrical lines underground is preferred. However, historic towers may be considered for use within the Historic Zone when evaluating options for powering park facilities.

Aesthetic Resources

Visitors to Chino Hills State Park enjoy many aesthetic qualities inherent to the park's natural conditions. Some of these include open space, sounds of nature, and scenic views. Impacts to aesthetic qualities are, at times, created by developments, activities, or land uses, within or outside the park, that are incompatible with these qualities.

Goal: Protect scenic features from man-made intrusions and preserve the visitor's experience of the natural landscape by minimizing adverse impacts to aesthetic resources.

Guidelines:

- Unnecessary structures such as interior fences and signs will be removed. The Department will work with utility companies to remove electric lines that are no longer used and are not considered historic resources.
- The Department will work to reduce the negative impacts of utility easements in the park. All utility companies will be encouraged to reduce the impacts by consolidating easements into fewer or smaller corridors, or by placing the equipment underground. The Department will work with utility companies to remove unnecessary utility roads and reduce road widths, and will discourage any new easements within the park unless mitigated to benefit park resources.
- Ridgeline and knoll developments outside the park that adversely affect significant views will be discouraged. The Department will work with park neighbors and local government to review and plan adjacent developments in a manner that protects views.
- Tranquility and the sounds associated with the park's natural resources will be preserved. Unnatural sounds that adversely affect park resources, values, or visitors' enjoyment will be prevented or minimized.
- The Department will cooperate with park neighbors and local government agencies to minimize the intrusion of artificial light into the night scene, recognizing that darkness and the night sky play significant roles in the overall visitor experience. Artificial outdoor lighting within the park will be limited to basic safety requirements and shielded when and where possible.

INTERPRETATION

Interpretation is based on the premise that knowledge deepens the park experience and provides lasting benefits not only to individuals but also to society in general. Interpretive themes define the point of view given to the park's natural, cultural, aesthetic, and recreational resources.

Goal: Expand the visitor's awareness, understanding, and appreciation of the park's resources. The unifying theme explores how Chino Hills State Park is part of southern California's natural and cultural heritage.

The following primary and secondary themes will support the unifying theme:

Primary Theme: Chino Hills State Park is a remnant of California's past natural and cultural landscapes.

Secondary Theme: Native plants and animals find refuge in the fragile natural environment of Chino Hills State Park.

Secondary Theme: The connection of Chino Hills State Park to other wildland areas is crucial to the survival of plants and animals throughout the region.

Secondary Theme: Chino Hills State Park is a landscape reflective of its prehistoric and historic inhabitants and their cultures.

Secondary Theme: Fossil remains and petroleum deposits in Chino Hills State Park tell the secret of how natural forces shaped the land.

Secondary Theme: Showing respect for the environment and other visitors while recreating at Chino Hills State Park will ensure safety for the park and people.

COLLECTIONS

The Department acquires and maintains collections for several reasons. First, to preserve elements of the natural and cultural environment original to the park; second, to document the people, events, and cultural or natural features that are central to the park's purpose; and third, to support the interpretation of themes that are important to the park.

Goal: Provide for the collection of natural and cultural artifacts original to Chino Hills State Park which support the Declaration of Purpose and Department mission.

The following Scope of Collections Statement for Chino Hills State Park states the management objectives and provides guidance for the type of park collections.

Scope of Collections Statement

Natural and cultural material and object collections at Chino Hills State Park will have a specific connection to the natural and cultural history of the park, or provide support for interpretive themes and programs. Archaeological and paleontological materials, natural history specimens of park flora and fauna, and objects like historic furnishings, equipment, or personal items associated with the park are all potential collection items at Chino Hills State Park. Historic object collections will include those of the ranching period up to the year 1950.

- Acquisitions of ranching era artifacts and props will have a local historical association to the Rolling M Ranch, or other ranching activities within or near Chino Hills State Park.
- Natural history specimens of rare species will not be collected. Only lawfully salvaged specimens will be maintained in collections.
- The Department will establish safe and secure spaces for storage and display of park collections, and systems for inventory and management. Policies as outlined in the Department Operations Manual (DOM) Chapter 20 will be followed.

Hills For Everyone Nature Trail interpretive sign

VISITOR USE AND DEVELOPMENT

RECREATIONAL USES

Chino Hills State Park is a place where visitors can appreciate undeveloped scenic open spaces; enjoy diverse, abundant wildlife and vegetation; and recreate on a regionally significant trail system.

Goal: Provide for appropriate visitor uses of the park and at the same time protect resources.

Guideline:

- Recreational uses will satisfy both user needs and resource protection requirements, and for the most part be compatible with other visitor experiences. Recreational uses will generally occur where manageable with existing park staff or volunteers and where there is adequate, safe access to the recreation activity areas.

Mountain biker in Telegraph Canyon

DEVELOPMENT

Chino Hills State Park offers public facilities for visitor use and education, as well as maintenance and operational facilities for park management.

Goal: Provide essential visitor services and operations facilities to enhance the visitor's experience and at the same time maintain the park's natural, cultural, and aesthetic values.

The following guidelines for development pertain to all built and maintained facilities for public and park use, including such facilities as roads, trails, campgrounds, picnic areas, utilities, and buildings.

Natural Resources

- Resource protection and management will take priority in decisions regarding development and use. Development will not adversely affect park resources, including natural, cultural, and scenic resources. Development will be located a sufficient distance away from sensitive habitat areas, such as riparian zones,

wildlife corridors, or where sensitive species are known to occur. Design of public-use facilities will protect resources by preventing inadvertent damage by users. The location and type of facilities and visitor uses will be consistent with the protection of biological exchange (biocorridors) and the maintenance of core habitat areas.

- Programs, projects, and developments within the park will be designed so that sensitive animal populations, aquatic systems, and native plant communities are protected. When disturbance is unavoidable, efforts will be made to minimize and mitigate disturbance.

Cultural Resources

- Cultural resource surveys will be completed at proposed development sites prior to any facility development. Additional archaeological investigations, such as archival research, detailed site mapping, and subsurface testing will occur at any project or undertaking that would disturb a known or potential cultural site. Project design modifications and/or monitoring can further serve to minimize or prevent disturbance of significant archaeological resources.

Aesthetics

- The design and placement of facilities will be aesthetically pleasing and blend with the natural environment. Development will not compete with nor dominate park features. Visitor services will be provided, however, the number of buildings will be minimized and their visual impacts reduced.
- Structures will be placed away from prominent locations, such as ridgelines, and screened and blended into the natural terrain with native vegetation, strategic siting, appropriate grading, and natural-appearing materials. The general appearance and design details of new structures will be compatible with a ranch style.
- Manufactured slopes will be graded and planted so as to blend into natural, adjoining slopes. Utilities will be placed underground where feasible, and erosion control will be used for all projects that involve grading.

Roads and Trails

- The Department will study the feasibility of realigning existing roads to avoid sensitive habitat when and where possible, with an emphasis on riparian areas. The benefits of reducing the current adverse effects on sensitive habitat by realigning roads will be balanced against the possible adverse effects of new road construction on alternative alignments.

- Road maintenance standards will be developed and implemented in cooperation with utility companies. These standards will be designed to maintain natural drainage patterns, reduce erosion and stream siltation, and minimize road widths and impacts to aquatic habitats.
- When road or trail conditions are such that further use is either unsafe or would result in significant impacts to natural or cultural resources, the affected routes will be closed until appropriate repairs are made or conditions change.
- The Department will seek the input and cooperation of local jurisdictions, park neighbors, and significant user groups to develop and implement a trails management plan. This plan will address pedestrian access points, trailhead parking facilities, the trail system and connections to regional trails, trail maintenance, and appropriate recreational uses of trails.

Park Access Points

Access points that are properly placed enable visitors to reach all primary-use areas of the park and access facilities such as trails, campgrounds, and visitor centers with minimal impacts on park resources.

Vehicle Access

A vehicle access point currently exists at the Bane Canyon entrance. Using this road, park visitors can reach the Rolling M Ranch, a focal point of the park that provides structured recreation and houses park operations. A better and more reliable vehicle access point in Slaughter Canyon may be considered in the future. A second access point identified at Carbon Canyon could be improved for trailhead parking.

Goal: Provide safe, reliable vehicle access points for park visitors to enter the park and travel to the primary park destinations.

Guidelines:

- The main park access road will clearly orient and safely guide the visitor from the park entry to the primary park destinations. The road design will reduce vehicle speed and minimize impacts on park resources. The road alignment should allow, if possible, a scenic and panoramic view of the park, complement the land's natural contours, and minimize any visual impacts. Park access roads will fall within the Recreation and Operations Zone (see Figure 6).
- If additional accessibility is needed, trailhead parking will be developed adjacent to the park boundary within the zone designated as Natural Open Space as long as such development is consistent with the protection of park resources.

Pedestrian Access

Trailhead parking should be developed in appropriate locations to provide access to park facilities. On the other hand, when development occurs adjacent to the park, coordination and advance planning should avoid the creation of de facto trailheads that cause damage to park resources.

Goal: Create appropriate pedestrian access points to meet the needs of both the park and the local jurisdictions that are contiguous to the park boundary.

Guidelines:

- The Department will seek the input and cooperation of local jurisdictions to develop appropriate pedestrian access points and trailhead parking facilities, and in developing solutions to localized parking concerns.

The following criteria will be used to determine appropriate pedestrian access point locations. Designated access points should generally:

- Provide access to trails that offer scenic and panoramic views of the park
- Accommodate multiple trail uses (hikers, bikers, equestrians)
- Avoid adverse impacts to sensitive resources and important resource values (gnatcatchers, coastal sage scrub, raptor nests, archaeological sites, etc.)
- Be manageable with available park staff and reasonably accessible to park patrol and emergency vehicles
- Require minimum grading
- Have minimal affect on significant viewsheds and aesthetic resources
- Be in close proximity to trail loops and connectors
- Include parking that is limited in size to ensure that visitor use is within the park's carrying capacities (see Management Zone Matrix, Figure 7)
- Be spaced so that resources and visitor experiences are not adversely affected by overuse of an area
- Provide a connection to local or regional trail systems outside the park boundary to the extent feasible and appropriate. Efforts will be made to integrate the park's trail system with regional and local trail systems where feasible. These pedestrian access point criteria, where applicable, will be used in determining linkages to other trail systems.

Acquisitions

Past land acquisitions have emphasized the inclusion of ridgelines, watersheds, and buffer areas. This practice helped to maintain views and protect resources as the park was formed and as new parcels were added.

Goal: Protect and enhance park resources and improve visitor's enjoyment and education in the park through appropriate land acquisitions.

When evaluating the desirability of proposed land acquisitions at the park, the Department will consider the following guidelines:

- The Department will evaluate each proposal of land dedication and accept only those dedications that are in keeping with the purposes of Chino Hills State Park. Land acquisitions will support the park's resource management goals by enhancing watershed protection and adding significant or unique resources, habitats, or features to the park. They will create buffer areas (areas between developments and park resources) and include ridgelines whenever possible, increase the size and improve the effectiveness of biocorridors, and establish park facilities outside of sensitive resource areas. Land acquisitions may also add to the park's recreational opportunities and establish links to regional trail systems.
- The Department must exercise caution when considering land adjacent to developed areas. Difficulties arise from illegal-refuse dumping, illegal off-highway vehicle activity, the spread of exotic plant species onto parkland, and wildlife predation and harassment by domestic animals.
- The Department will actively work towards acquisition of properties that contribute to biocorridors ensuring that key linkages will be preserved.
- In order to accomplish mutual goals such as resource protection, biocorridor enhancement, and providing recreational opportunities, partnerships with local and regional jurisdictions as well as state and federal agencies will be encouraged.

Concessions

Concession operations in Chino Hills State Park are governed in part by Public Resources Code, Section 5080.02, by State Park and Recreation Commission policies, and the Department Operations Manual (DOM).

Goal: Concession operations will provide visitor services that enhance recreational and educational experiences at the park and at the same time will protect natural, cultural, and aesthetic resources.

Guideline:

- Concession operations will be consistent with the park's purpose and classification, and in conformance with the park's general plan. No concessions will be permitted in the Core Habitat Zone. Concessions will be compatible

with the historic settings and the visitors' experiences of the Historic Zone. Concessions will not typically compete against similar private concessions that are within a reasonable distance to the park. Examples of possible concessions may include, but are not limited to, an equestrian center, bicycle rentals, and camp store.

Corrals in campground area

SPECIFIC-AREA GOALS AND GUIDELINES

This section defines the management goals and guidelines that are more specific to individual areas in Chino Hills State Park and will clarify the application of broader park-wide goals and guidelines.

LEMON GROVE AREA

The Lemon Grove Area is a part of the Recreation and Operations Zone, and is located in Carbon Canyon on the far-western end of the park (see Figure 6). This trailhead area can be reached from Carbon Canyon Road by entering through Carbon Canyon Regional Park (County of Orange) and provides the only access from the western side of the park. Visitors can reach the park's interior by traveling through Telegraph Canyon. The area contains significant riparian habitat as well as approximately 40 acres of trees that represent the only extant remnant of the historically significant citrus industry that once surrounded the park.

Goal: Management efforts will support the use of the Lemon Grove Area for park access, habitat restoration, and interpretation of the historic citrus industry that once surrounded the park.

LIVESTOCK PONDS

Of the six livestock ponds that were constructed in the park during the ranching era, four are still present. Three of these ponds offer year-round water for wildlife and suitable conditions for the establishment of aquatic plants including emergent wetland vegetation. The increase in wildlife habitat and diversity that the McDermott Spring, Windmill, and Panorama ponds provide justifies maintaining them. In addition to its wildlife value, Windmill Pond is located within the Historic Zone and is a contributing element to the historic ranching landscape.

Goal: Preserve the Windmill Pond for both its natural and cultural value. Preserve McDermott Spring and Panorama Ponds for their natural habitat values. Visitors will learn about historic uses of the ponds as well as present-day management activities associated with the preservation of sensitive plants and animals.

Guideline:

- Appropriate efforts will be made to maintain the earthen dams and to conserve and enhance native vegetation around the ponds. Other ponds in the park will be evaluated for their contribution to habitat enhancement and historic significance. If it is determined that they will be removed, the streambed will be restored to natural contours and native vegetation will be re-established.

SANTA ANA RIVER

The Santa Ana River passes through the park in the southeast corner. It drains a large watershed area of southern California and passes through the cities of San Bernardino, Riverside, Corona, and other communities before entering Chino Hills State Park. Treated sewage effluent as well as non-point source pollution is discharged into the river by many of these communities, resulting in river pollution. Poor water quality seriously threatens aquatic resources, including the native fishes and the wildlife species that feed upon them.

As of 1998, the invasive, non-native plant giant cane (*Arundo donax*) in the Santa Ana River portion of the park was manageable. However, efforts will be necessary to limit and eradicate this invasive species from park property.

Goal: Protect and enhance natural resources in the Santa Ana River and adjacent habitat.

Guidelines:

- The Department will work with state and regional water quality control entities and other appropriate agencies to seek solutions to the water quality problems in the section of Santa Ana River that passes through Chino Hills State Park.
- The Department will work with local jurisdictions regarding land use and resource management decisions that may affect the Santa Ana River. (See *Planning Influences*, Page 37)
- The Department will work to eradicate invasive species such as the giant cane (*Arundo donax*) from its property along the Santa Ana River.

ISSUE RESOLUTION

There are a number of issues and planning efforts that require attention beyond the scope of this general plan. Funding and staffing limitations restrict what issues and studies the Department is able to immediately address and require that the Department set priorities. Many goals and guidelines of the *Plan Section* (Page 47) provide direction for each issue. Some of these goals and guidelines recommend future planning efforts such as management plans and studies. The following lists are not intended to be a restriction to working on other issues or lower priority issues or planning efforts.

The general plan recommends that the following issues be resolved:

- **Biocorridors and Core Habitat Areas** – Protect and enhance the park's wildlife habitat linkages with nearby wildlife habitat areas through coordination with local, state, and federal agencies, and acquisition and restoration projects.
- **Park Access Points** – Resolve main park road and boundary access problems through detailed site planning, coordination with local agencies, and facility implementation. Solutions to access problems may require additional property acquisitions.
- **Appropriate Recreational Uses** – Provide quality recreational activities and public-use facilities without compromising resource integrity.

Note: Interpretation plays a significant role in the resolution of these general plan issues. The general plan recommends that educational programs, interpretive planning, design, and facility implementation be accomplished with the resolution of the above issues.

The general plan recommends that the following planning efforts and studies be undertaken. See the referenced page number for a complete description of the guideline:

- Collection of information and monitoring of the health and function of core areas and biocorridors (Page 57)
- Management plans, studies, and updates to the park's Unit Data File as necessary to meet vegetation management guidelines (Page 59)
- Collection of information regarding sensitive species presence within, movement through, and uses of the park (Page 60)
- Management programs to monitor and control non-native pests (Page 60)

- Regular monitoring of medium and large mammals necessary to gauge the effectiveness of biocorridors and to identify declines or increases in wildlife populations (Page 61)
- Management programs to protect and restore sensitive animal populations and their habitats (Page 61)
- Wildfire management plan (Page 61)
- Trail management plan (Page 70)

Looking southwest toward lower Aliso Canyon

Chino Hills State Park General Plan

ENVIRONMENTAL ANALYSIS SECTION

Coast Horned Lizard (photo by Gordon Ruser)

INTRODUCTION

The California Department of Parks and Recreation is the lead agency responsible for the preparation of environmental review documentation for the proposed Chino Hills State Park General Plan, in compliance with the California Environmental Quality Act (CEQA) (PRC §§21000 et. seq.) and the CEQA Guidelines (CCR §§15000 et. seq.). This Environmental Analysis Section and other sections of this document, incorporated by reference, constitute the Environmental Impact Report (EIR) in fulfillment of CEQA requirements (CCR §§15166, 15120[b]), and reflect the independent judgement of the Department. It should be recognized that the level of detail addressed by this EIR is commensurate with the level of detail provided in the land-use proposals of the general plan. As subsequent management plans and site-specific projects are proposed they will be subject to further environmental review, and appropriate environmental documents will be prepared with specific mitigation measures, as necessary.

The proposed Chino Hills State Park General Plan intends to reduce the potential for significant environmental impacts allowed in the original general plan (approved in 1986). It also includes modifications to the declaration of purpose for the park, changes in land-use designations and management goals to reflect the new statement of purpose, and the incorporation of new guidelines for the protection of resources, future acquisitions, and the development of recreational, interpretive, and operational facilities.

PROJECT DESCRIPTION

See the *Introduction* (Page 1) and *Plan Section* (Page 47).

ENVIRONMENTAL SETTING

See the *Existing Conditions and Issues* (Page 7), *Significant Resource Values* (Page 16), and *Planning Influences* (Page 37).

ANALYSIS OF ENVIRONMENTAL EFFECTS

The Initial Study for the Chino Hills State Park General Plan EIR identified potential impacts related to soil erosion, drainage, water quality, flooding, air quality, plants, animals, noise, light and glare, transportation/circulation, fire protection, utilities, recreation, and cultural resources. A Notice of Preparation was circulated through the State Clearinghouse, to local city and county planning offices, as well as to affected utility companies and special interest groups. A total of twelve comment letters were received representing the following agencies and groups:

California Department of Transportation, Districts 8 and 12
County of Orange, Planning and Development Services

City of Anaheim
City of Brea
City of Chino Hills
City of Yorba Linda
Metropolitan Water District of Southern California
Hills for Everyone
Friends of Tecate Cypress
Wildlife Corridor Conservation Authority

In general, the environmental issues raised for consideration in the draft plan were in regards to potential impacts to transportation/circulation (roads and trails), plants and animals (acquisition of biocorridors), public services/hazards (existing water utility right-of-ways, proximity of a landfill and fire suppression), noise, and aesthetics/viewshed.

A high number of significant resource values are recognized within Chino Hills State Park. These include sensitive plants and animals, plant communities, natural open space connectivity, solitude, scenic vistas, and cultural landscapes (See *Significant Resource Values*, Page 16). Due to the location of the park within a highly urbanized area and its tenuous connection to other open space areas in the region, the significance of these values is amplified. Therefore, any proposals that affect these values have the potential to result in significant environmental impacts. In addition, any proposals for the development and management of the park have the potential to cause impacts to the surrounding communities and associated public services, due to their proximity to the park.

Unavoidable Significant Environmental Effects

The land-use designations and the management goals and guidelines presented in the general plan are intended to avoid or mitigate all significant environmental effects of facility development, maintenance, operations, and visitor use. If a specific project is proposed that does not conform to all of the guidelines contained in the plan, it will not be implemented. Therefore, there are no unavoidable significant environmental effects.

Mitigable Significant Environmental Effects

Impact: Even though the majority of development will occur within a limited portion of the park (Recreation and Operations Zone), development and maintenance of facilities such as roads, trails, parking lots, camp sites, picnic areas, utilities, septic systems, and buildings have the potential for significant short- and long-term impacts to the environment. These impacts could include soil disturbance, dust, increased erosion, altered drainage patterns, lowered water quality, degradation of cultural resources, and degradation of sensitive plant or animal populations or their habitat.

Mitigation: Site-specific searches for sensitive species of plants and animals will be conducted in areas proposed for development or for other activities. The proposed project will be modified to avoid significant adverse impacts to any detected sensitive populations. Impacts to rare plant communities will be avoided to the maximum extent possible. Where unavoidable, the loss of a rare vegetation type will be compensated for through restoration of the same vegetation type at an appropriate location within the park at a replacement ratio of at least one to one.

Mitigation: Site-specific cultural resource surveys will be conducted in areas proposed for development or for other ground disturbing activities. The proposed project will be modified to avoid significant adverse impacts to any archaeological or historical resources, in accordance with the Department's resource management directives and professional standards for the treatment of historic properties.

Mitigation: Facilities will be designed and constructed to minimize the footprint of impact and will generally be located in relatively flat areas to minimize the potential for soil disruption. Any bare disturbed surfaces resulting from construction, which is not part of a trail or parking area, will be revegetated with appropriate native plant species for the site. See *Vegetation Management Guidelines*, Page 59.

Mitigation: Design, construction, and maintenance of facilities will follow the best management practices for the elimination or reduction of adverse effects to air quality, water quality, and drainage patterns. No activities or developments that significantly affect the park's aquatic systems will be allowed.

Impact: The soils of the Chino Hills are such that they become very slippery when wet and are prone to landslides and other forms of erosion. Use of roads and trails within the park may, under certain conditions, be unsafe for the public or increase the potential for soil movement and erosion.

Mitigation: When trail or road conditions are such that further use is either unsafe or would result in significant impacts to natural or cultural resources, the affected routes will be closed until appropriate repairs are made or conditions change.

Impact: The locations of trailhead parking sites on the boundaries of the park have the potential to create impacts to adjacent residential areas, in terms of an increase in traffic, noise, and litter. They also have the potential to concentrate public use in sensitive resource areas.

Mitigation: The Department will coordinate trail access points with appropriate local planning agencies and avoid significant environmental impacts by following a set of criteria contained in the general plan (See *Park Access Points*, Page 70). Appropriate mitigation is also discussed in the plan and made a part of specific site plans, where necessary.

Nonsignificant Environmental Effects

The following potential impacts have been determined to be less than significant:

Impact: Construction of facilities and their recreational use may increase noise, dust, and traffic levels either temporarily or periodically.

Discussion: Most of the development activities and higher intensity recreational uses are located within the Recreation and Operations Zone, which is primarily located within the interior portion of the park, or adjacent to State Route 142 and Carbon Canyon Regional Park. As such, the potential for significant noise, dust, and traffic impacts to residential or commercial areas is limited to temporary construction impacts of the main park entrance (east end of Slaughter Canyon) and boundary trailhead parking. Development within these areas is not anticipated to be substantial and will utilize standard construction noise and dust reduction measures.

Impact: Potential development may produce associated increases in light or glare.

Discussion: The general plan states that materials for facilities will be chosen to preserve the rural qualities of the park and lighting of use areas will be limited to the minimum necessary to provide for public safety and shielded where feasible. Therefore there should be no significant impacts from light or glare.

Impact: Use of camping facilities within wildland areas has the potential to place the public at risk due to wildfires caused by inadvertent ignition from within, as well as from outside the park.

Discussion: No campfires or nighttime activity will be allowed outside designated areas within the Recreation and Operations Zone or Historic Zones. Following Department standards, these designated areas will be designed to reduce the chance of accidental escape of fire to surrounding vegetation. A wildfire management plan will be developed, as appropriate, to ensure protection of human lives and property, and will emphasize control of fires along predetermined suppression lines, which divide the park into control compartments, and will include evacuation procedures.

Impact: The use of prescribed fire as a vegetation management tool has the potential for significant impacts to regional air quality and may, in the event of an escape, place the public in danger.

Discussion: The restoration of the role of fire in natural ecological processes will include a prescribed fire management plan. This plan will include provisions for coordinating with regional air quality control boards to avoid significant emissions of smoke during sensitive time periods. It will also provide for public notification and exclusion areas prior to and during prescribed burning operations. In the event of an escape, the wildfire management plan is invoked, which provides for public evacuation and appropriate suppression activities.

Impact: The proposed Chino Hills State Park General Plan calls for an overall reduction in the number of vehicles trips to and from the park relative to the original general plan. Even so, an increase and change to the current traffic pattern as a result of potential future development allowed in the proposed general plan is anticipated (See Appendix C - *Comparison of Public Use Under Plan Alternatives*, Page 97).

Discussion: The majority of the maximum vehicle trips estimated to be generated would result from recreational development in the main use area located in Upper Aliso Canyon (See Appendix D - *A Public-Use Scenario*, Page 98). This area is currently accessed through the Bane Canyon park entrance located on Sapphire Road (15,000 Average Daily Traffic [ADT] capacity) and accessed via Soquel Canyon Parkway (56,300 ADT capacity) and Elinvar Road (15,000 ADT capacity) in the City of Chino Hills. The general plan calls for relocating this park entrance to Slaughter Canyon off Butterfield Ranch Road (56,300 ADT capacity) also within the City of Chino Hills, when and if associated acquisitions or rights-of-way can be obtained. Recent (November 1997, January 1998) traffic estimates indicate that current use of these roads is well below their capacity (5-9% of rated capacity). The projected increase in traffic potentially generated as a result of the proposed Chino Hills State Park General Plan (estimated 945 maximum trips per day) is not anticipated to add significantly to the volume of traffic on these routes. Furthermore, if at the time park developments are proposed, it is determined that the development would produce an increase in vehicle trips in excess of the capacity of the access roads, the proposed facilities will be downscaled to avoid significant impacts.

Impact: According to the Metropolitan Water District, the Robert B. Diemer Water Filtration Plant, located adjacent to the southwest boundary of the park, uses and stores various hazardous chemicals. Accidental release of these chemicals may affect park users in the immediate vicinity. In addition, abandoned oil wells in the park may present a potential hazard.

Discussion: Park facilities adjacent to or within the drainage from the Robert B. Diemer Plant are limited to existing roads and trails. No new facilities are planned for that area. Any abandoned oil wells in the vicinity of planned development will be re-abandoned in accordance with PRC 3208.1 to assure public safety. There are no significant public health risks anticipated as a result of the general plan.

Impact: Development of visitor use and operational facilities within a rural park has the potential to adversely affect aesthetics and viewsheds.

Discussion: The proposed general plan calls for facilities to be located off of ridgelines and to be sited, designed, and constructed to blend into the natural (or historic, where appropriate) terrain and setting, thereby avoiding significant impacts to aesthetics.

Beneficial Environmental Effects

Many of the proposed management practices will protect or enhance park resources, such as plants, wildlife, viewsheds, and cultural resources, above and beyond that required for mitigation of impacts resulting from development and use of the park. The following sets of management guidelines provide for beneficial environmental effects:

- Biocorridors
- Water Canyon Natural Preserve
- Historic Zone
- Resource Management and Protection
- Core Habitat Zone

Growth-Inducing Impacts

Implementation of the general plan will result in an increase in the number of day-use and overnight visitors in Chino Hills State Park. Based on *Appendix D - A Public-Use Scenario* (Page 98), an estimated peak total of 1,310 people and 395 vehicles may be present within the unit at a moment in time, if full development of the park is achieved. These levels of visitor use are not expected to contribute to an increase in need for local services. The developing cities adjacent to the unit provide services adequate to meet the needs of the local residents and visitors to the local parks, including Chino Hills State Park. The projected peak number of vehicle trips per day has been estimated to be 945, but at no time will parking facilities be developed that cause an increase in vehicle trips in excess of the capacity of the affected roads. Therefore, there will be no significant growth-inducing impacts.

Cumulative Impacts

None of the proposals contained in the plan will contribute significantly to the cumulative impacts of past, ongoing, or future projects, which include primarily residential, highway, and public service developments within the region. In fact, this plan recognizes and attempts to provide for the increasing rarity of natural open space

and rural landscapes within the region, by setting guidelines for the preservation of natural and cultural resources within the park and of biological corridors that link the park to similar wildland areas. These guidelines reduce some types of recreation proposed in the original general plan (such as camping and picnicking). However, several regional parks in the vicinity of Chino Hills State Park, including Carbon Canyon Regional Park in Carbon Canyon, Featherly Regional Park on the Santa Ana River, Prado Regional Park, and Yorba Regional Park provide for structured daytime recreation (picnic facilities). Camping facilities in the Chino and Puente Hills area are not now, nor are they anticipated to be, in high demand.

PLAN ALTERNATIVES

Based on the accumulation of information from biological studies, local planners, park managers, and the general public (at four public meetings), three plan alternatives were considered during formulation of the proposed general plan.

Alternative 1: the Existing General Plan Alternative (representing the "no project" alternative required by CEQA) which allows for more intensive recreational use and development of the park unit relative to the other two alternatives;

Alternative 2: the Core Habitat Zone Without Trail Corridors Alternative, which provides for an increase in protection of natural resource values at the expense of some recreational opportunities; and

Alternative 3: the Core Habitat Zone With Trail Corridors Alternative or the "preferred" alternative, which (like Alternative 2) provides for an increase in natural resource protection, but allows for the maintenance of existing recreational opportunities (see Figure 7 – Management Zone Matrix, Page 55).

Alternative 1: Existing General Plan - "No Project"

Under this alternative, the park unit would continue to be managed in accordance with the existing general plan (approved in 1986). The land-use section of the original general plan provides equivalents to three of the four management zones found in the proposed general plan, but in differing relative proportions. The "primitive zone" of the original 1986 plan, described as a precursor to natural preserve designation, encompasses portions of Upper Aliso Canyon, Water Canyon, and Brush Canyon for a total of approximately 2,825 acres. The "developed park zone" provides for public vehicle access, parking, day use, camping, administrative facilities, and operational facilities development, and includes portions of Upper (Rolling M Ranch) and Lower Aliso Canyon, Slaughter Canyon, Santa Ana River floodplain, and the mouth of Telegraph Canyon adjacent to State Route 142 (640 acres). The remainder of the park is designated as "park land zone" with land use limited to trails, picnicking, and

primitive trailside camping. Access to the main use area of the park would eventually be limited to the entrance through Slaughter Canyon.

Given the current knowledge and understanding of sensitive resources within the park, this alternative would likely cause significant impacts to riparian habitat, rare birds, rare aquatic animals, animal movement, and water quality due to the extent of park development proposed in the original general plan for Lower Aliso Canyon and the Santa Ana River floodplain. In addition, campground and picnic facilities proposed for the Santa Ana River floodplain would cause an increase in noise, light and glare, impacts to local air quality (smoke from campfires and barbecues) and traffic, immediately adjacent to private residences and a major freeway (State Route 91). Also under the original general plan the significance of historical resources within the park is not recognized nor defined, possibly leading to significant impacts to recently recognized important cultural resources, such as ranching-era features and landscapes.

Alternative 2: Core Habitat Zone Without Trails

This alternative, like the preferred alternative, would designate four types of management zones: Core Habitat, Historic, Natural Open Space, and Recreation and Operations. The Core Habitat Zone would encompass about half of the unit (approximately 6,000 acres) and provide increased protection for large portions of the Aliso Creek drainage, Water Canyon, Brush Canyon, and the north-facing side of Telegraph Canyon. No mechanized vehicles or bicycles would be allowed within this zone. The Historic Zone (approximately 70 acres) is a new designation that would recognize and provide guidance for the protection of ranching-era features and landscapes associated with the Rolling M Ranch. The Recreation and Operations Zone (approximately 370 acres) would no longer include the Santa Ana River floodplain or sensitive reaches of Lower Aliso Canyon as in Alternative 1, but would include a portion of Bane Canyon to allow for the existing entrance road and picnic areas.

This alternative would reduce short- and long-term impacts associated with park facility development, such as loss of vegetation, increased erosion, reduced water quality, and impacts to sensitive fish, animals, and riparian habitat. It would also eliminate impacts to adjacent residents in the Santa Ana River floodplain area, including noise, light and glare, local air quality, and traffic. The Core Habitat Zone designation would, however, reduce recreational opportunities by causing closure of some trails to bicycles, and reduce accessibility of utility and emergency response vehicles to portions of the park, thereby potentially affecting public services. Facilities proposed for Lower Aliso and the Santa Ana River floodplain in the original (1986) general plan have not yet been developed; nevertheless, elimination of these areas for consideration of such development represent a reduction in future recreational opportunities within the park. This reduction in recreational opportunities would not be expected to be significant in a regional context.

Alternative 3: Core Habitat Zone With Trails - "Preferred"

This preferred alternative is essentially the same as Alternative 2, with two exceptions. First, the Core Habitat Zone boundaries would include currently recognized established roads and trails that traverse this zone, thereby eliminating the impacts to recreation and public services associated with the Core Habitat Zone in Alternative 2. Second, a portion of the Core Habitat Zone (Water Canyon and Brush Canyon) would be designated as a natural preserve. Within the preserve area, resources would receive the highest level of protection. Impacts associated with the Alternative 3 are discussed under *Analysis of Environmental Effects* above.

Chino Hills State Park General Plan

APPENDICES

Purple sage

APPENDIX A

List of Sensitive Wildlife Species (January 1998) That Occur, or For Which Potential Habitat Exists Within Chino Hills State Park

TYPE	SPECIES	COMMON NAME	STATUS*	PROBABILITY IN CHINO HILLS S.P.
AMPHIBIANS	*Taricha torosa torosa*	Coast Range newt	CSC	not likely
	Ensatina eschscholtzi eschscholtzi	Monterey salamander	CSC	**present**
	Batrachoseps nigriventris	black-bellied salamander	local concern	**present**
	Batrachoseps pacificus	pacific slender salamander	CSC	probable
	Aneides lugubris	arboreal salamander	local concern	**present**
	Scaphiopus hammondi	western spadefoot	CFP, CSC	**present**
	Bufo microscaphus californicus	arroyo southwestern toad	FE, CFP, CSC	not likely
	Rana aurora	red-legged frog	FT, CFP, CSC	not likely
	Rana muscosa	mountain yellow-legged frog	CFP, CSC	not likely
BIRDS	*Phalacrocorax auritus*	double-crested cormorant	CSC	not likely
	Ixobrychus exilis hesperis	western least bittern	CSC	not likely
	Plegadis chihi	white-faced ibis	CSC	not likely
	Pandion haliaetus	osprey	CSC	not likely
	Elanus leucurus	white-tailed kite	CFP	**present**
	Haliaeetus leucocephalus leucocephalus	bald eagle	FT, CE, CFP	not likely
	Circus cyaneus	northern harrier	CSC	**present**
	Accipiter striatus	sharp-shinned hawk	CSC	**present**
	Accipiter cooperii	Cooper's hawk	CSC	**present**
	Buteo swainsoni	Swainson's hawk	CT	**present**
	Buteo regalis	ferruginous hawk	CSC	**present**
	Aquila chrysaetos	golden eagle	CFP, CSC	**present**
	Falco columbarius	merlin	CSC	**present**
	Falco peregrinus anatum	peregrine falcon	FE, CE, CFP	possible
	Falco mexicanus	prairie falcon	CSC	**present**
	Charadrius montanus	mountain plover	CSC	possible
	Numenius americanus	long-billed curlew	CSC	possible
	Larus californicus	California gull	CSC	not likely
	Coccyzus americanus	western yellow-billed cuckoo	CE	possible
	Athene cunicularia	burrowing owl	CSC	possible
	Strix occidentalis	spotted owl	FT, CSC	not likely
	Asio otus	long-eared owl	CSC	not likely
	Asio flammeus	short-eared owl	CSC	not likely
	Cypseloides niger	black swift	CSC	not likely
	Chaetura vauxi	Vaux's swift	CSC	**present**
	Empidonax traillii	willow flycatcher	FE, CE	**present**
	Eremophila alpestris actia	horned lark	CSC	**present**

APPENDIX A (continued)

TYPE	SPECIES	COMMON NAME	STATUS*	PROBABILITY IN CHINO HILLS S.P.
	Progne subis	purple martin	CSC	possible
	Riparia riparia	bank swallow	CT	**present**
	Polioptila californica	California gnatcatcher	FT	**present**
	Lanius ludovicianus	loggerhead shrike	CSC	**present**
	Vireo bellii pusillus	least Bell's vireo	FE, CE	**present**
	Vireo vicinior	gray vireo	CSC	not likely
	Vireo huttoni	Hutton's vireo	local concern	**present**
	Campylorhynchus brunneicapillus	cactus wren	CSC	**present**
	Dendroica petechia	yellow warbler	CSC	probable
	Icteria virens	yellow-breasted chat	CSC	**Present**
	Piranga rubra	summer tanager	CSC	**present**
	Parus inornatus	oak titmouse	local concern	**present**
	Aimophila ruficeps canescens	rufous-crowned sparrow	CSC	**present**
	Ammodramus savannarum	grasshopper sparrow	local concern	**present**
	Amphispiza belli belli	sage sparrow	CSC	possible
	Agelaius tricolor	tricolored blackbird	CSC	possible
MAMMALS	*Sorex ornatus*	ornate shrew	CSC, FC/P	possible
	Scapanus latimanus parvus	broad-footed mole	CSC	**present**
	Macrotus californicus	California leaf-nosed bat	CSC	not likely
	Euderma maculatum	spotted bat	CSC	not likely
	Plecotus townsendii	Townsend's big-eared bat	CSC	not likely
	Antrozous pallidus	pallid bat	CSC	probable
	Eumops perotis californicus	western mastiff bat	CSC	**present**
	Lepus californicus benneti	San Diego black-tailed jackrabbit	CSC	not likely
	Perognathus longimembris brevinasus	Los Angeles pocket mouse	CSC	not likely
	Chaetodipus fallax	San Diego pocket mouse	CSC	not likely
	Chaetodipus californicus femoralis	California pocket mouse	CSC	probable
	Dipodomys stephensi	Stephen's kangaroo rat	FE, CT	not likely
	Dipodomys merriami parvus	San Bernardino kangaroo rat	CSC, FC/P	possible
	Onychomys torridus	southern grasshopper mouse	CSC	not likely
	Neotoma lepida intermedia	San Diego desert woodrat	CSC	probable
	Microtus californicus stephensi	Stephen's vole	CSC	??
	Bassariscus astutus	ringtail	CFP	possible
	Taxidea taxus	American badger	local concern	probable
	Felis concolor	mountain lion	CFP, CSC	**Present**

TYPE	SPECIES	COMMON NAME	STATUS*	PROBABILITY IN CHINO HILLS S.P.
REPTILES	*Clemmys marmorata pallida*	southwestern pond turtle	CFP, CSC	**present**
	Coleonyx variegatus abbotti	San Diego banded gecko	local concern	possible
	Phyllodactylus xanti	leaf-toed gecko	CFP	not likely
	Phrynosoma coronatum	coast horned lizard	CFP, CSC	**present**
	Xantusia henshawi	granite night lizard	CFP, CSC	not likely
	Eumeces skiltonianus interparietalis	Coronado skink	CSC	not likely
	Cnemidophorus hyperythrus	orange-throated whiptail	CFP, CSC	Probable
	Cnemidophorus tigris multiscutatus	coastal western whiptail	local concern	**present**
	Charina bottae umbricata	southern rubber boa	CT, CFP	not likely
	Lichanura trivirgata	rosy boa	local concern	possible
	Salvadora hexalepis virgultea	coast patch-nosed snake	CSC	**present**
	Coluber constrictor mormon	western yellow-bellied racer	local concern	**present**
	Lampropeltis zonata parvirubra	San Bernardino mountain kingsnake	CSC	not likely
	Lampropeltis zonata pulchra	San Diego mountain kingsnake	CFP, CSC	not likely
	Thamnophis sirtalis parietalis	red-sided garter snake	local concern	possible
	Thamnophis hammondii	two-striped garter snake	FT, CT, CFP	possible
	Diadophis punctatus modestus	San Bernardino ringneck snake	local concern	**present**
	Crotalus ruber ruber	northern red diamond rattlesnake	CSC	**present**
FISHES	*Gila orcutti*	arroyo chub	CSC	**present**
	Gasterosteus aculeatus williamsoni	unarmored three-spine stickleback	CE, FE	possible
	Rhinichthys osculus	Santa Ana speckled dace	CSC	possible
	Catostomus santaanae	Santa Ana sucker	CSC	possible

*Status Codes: FE = Federal Endangered; FT = Federally Threatened; FC/P = Federal Candidate/Proposal; CE = California Endangered; CT = California Threatened; CFP = California Fully Protected; CSC = California Species of Concern

APPENDIX B

System-Wide Planning Influences

Public Resources Code (PRC)
California Code of Regulations (CCR)
Policies, Rules, Regulations, and Orders of the California State Park and Recreation Commission and California Department of Parks and Recreation
California Department of Parks and Recreation Operation Manual (DOM)
California Department of Parks and Recreation Administration Manual (DAM)
California State Park System Plan
California State Parks *Mission Statement*
California State Parks Access to Parks Guidelines
Resource Management Directives for the California Department of Parks and Recreation.
These directives amplify the legal codes contained in the PRC, the CCR, and the California State Park and Recreation Commission's Statements of Policy and Rules of Order. Specific Resource Management Directives that are particularly pertinent to the management of resources at Chino Hills State Park are:

#3 - Inventory of Features Updates
#5 - The Purposes of Developments in State Parks
#7 - Acquisition Boundaries
#9 - Boundaries and Developments in Natural Preserves
#27 - Establishment of Natural Preserves
#28 - Visitor-Use Impacts
#31 - Implementing Resource Elements
#33 - Exotic Plant Introduction
#34 - Exotic Plant Removal
#35 - Wildlife Management
#37 - Controlling Erosion
#43 - Water Diversion
#46 - Protection of Esthetic Quality
#58 - Cultural Resources
#59 - Underground Work
#70 - Archaeological Values
#72 - Archaeological Research
#74 - Recreational Resources

APPENDIX C

Comparison of Public Use Under Plan Alternatives

	Alternative 1 Existing Plan		Alternatives 2 and 3 Revised Plan
	Current Estimate	Projected Plan Scenario for Peak Use	Projected Plan Scenario for Peak Use
Peak Day-Use Vehicles	20-40	366	235
Peak Night-Use Vehicles	10-30	550	160
Walk- or Ride-In	155	205(3)	205
Peak number of People In Park (1)	365	2,925	1,310
Peak number of Trips per day (2)	165	1,923	945

(1) See calculations used in Appendix D – A Public-Use Scenario.
(2) Does not include use of easements by utility vehicles, which is presumed to remain the same.
(3) Not projected in original (1986) general plan.

APPENDIX D

A Public-Use Scenario

The following scenario represents a reasonable estimate of the type and size of public-use facilities that might be fully implemented within the parameters set by the *Plan Section* (Page 47) of this document. It is just one of a range of possibilities of types/sizes of facilities and is provided merely for the purpose of assessing the potential environmental impacts on the park and nearby properties and highways.

	Number of Parking Spaces	Turnover Rate	Peak Trips per Day*	Visitors/ Vehicle	Peak Number of Visitors in Park
Upper Aliso/Bane Canyon					
• Overnight Use (2 vehicles/campsite)	160	28%	240	3	480
• Day-Use Parking (inc. Visitor & Admin. Center)	120	50%	360	3	360
Boundary Trailheads					
• Day-Use Parking (5 locations)	75	50%	225	2.3	173
Lemon Grove					
• Day-Use Parking	40	50%	120	2.3	92
Walk-in					205
TOTALS	*395*		*945*		*1310*

*Trips per day is based on the following:
Day Use: 50% turnover rate = 3 trips x number of spaces
Overnight: 28% leave and return each day = 1.5 trips x number of spaces
A trip is defined as one-way travel over the entry road either entering or leaving

APPENDIX E

CEQA Review - Public Comments and DPR Responses

As a part of the public review process required by the California Environmental Quality Act, the preliminary (draft) of a General Plan document is made available for public review and comment for a minimum of 45 days. For the review process, each plan is assigned a unique number by the State Clearinghouse, located in the Governor's Office of Planning and Research.

The State Clearinghouse number assigned to the preliminary general plan for Chino Hills State Park is No. 98101049.

At the close of the review period, all public comments which are received in writing, comments from individuals, organizations, and other public agencies, are evaluated by the Department's planning staff, which prepares written responses. The California Park and Recreation Commission reviews these materials as part of the process of evaluating and approving a general plan.

These comments and the resultant departmental responses are retained by the Department as part of the public record. Those wishing to examine these materials should contact the Department at its Sacramento headquarters or at the office of the District in which the park unit is located.

The mailing address of the Department's Sacramento Headquarters is:

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Chino Hills State Park General Plan

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With thanks to:
- Claire Schlotterbeck, Hills For Everyone, who readily offered information and assistance to the planning team
- Members of the Chino Hills State Park Interpretive Association
- Individuals with various local, state, and federal agencies
- The Chino Sector, Inland Empire District, and park staff, who provided considerable knowledge and support
- The many citizens who helped shape this plan through their participation at workshops and meetings

EXHIBIT F

Orange County Fire Authority

After Action Report
Freeway Complex Fire

November 15, 2008

A Report to the
Orange County Fire Authority
Board of Directors

FREEWAY COMPLEX FIRE

AFTER ACTION REPORT

November 15, 2008

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Illustrations, Maps, and Tables Index

Foreword

On November 15, 2008, our communities were impacted by what ultimately became one of the largest wildland fires ever to strike Orange County. The Freeway Fire, which started in the City of Corona on the border of Riverside and Orange Counties, was driven by fierce Santa Ana winds. It spread quickly on a massive fire front, causing widespread damage in the cities of Yorba Linda, Anaheim, and Corona, as well as to Chino Hills State Park. The fire merged with a second one-the Landfill Fire, that had started in the Carbon Canyon area. This caused further damage in the City of Brea and community of Olinda Village, ultimately threatening Chino Valley and driving into Los Angeles County, where it menaced the City of Diamond Bar. Miraculously, no lives were lost or major injuries occurred during this wildland/urban conflagration. However, 381 structures belonging to residents of all impacted jurisdictions were damaged or destroyed by these fires.

The Freeway Complex Fire tasked our fire and law enforcement personnel to extremes. They courageously fought to protect lives and as many homes as possible that were lying in the path of this fast moving firestorm. Ultimately, thousands of homes were saved. I am extremely proud of the heroic work of our fire and law enforcement personnel, the coordination among the many jurisdictions threatened by the fire, and the gallant efforts of hundreds of residents during and after this disaster.

Many of the homes saved were the result of fire-resistant construction features that had been put in place in recent years. The majority of the homes claimed by the fire were built prior to the newer wildland urban interface building requirements. In most cases, these homes succumbed to fires caused by the intrusion of embers driven by fierce winds. Like paper confetti thrown into a fan, these embers rained down on our communities well ahead of the fire.

This was not the first time a fast moving wildfire burned through these communities. In 1980, driven by Santa Ana winds, the Owl Fire (October 28, 1980) and the Carbon Fire (November 16, 1980) burned in the same areas. The difference 28 years later, with regard to structures taken by the fire, is the number of homes now located within this historic fire corridor.

As with any disaster, the lessons learned from this event will help better prepare our communities for the future as we collectively confront the all-too-frequent occurrence of these destructive "mega-fires." The Orange County Fire Authority's and my own renewed commitment is to (1) find additional measures we can implement to better protect our communities from these types of fires, (2) work continually toward enhancing our local capabilities to respond to major incidents of this type, and (3) find new ways for the residents in our communities to help.

Respectfully,

Chip Prather
Fire Chief

Executive Summary

In what has become a year-round occurrence for California firefighters, the 2008 fire season was one of the worst in the state's history—scorching roughly 1.4 million acres. It began in May when dry lightning storms in Northern California sparked over two thousand wildfires. In the fall of 2008, wildland fires threatened Southern California when the Santa Ana winds battered the region.

As the winds raised the temperature and lowered the humidity, the first of several significant wildland-urban interface fires began on October 12, 2008: the Marek Fire. Occurring in the Lakeview Terrace area of Los Angeles County, this fire consumed nearly 5,000 acres, destroyed 40 homes, and damaged 9 others. Then on October 13, the Sesnon Fire began in the Porter Ranch community of Los Angeles County. By the time it was contained, almost 15,000 acres had been scorched and 26 residences had been damaged or destroyed.

The fire siege continued in November as the Santa Ana winds returned. A moderate wind event had been forecasted for November 13–15 in the Southern California region. On the evening of November 13 at approximately 6:00 p.m., an unattended campfire sparked a blaze that was driven by 70 mph winds into the cities of Montecito and Santa Barbara. Known as the Tea Fire, it consumed nearly 2,000 acres and over 230 homes, as well as evacuating nearly 9,000 residents.

On November 14 at 10:29 p.m., only one day later, the fast-moving Sayre Fire broke out in Los Angeles County. Driven by 60 mph Santa Ana winds, it ripped through the northern San Fernando Valley burning all in its path. By the time the fire was controlled, 11,262 acres had been seared and more than 600 structures had been destroyed, including 480 mobile homes at the Oakridge Mobile Home Park. The *Los Angeles Times* called it "the worst loss of homes due to fire in the city of Los Angeles" and reported it "appeared to be the largest number of housing units lost to fire in the city of Los Angeles, surpassing the 484 residences destroyed in the 1961 Bel Air Fire."[1]

Due to extreme weather conditions and increased fire activity, the Orange County Fire Authority (OCFA) implemented an emergency staffing pattern on November 15. Additional resources—including one Type 3 strike team, a second helicopter, and increased personnel on engine companies located in the wildland interface areas—were put in place for the third day of strong Santa Ana winds.

On Saturday, November 15 at 9:01 a.m., the Corona Fire Department received the initial report of a vegetation fire at the westbound 91 Freeway and Green River: the Freeway Fire. Within minutes, the OCFA began receiving reports of the fire at its Emergency Command Center. Driven by hot Santa Ana winds in excess of 60 mph, combined with 8 percent humidity and long-range spotting of one mile or greater, this fire would cause the most catastrophic loss of homes in Orange County since the Laguna Fire in 1993.

The Freeway Fire marched quickly to the west and through the Green River Homes community, spotting far ahead of the main fire. From the onset, it was apparent this would become a rapidly

[1] Tami Abdollah and Howard Blume. November 16, 2008. *Schwarzenegger calls for review after Sylmar tragedy as blazes rage on*, Los Angeles Times. Accessed http://www.latimes.com/news/local/valley/la-me-firemain17-2008nov17,0,2305426.story on January 14, 2009.

spreading and significant conflagration. One hour after it was reported, erratic winds drove the fire in several directions, including north into the Chino Hills State Park, south across the 91 Freeway towards the City of Anaheim, and west into the hills of Yorba Linda. The fire then turned to the northwest, impacting the communities of Carbon Canyon and Diamond Bar.

At 10:43 a.m. on November 15, the OCFA Emergency Command Center received a report of a second fire: the Landfill Fire. This one was located in the area of the Olinda Alpha Landfill, near Valencia Avenue and Carbon Canyon. Fanned by the wind, it spread quickly toward the cities of Brea and Diamond Bar and the 57 Freeway. Borrowing resources from the Freeway Fire, the OCFA and the Brea Fire Department dispatched crews to fight the new threat. Around 5:30 p.m. on November 16, the decision was made to merge the Landfill Fire and the Freeway Fire into a Complex, due to their geographical proximity. By merging the two into the Freeway Complex Fire, it allowed for the sharing of incident management and logistical support and provided a single base of operations for continuity and efficiency.

The Freeway Complex Fire was contained on November 19, 2008, at 7:00 a.m. after consuming over 30,000 acres and impacting six cities in four counties. This was the largest fire in Orange County, since the Green River Fire in 1948. During the final stages of the fire, control lines were secured and aggressive restoration action and recovery efforts were initiated to protect burned areas from flooding and debris flows due to the winter rains.

The fire burned 30,305 acres and damaged or destroyed over 381 homes, commercial structures, and out-buildings. Numerous vehicles, city parks, and sensitive ecological areas in the Chino Hills State Park and the Santa Ana River riparian area were also damaged or destroyed. The impact to residents and businesses from smoke exposure or damage, as well as the economic impact, is difficult to calculate.

To date, the cost for fighting the Freeway Complex Fire is approximately $16.1 million. As a result of the Local Government Fiscal Responsibility Agreement made between OCFA, CAL FIRE, and FEMA/OES, the OCFA will be responsible for a percentage of the cost of fighting the fire on the first day. After reimbursement is received from federal and state resources, the OCFA cost share responsibility is approximately $33,000.

Thankfully, no deaths or serious injuries to residents or firefighters were attributed to the fire; however, 14 firefighters suffered minor injuries. At its height, the Freeway Complex Fire forced as many as 40,000 people from their homes across the four impacted counties: Orange, Los Angeles, Riverside, and San Bernardino.

A unified command and strong coordination between fire and law enforcement was the key to evacuating large numbers of residents and animals in the path of this rapidly burning fire. The efforts of firefighters and citizens and the existing fire prevention measures—those requiring defensible space, non-combustible roofs, fuel modification zones, and ignition resistant construction—were the major factors in saving hundreds of homes.

Ultimately, over 3,800 personnel from more than 260 fire agencies—with over 650 fire engines—were assigned to the incident. The Brea Police Department, which was tasked with large-scale evacuations over a widespread area as well as traffic and crowd control, received assistance from various Southern California law enforcement agencies. Approximately 375 officers from 19 local

police agencies, along with deputies from the Orange County Sheriff's Department, Los Angeles County Sheriff's Department, Riverside County Sheriff's Department, and the Department of Homeland Security responded to the call. The incident was managed by a unified command structure, which included the OCFA, Los Angeles County Fire Department, CAL FIRE, Corona Fire Department, Brea Fire Department, Anaheim Fire Department, Chino Valley Fire District, and the Orange County Sheriff's Department.

While the Freeway Complex Fire presented the OCFA with several difficult challenges, other factors contributed to its complexity. These included several years of drought that increased available dead fuels and lowered live fuel moistures resulting in intense fire behavior and burning conditions. The two fires—the Freeway and the Landfill—started less than two hours apart and placed a great demand on emergency response resources. The topography and the east-west alignment of the Santa Ana Canyon—together with offshore winds—resulted in extremely rapid fire spread, long-range spotting due to flying embers, large-scale evacuations, and the difficult task of deploying resources to protect lives and property over a broad and unpredictable area.

A number of the conclusions in this After Action Report point to things that went well such as OCFA's advance planning and additional staffing for the extreme weather conditions throughout the region. Additionally, OCFA's ongoing fire prevention efforts contributed directly to saving thousands of homes, by providing firefighters with defensible space to protect threatened structures. Other conclusions illustrate areas that can be improved or should be reviewed for follow-up action with the appropriate agency or policy group.

The recommendations contained in this report are intended to help the OCFA better prepare for this type of disastrous wildland fire in the future and improve local capability and surge capacity where possible. Some of these recommendations will require further study, review, and cost analysis to determine the feasibility of implementation. Others are no cost items to implement, or require follow-up action with the appropriate agency or group.

Historical Information

The Santa Ana Canyon has an extensive wildland fire history. The canyon's geographical location plays a major role in directing wildland fire into Orange County. Since 1980, the Santa Ana Canyon area has experienced 25 separate wildland fires, burning a total of 82,734 acres with the events ranging from 1 to 19,986 acres. Until the recent Freeway Complex Fire, the most notable and devastating events have been the 1980 Carbon Canyon Fire (14,613 acres), the 1980 Owl Fire (18,332 acres), the 1982 Gypsum Fire (19,986 acres), and the 2006 Sierra Peak Fire (10,506 acres).

The Santa Ana Canyon's steep topography and east-west alignment serve as a wind funnel. The geography increases the wind's speed and magnifies the effects of fire on the available fuel bed, contributing to the rapid rate of fire spread. Additionally, the encroachment of civilization into the wildland-urban interface (WUI) enhances the severity of wildland fires during Santa Ana wind conditions. The frequency of fire in this area has allowed non-native vegetation of volatile grass, weeds, and shrubs to become the dominant fuel type.

One particular fire of interest is the 1980 Owl Fire—given that several parallels can be drawn between it and the Freeway Fire. The weather, fuel conditions, and point of origin of the two were jarringly similar. Both fires began as Southern California was experiencing Santa Ana wind conditions. The forecast for the Owl Fire was for continued strong, dry winds blowing 15 to 50 mph with gusts to 60 mph. At the start of the Freeway Fire, wind speeds were sustained at 43 mph with gusts of 61 mph and extremely low humidity. The Owl Fire began on October 28, 1980, at 1:47 a.m. near Highway 71 and Prado Dam in Riverside County. The Freeway Fire started in nearly the same area on the north side of the 91 Freeway at Green River. Both fires, fanned by strong Santa Ana winds and fed by dry fuels, quickly burned into Chino Hills and marched west into Orange County.

> The Santa Ana Canyon's steep topography and east-west alignment serve as a wind funnel—increasing the wind's speed and contributing to the rate of fire spread.

Initial Response

The Owl Fire After Action Report states, "The first arriving fire unit on scene reported the fire at five acres in size moving out." The fire's radio traffic was being monitored then by what was known as the Orange County Fire Department's Emergency Command Center. "Although the fire was over two miles away from the Orange County line, all who heard the report on conditions knew the potential that existed: historically, Orange County seems to be the recipient of major wildland fires that start outside its boundaries." Immediately, plans were put into effect to place resources ahead of the Owl Fire's arrival into Yorba Linda.

Familiar with the area's fire history, OCFA Battalion Chief Reeder ordered two Type 1 engine strike teams to stage at Fire Station 53 in Yorba Linda in anticipation that the Freeway Fire would eventually reach the City. However, after hearing requests for resources in Corona, the two strike teams responded to the 91 Freeway and Green River. Prior to arriving on scene, Chief Reeder also ordered fire attack aircraft.

Fire Behavior

As the 1980 Owl Fire's progress was monitored, it became obvious "this was a major fire and that it was spotting as much as a half-mile ahead of itself" and "thick volumes of smoke obscured the actual location of the fire line, further hampering firefighting efforts." Reports from the fire crews on the fire line "showed that the fire was gaining momentum and consuming at least 1,000 acres per hour. At 3:30 a.m. there was little doubt that no amount of effort would stop this blaze before it reached the highly populated areas of Orange County: this fire was going to hit the extreme eastern edge of Yorba Linda very, very hard."

This same extreme fire behavior was observed during the 2008 Freeway Complex Fire. The strong winds kept the thick column of smoke from rising. Instead, it stayed close to the ground, making it extremely difficult to see the fire's perimeter and progression. OCFA Helicopter 41 reported seeing spot fires from one to one and a half miles ahead of the fire front. These same winds pushed the Freeway Complex Fire at an incredible rate of spread. **Historical Information – Map 1** shows over 10,000 acres were consumed in the first 12 hours—roughly 14 acres per minute. That's nearly the length of 14 football fields every 60 seconds.

> The Freeway Complex Fire consumed over 10,000 acres in the first 12 hours—roughly 14 acres per minute. That's nearly the length of 14 football fields every 60 seconds.

Divided Fronts

The Owl Fire divided into two distinct fire fronts primarily due to wind and topography. One burned in a northwesterly direction into "Aliso Canyon in a largely uninhabited area, and never became a major problem." The second and main fire front continued towards Orange County, pushed by 50 mph winds.

The Freeway Fire also traveled in two different directions. One front headed in the direction of Chino Hills State Park, the cities of Yorba Linda and Chino Hills, and the community of Sleepy Hollow in Carbon Canyon. The other followed the Santa Ana River, crossed the 91 Freeway, and moved into the City of Anaheim.

Staging Areas

To prepare for the fire front's arrival, resources dispatched to the Owl Fire were staged in eastern Yorba Linda. "As the fire ate its way towards Yorba Linda, strike teams began positioning themselves along streets in the interface area … all of this complicated by smoky conditions so severe that it caused smoke detectors in many homes to activate." The fire arrived battering the area at the east end of La Palma Avenue and Esperanza Road and along the east side of Dominguez Ranch Road at about 11:00 a.m. This was nearly nine hours after the start of the fire. In 1980, these roads formed the eastern border of Yorba Linda. "Firefighters, along with residents that had elected to remain behind to hose down their roofs, were hit with a blinding gale of choking smoke and showers of burning embers."

By comparison, during the Freeway Fire, resources were ordered to stage at Station 53 located within the eastern border of Yorba Linda in anticipation of the threat. At about 10:00 a.m., the fire

was burning near the river bottom along the Green River Golf Course. At 10:08 a.m., OCFA Helicopter 41 reported a large spot fire one mile ahead of the main fire front. Immediately, additional engine strike teams, aircraft, and helicopters were ordered to augment the resources protecting the city. Additional orders were given at 10:20 a.m. to notify the Brea Police Department to begin evacuations in the area of Brush Canyon. The OCFA Emergency Command Center also telephoned the Yorba Linda City Manager. A message was left notifying him that the fire was now heading toward his city and would arrive in 30 minutes. At 10:39 a.m.—31 minutes later, the fire was threatening the communities of Big Horn and Evening Breeze. This occurred approximately 90 minutes after the start of the fire and less than 30 minutes since the report of the spot fire. The first structure fire was reported at 10:58 a.m. on Merryweather Circle—about three miles from the point of origin.

Fire Containment

The Owl Fire was 100 percent contained on October 30, 1980, at 5:00 a.m. after burning 18,832 acres and destroying 3 homes. Over 136 engines and 790 firefighters, along with 4 helicopters, battled the fire for two days to bring it under control. The Owl Fire After Action Report credits the subsiding winds for the ability of firefighters to stop the progression of the fire. Refer to the **Owl Fire After Action Report** at http://www.ocfamedia.org/_uploads/PDF/ofaar.pdf for more details.

The Freeway Complex Fire was declared under control on November 19, 2008, at 7:00 a.m. after consuming 30,305 acres and destroying 187 homes. More than 650 engines and 3,800 firefighters, with 17 helicopters and 12 air tankers, succeeded in keeping the loss of homes from being much worse.

Although the number of acres consumed is very different for each fire, what is rather striking is the final "footprint" or fire perimeter of both fires. **Historical Information – Map 2**, both followed the geographical contours as they were driven by the strong winds through the Santa Ana Canyon, resulting in nearly identical burn perimeters.

> More than 650 engines and 3,800 firefighters, with 17 helicopters and 12 air tankers were assigned to the Freeway Complex Fire.

Summary

Traditionally, the fire season in Southern California has been from May through September. Over the past 15 years, a trend has emerged where Orange County—and Southern California—has experienced some of its most devastating wildfires from October through April. In fact, two major fires in Orange County in the past six years have occurred in February: the 2006 Sierra Fire and the 2002 Green Fire. Another occurred in March: the 2007 Windy Ridge Fire. Most recently, the Santiago Fire occurred in October 2007.

In the two-month period of October and November 2008, Southern California experienced several significant wind events sparking multiple wildfires. Five of these became major incidents resulting in thousands of acres burned, numerous homes destroyed, and countless people displaced. These fires shared several common denominators, including (1) Santa Ana winds; (2) competition for resources due to multiple, simultaneous fire activity throughout Southern California; and (3)

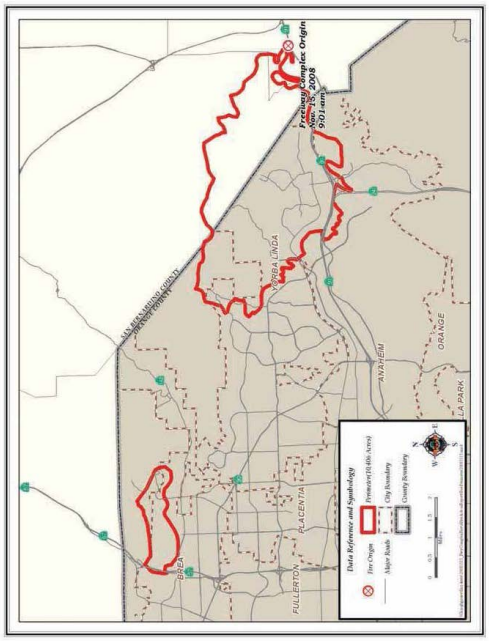
wildland fire occurrence late or outside the traditional fire season.

Over the past 60 years, Orange County has experienced a number of major wildland fire disasters. Table 1: Sixty-Year Major Fire History—Orange County, lists selected Orange County wildland fires that covered large geographic areas, burned out of control for an extended period of time, and/or resulted in extraordinary property loss—homes, businesses, and valuable watershed. The Freeway Complex Fire was the largest wildland fire in terms of acreage—over 30,305 acres—the OCFA has faced in the past 40 years. The fire was one of the most challenging and complex due to the rapid rate of spread, wildland-urban interface (WUI) encroachment, vast evacuations, and sustained Santa Ana winds.

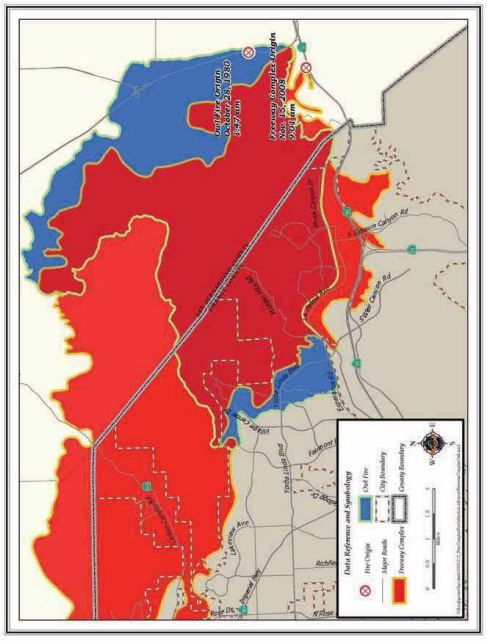
Table 1: Sixty-Year Major Fire History—Orange County

INCIDENT YEAR	INCIDENT NAME	ACRES CLAIMED	COUNTY(IES) INVOLVED
1948	Green River	53,079	Orange
1958	Steward	69,444	Orange/San Diego
1967	Paseo Grande	51,075	Orange/Riverside
1980	Indian	28,408	Orange/Riverside
1980	Owl	18,332	Orange/Riverside
1982	Gypsum	19,986	Orange
1993	Laguna	16,682	Orange
1993	Ortega	21,010	Orange
2007	Santiago	28,517	Orange
2008	Freeway	30,305	Orange/Riverside/San Bernardino/Los Angeles

Historical Information – Map 1
Freeway Complex Fire—12-Hour Perimeter 11-15-08 9:00 p.m.



Historical Information – Map 2
Owl Fire and Freeway Complex Fire—Fire Perimeter Overlay



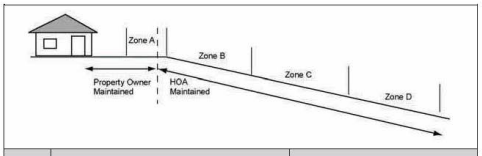
Fire Prevention

Land use planning and fire prevention play a key role in reducing the wildfire threat to communities in the wildland-urban interface (WUI). To adequately protect communities in WUI areas, a combination of brush clearance measures, ignition resistant construction of structures, and community preparedness and participation is necessary.

Brush Clearance

In 1979, Orange County adopted "fuel modification" provisions for new developments to protect homes in the WUI. The OCFA has enforced these requirements ever since. The provisions and requirements are also included in the local ordinances of the 22 cities protected by OCFA. Homes constructed in Yorba Linda since 1980 are most likely protected by a fuel modification program.

Table 2: OCFA Fuel Modification Program



ZONE	REQUIREMENTS	PURPOSE
A	• 20 feet wide and on level ground • Landscaped with approved plants • No combustible construction permitted	Limits direct flame impingement on structures and deflects radiant heat
B	• Minimum of 50 feet wide • Irrigated and landscaped with approved plants	Slows fire and reduces intensity
C/D*	• Minimum of 50 feet wide for each zone • All dead and dying materials are removed • Native vegetation thinned 50% in Zone C and 30% in Zone D	Slows fire and reduces intensity

*Some older areas may *only* have a Zone C.

The fuel modification program for OCFA communities requires the creation of a minimum of 170 feet of irrigated and non-irrigated zones and setbacks. Landscaping should include a selection of appropriate plant palettes for each zone. This is unlike State law that requires 100 feet of clearance or to the property line if 100 feet is not available.

The OCFA fuel modification program also differs from State law by containing provisions to ensure adequate space is available to protect structures before building permits are issued. If 170

feet is not available, the landowner must either (1) obtain dedicated, legal off-site easements from the adjacent property owner or (2) mitigate the lack of defensible space with construction features that can withstand the anticipated radiant heat. Requirements for on-going maintenance are also included in the property deed and/or homeowner association by-laws.

Homes constructed in the WUI prior to 1980 are required to maintain "defensible space" between the home and the property line separating it from the WUI. Defensible space is less prescriptive than fuel modification and consists of thinning vegetation and ensuring tree branches are not within ten feet of chimneys.

Although fuel modification and defensible space provisions are typically applied at the perimeter of a development the "edge" of the WUI, homes on or near interior slopes are also at risk. The vegetation in these areas should also be managed to reduce the risk of home loss from fires.

Arrow pointing to an overgrown interior slope prior to the Freeway Complex Fire

Arrow pointing to the same slope after the Freeway Complex Fire showing the tragic loss of homes along the ridge

The provisions for fuel modification and defensible space have evolved over the past 30 years. Although proven effective in protecting communities during wildfire incidents, the provisions are not without implementation challenges. The most significant of these is maintenance.

Maintenance of Brush Clearance

The OCFA does not have a formal WUI inspection program. As a result, if areas are not properly maintained and irrigated by the responsible landowner, overgrowth and/or plant death may occur. OCFA staff attempts to identify the worst cases and work with landowners to restore the land to an approved condition. In Yorba Linda, this is complicated since most fuel modification areas are on individual properties managed by a single homeowner. This is unlike most of Orange County where fuel modification zones are owned and maintained by a homeowners' association.

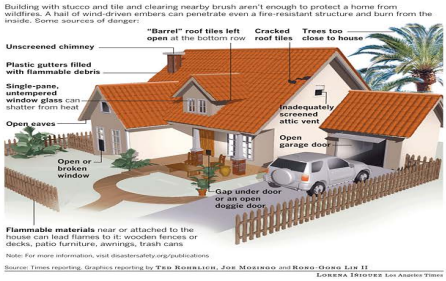
Despite the lack of a formal program, OCFA determined both the 2007 and 2008 fire seasons posed a significant enough risk to revise priorities and put efforts toward mitigation of this risk. Due to the severity of drought conditions and anticipated fire activity in 2008, the OCFA conducted inspections of all WUI properties in its jurisdiction. In Yorba Linda, the OCFA inspected the 589 parcels that are part of the defensible space program: homes/neighborhoods developed before 1979. The OCFA found only 16 out of compliance with minimum requirements

for defensible space. Additionally, 794 fuel modification parcels were inspected to ensure they were in "substantial compliance" with provisions of the post-1979 formal fuel modification program requirements. Of those inspected, 325 needed some type of corrective action. Prior to the start of the Freeway Fire, all but 25 had met the minimum requirements.

Ignition Resistant Construction

Properly established and maintained brush clearance is typically very effective in protecting homes from direct flame impingement and radiant heat. However, it does not provide additional protection from ember intrusion. Homes must be constructed to withstand ignition from embers that land on homes or enter through attics and other openings.

Illustration 1: How Fire-Resistant Homes Can Burn



The damaged or destroyed homes in Yorba Linda had many of the more traditional features that protect homes from flames and radiant heat. In some cases, these features are also effective in protecting homes from embers. However, in a wind driven fire storm, additional protection is necessary.

Following the disastrous 1993 Laguna Beach Fire, the Orange County Board of Supervisors commissioned a report to assess the damage and make recommendations to minimize the impact of future wildfires. The subsequent report, written in 1995, contained development requirements, including water supply, street design, brush clearance—current fuel modification provisions were found adequate, and construction features to "harden homes" from wildfire.

These requirements became effective January 1, 1996, as local amendments to the California building and fire codes that went into effect that date. The application of the requirements was limited to those County areas and cities that chose to adopt the Very High Fire Hazard Severity Zones mapped by CAL FIRE. Although Yorba Linda chose not to adopt the CAL FIRE maps, the

City Council did adopt and apply the local amendments in designated areas, referred to as Special Fire Protection Areas (SFPA).

Recently, the California legislature determined homes were not adequately protected since structure losses from wildfire continues to grow. Pursuant to that finding, the legislature charged the Office of the State Fire Marshal (OSFM) to take action to reduce the impact of future fires. The OSFM worked with stakeholders and University of California (UC) Berkley's fire lab to develop new "ignition resistant" building standards and material testing criteria. These standards—which dictate construction methods for roofs, eaves, vents, walls, doors, windows, and patio covers and decks—apply to all homes constructed in "Very High Fire Hazard Severity Zones" or locally designated wildland-urban interface areas, beginning in January 2008.

Homes must be constructed to withstand ignition from embers that land on homes or enter through attics and other openings.

Orange County has not received the final Very High Fire Hazard Severity Zone designation maps for adoption by the City of Yorba Linda. The County anticipates the maps will be released later in 2008. In the interim, the regulations are applicable in the SFPA adopted by the City in 1996. Many construction requirements of that 1996 ordinance are similar to the new statewide standards. Notably, improvements relative to application and protection of walls and vents were made to the new provisions. **Fire Prevention – Table 4** shows a comparison of OCFA's current requirements to the regulations adopted by the State Building Standards Commission in 2006, effective in 2008.

Access and Water for Firefighting

Brush clearance and "hardened"—ignition resistant—homes go far to increase the chances for a home's survival from a wind-driven WUI fire. However, intervention by firefighters is often necessary in saving a home determined to be defensible. Thus, emergency access and water availability play an integral part in aiding firefighters in these efforts.

OCFA's Planning and Development Services Section reviews all plans for new development to ensure adequate access and water supply is provided in accordance with the City-adopted Fire Code. Like all California jurisdictions, State law requires Yorba Linda to adopt the California Fire Code (CFC). The City adopted the 2007 edition in that same year.

Local amendments present in the CFC since 1996 require 28-foot wide roadways in high fire hazard areas, as well as a minimum of two ways into all communities with 150 or more homes.

The CFC also requires all structures to be within a specified distance to an "approved" water supply. An "approved" water supply can be defined by the adopting jurisdiction, or the jurisdiction may choose to adopt the water supply provisions found in Appendix B of the CFC. At OCFA's recommendation, Yorba Linda adopted the Appendix B provisions. One table specifies the water supply, known as "fire flow," based on the square footage of the structure and the construction type. Fire flow is comprised of the flow volume (gallons per minute [gpm]), residual pressure (pounds per square inch [psi]), and duration of flow (in hours). Another table indicates the number of fire hydrants that must supply this fire flow and their spacing relative to protected structures. (See the **OCFA Fire Master Plans for Commercial and Residential Development** at http://www.ocfa.org/_uploads/pdf/guideb09.pdf for additional CFC details.)

Using these tables, a typical street with homes not exceeding 3,600 square feet would be protected by hydrants that deliver 1,500 gpm each for a minimum of 2 hours at 20 psi residual pressure. For homes between 3,600 and 4,800 square feet, hydrants must deliver 1,750 gpm for 2 hours at 20 psi residual pressure. Locally adopted amendments require hydrant spacing of 300 feet along the street.

Getting water for structure protection

During the Freeway Fire, the demand for water by the structure protection engines exceeded the available supply. Areas of Yorba Linda, such as Hidden Hills, had loss of water pressure during which firefighters had to shuttle water from other areas. As defensible space and ignition construction have been studied over the years, so to have been the water needs in the WUI. New standards have been drafted and are available for local adoption.

Fire "Losses" and "Saves"

Although 117 homes were destroyed and another 77 were damaged as well as 27 out-buildings and 22 vehicles, **Table 3** below shows the losses were a small percentage of the structures and vehicles threatened within the fire perimeter/evacuation zone. This was due to a combination of brush clearance, home construction, and aggressive firefighting.

Table 3: Fire Losses and Structures Saved Within the City of Yorba Linda

Category	Residential		Commercial/Industrial		Other	
	Total No.	Percentage of Total (%)	Total No.	Percentage of Total (%)	Vehicles	Out-Buildings
Threatened	9,525	100.00	126	100.00	N/A	N/A
Destroyed	117	1.22	0	0.00	45	10
Damaged	77	.80	2	1.59	22	27
Saved*	9,331	97.96	124	98.00	NA	NA
Dollar Loss	Structures: $84,361,455 Contents: $39,989,500 Total: $124,350,955					

*Does not include damaged structures considered as partial "saves." *Based on OCFA Fire Incident Reporting Data.*

An assessment of homes destroyed or damaged indicates they were victims of ember intrusion rather than direct flame impingement suggesting brush clearance was adequate. The exceptions were instances where embers ignited one home and then burned the homes on either side in "cluster burns," which continued until firefighters stopped the spread.

Although the burned homes were somewhat "hardened" to embers, the construction was not adequate for the conditions presented with this fire. Embers entered homes mainly through attics as they penetrated roofs through the ends of barrel-shaped clay tiles, loose flashing at roof/wall interfaces, grooves at roof valleys, and combustible rain gutters particularly those containing plant debris. Embers also entered attics through unprotected eaves and attic vents.

Several homes were lost to embers gathering under unprotected exposed wood underside balconies or wooden decks and patio covers. Once these ignited, the flames burned through walls and entered homes.

Notably, all the homes damaged or destroyed were constructed prior to 1996. Thus, they were not protected by the CFC provisions required by the City's ordinance for WUI areas. However, the homes in Casino Ridge met the requirements of the 1996 ordinance. They were also protected by a relatively new fuel modification program. Firefighters stated they were able to focus resources and efforts on other areas of the city as this community was developed to withstand a wildfire with little firefighting intervention.

Challenges

The application of (1) ignition resistant construction requirements and (2) brush maintenance requirements are both critical to the survivability of homes subjected to intense heat and ember intrusion even those located hundreds of feet from the interface. Although proven effective in protecting communities during wildfire incidents, these requirements are not without implementation challenges. The most significant are:

Fire front approaching the Casino Ridge community

Maintenance of Fuel Modifications

Fuel modification requirements in communities developed after 1980 and brush clearance measures in those developed prior to 1980 must be maintained to be effective. Currently, OCFA does not have a formal inspection and enforcement program to ensure the over 14,000 parcels and lots are adequately maintained. As a result, areas can become overgrown and, in some instances, irrigation can be lacking due to cost or poor maintenance of water lines. OCFA staff attempts to identify the worst cases and work with landowners to restore the land to an approved condition. Due to the lack of penalties for failure to comply, sometimes several parcels/lots remain out of compliance for several years. This presents a hazard to community homes and adjoining lands.

The most significant challenge is protecting the areas established prior to current fuel modification and construction requirements.

Application of Construction Requirements

Applying ignition resistant construction requirements is critical to the survivability of homes subjected to ember intrusion both at the interface and within a few hundred feet of the interface. Maps depicting impact areas must be locally adopted. This process is often controversial, since the development community typically expresses concern over rising costs, real estate disclosure, and insurance premiums. As a result, areas needing protection based on topography, fuels, weather, and fire history are often left unmapped due to local action/inaction.

Existing Communities

The most significant challenge is protecting the areas established prior to current fuel modification and construction requirements. The pre-1980 established areas lack adequate brush clearance, and

some have home lots that are too small to create adequate defensible space on the property. Homeowners often cannot obtain permission for off-site clearance from neighbors or government entities. Environmental restrictions also hinder the ability to create defensible space. State and Federal agencies have conflicting missions with the fire service relative to control of native vegetation, although this was not the case during the 2008 inspection cycle.

Casino Ridge area of Yorba Linda with current fuel modifications and construction requirements

Fire Prevention – Table 4
Comparison of Current OCFA Requirements and New State Regulations

California Building Code Requirements for "Hardening Homes" *Indicates more restrictive requirement if not equivalent.	
Former Yorba Linda Ordinance (January 1996–January 2008)	**New State Code (July 2008)**
Applies to structures located in Very High Fire Hazard Severity Zones and Special Fire Protection Areas that are within 100 feet of fuel modification zones. Most provisions apply only to structures having an exposed side. Exposed side is defined as an exterior wall of a structure within 100 feet of the fuel modification zone.	Applies to all structures located in Very High Fire Hazard Severity Zones and locally designated Wildland Fire Areas. All exterior sides—not just the exposed sides—shall meet the requirements of Chapter 7A.*
Exterior Wall: Exposed side of exterior wall shall be of non-combustible construction or 1-hour fire-resistive construction for the exterior portion.	**Exterior Wall:** Shall be of approved non-combustible or ignition resistant material or heavy timber.
Glazed Openings: Shall be multi-glazed with at least two panes.	**Glazed Openings:** Shall be tempered glass or glass block or have a fire resistive rating of not less than 20 minutes.*
Doors: Shall be minimum 1 3/8 inches thick solid core or metal non-combustible.	**Doors:** Shall be non-combustible or solid core or 20-minutes rated.
Attic Vents: Not allowed on exposed sides. Other sides must be protected by metal louvers and 1/4-inch mesh corrosion-resistant metal screen. Vents shall not exceed 144 sq. inch per opening.*	**Attic Vents**: Shall be covered with 1/4-inch corrosion-resistant metal screen; no size limit.
Eave or Cornice Vents: Not allowed on exposed sides.	**Eave or Cornice Vents**: Prohibited unless they can resist the intrusion of flame and burning embers into the attic.
Roof Valley: Flashing shall not be less than 26 gauge galvanized sheet installed over a 36-inch under layment consisting of one layer of No. 72 ASTM cap sheet running the full length of valley.	**Roof Valley**: Flashing shall not be less than 26 gauge galvanized sheet installed over a 36-inch under layment consisting of one layer of No. 72 ASTM cap sheet running the full length of valley.
Roof Gutters: Shall be provided with means to prevent accumulation of leaves and debris.	**Roof Gutters**: Shall be provided with means to prevent accumulation of leaves and debris.
Roof Assembly: New construction and reconstruction shall be fire retardant Class A roof assembly.	**Roof Assembly**: New construction and reconstruction shall be fire retardant Class A roof assembly.
Skylights: Shall have a non-combustible frame with dual glazing of heat strengthened or fully tempered glass or 3-rated assembly.*	**Skylights**: No requirements
Roof Covering: Where roof profile allows a space between roof covering and roof deck, the space shall be fire stopped with approved material or have one layer of No. 72 ASTM cap sheet installed over the combustible decking.	**Roof Covering**: Where roof profile allows a space between roof covering and roof deck the space shall be fire stopped with approved material or have one layer of No. 72 ASTM cap sheet installed over the combustible decking.
Decking: Those on exposed side to be 1-hour rated, non-combustible or heavy timber.	**Decking:** Specific requirement for decking surface shall be of ignition resistant material, heavy timber, or non-combustible material.
INTENTIONALLY LEFT BLANK	Ignition resistant material definition provided: Tested according to ASTM 84 for 30 minutes.
INTENTIONALLY LEFT BLANK	Flame spread less than 25 with evidence of no progressive combustion.

Advance Planning

Although a Red Flag Warning was not in effect for Orange County on November 15, 2008, it was in other Southern California counties. Due to these warnings, CAL FIRE requested a special staffing pattern be implemented across the region. The OCFA asked CAL FIRE to approve the staffing enhancements for implementation on November 14, 2008. The following staffing pattern was approved by CAL FIRE and in place the morning of November 15:

- One Type 3 strike team with four-person staffing—five engines and a Chief Officer
- The staffing of a second helicopter
- The increased staffing of five engine companies in the wildland interface areas—from three firefighters each to four—referred to as the "Grey Book" stations
- An additional fire dispatcher at the Emergency Command Center

A conference call with CAL FIRE, USFS, and multiple county fire agencies was conducted at 9:00 a.m., November 15. OCFA's Assistant Chief Kramer and Division Chief Fleming, the OCFA Duty Officer, attended the meeting. A briefing on the status of the Tea and Sayre fires was provided, as well as current weather for Orange and other counties. The forecast for Orange County did not include a Fire Weather Watch or Red Flag Warning. In fact, the predicted winds for the local area were supposed to be relatively light—diminishing by 2:00 p.m. that day. OCFA routinely monitors weather forecasts and takes appropriate action. When extreme winds and red-flag conditions do exist, the OCFA implements procedures established by Operations SOP 209.13, *Extreme Weather Plan Winds/Red Flag & Rain/Floods*.

As a cooperating member of the California Fire and Rescue Emergency Mutual Aid Plan, the OCFA committed three strike teams of engines out-of-county prior to the start of the Freeway Fire. The mutual aid system is founded on the principle of neighbor helping neighbor. When an emergency overwhelms an agency's ability to manage it on its own, other fire departments voluntarily provide resources, if possible. The system allows for an orderly escalation and distribution of resources.

Additionally, neighboring Orange County MetroNet fire agencies had committed four strike teams of engines to the Tea and Sayre fires, including an OES engine strike team. A total of 35 fire engines and 7 strike team leaders from the OCFA and other County fire agencies were assigned to fires outside the County at the start of the Freeway Fire.

As OCFA resources are committed on a mutual aid response, personnel are recalled to staff relief engines to ensure adequate station coverage. All OCFA stations vacated due to the deployment of units outside the County were covered either through the use of backfill (ten engines) or by the on-coming shift personnel (five engines). **Table 5** shows the commitment of strike teams on November 14, 2008, by the OCFA and MetroNet Out-of-County Strike Teams.

Table 5: OCFA and MetroNet Out-of-County Strike Teams
November 14, 2008

Fire	Strike Team	Day/Time Committed
Tea	ORC Strike Team 9328C and XOR Strike Team 1421A and 1422A	November 13, 2008
Tea	OES Strike Team 1830C, including one OCFA engine (OES-E303), as part of OES Type 1 strike team (1830C)	November 13, 2008, 11:47 p.m.
Tea	ORC Strike Team 1400A	November 14, 2008, 3:55 a.m.
Sayre	ORC Strike Team 1402A	November 15, 2008, 12:40 a.m.
Sayre	XOR Strike Team 1423A	November 15, 2008

Pre-planning for emergency events is routine for the OCFA. Operational plans exist or are under development for many high-risk areas. A few weeks prior to the Freeway Complex Fire, a tabletop exercise was conducted to bring stakeholder agencies (OCFA, LACO, Corona Fire Department, CAL FIRE RRU/BDU, San Bernardino CFD, Chino Valley IFD, Anaheim Fire Department, Orange Fire Department, USFS, and South Operations) together. The goal was to develop and review operational plans for the wildland-urban interface area along the 91 Freeway corridor. The exercise provided chief officers the opportunity to consider a variety of events to better understand fire progression and fire spread potential. Decision trigger points and a course of action were also developed for each event. This tabletop exercise proved to be highly beneficial; some of the first responding chief officers to the Freeway Fire had been exercise participants.

One trigger point and its course of action was demonstrated through by OCFA Battalion 2 while en-route to the fire. Based upon the radio traffic from the initial attack crews, Battalion 2 ordered two strike teams to report to OCFA Station 53 in east Yorba Linda. This was done to get ahead of the fire and place additional engines into Yorba Linda, which was in the direct path of the rapidly advancing fire from Corona.

When the Department Operation Center opened at 11:30 a.m., the call back of off-duty personnel was initiated to get all available relief and surge apparatus in-service.

As the request for resources at the fire increased, the OCFA needed to begin staffing uncovered fire stations, relief, and surge apparatus. When the Department Operation Center (DOC) opened at 11:30 a.m., staff was tasked to initiate the call back of off-duty personnel and to get all available relief and surge apparatus in-service as soon as possible. Battalion Manpower Coordinators were organized to handle the hundreds of telephone calls necessary to meet this goal. The majority of necessary staffing was achieved within eight hours. By 10:00 p.m. November 15, all critical staffing needs had been met.

On Sunday, November 16—with continued Santa Ana winds along with multiple fires burning in Southern California and the potential for area resource drawdown—the Duty Officer ordered all suppression personnel be held on duty. This action increased manpower available to staff emergency apparatus from normal daily staffing of 253 personnel to 462 suppression personnel. By noon on Sunday, all personnel who were not required were released.

In addition to the extra engines that were staffed by full-time firefighters, OCFA reserve firefighters staffed ten patrols, three squads, four water tenders, one helicopter support unit, and five engines. These units were assigned to stand-alone Reserve Stations 3, 11, 14, and 16 and combination Station 23. The staffing level in the Emergency Command Center (ECC) was augmented with two additional dispatchers and one additional dispatch supervisor. One Division Chief and two Staff Captains were recalled to begin staffing the DOC.

The advance planning accomplished early Friday, November 14, prior to the Freeway Fire and the following staffing actions proved to be key in OCFA's ability to engage the fire. As the fire rapidly spread into neighborhoods in east Yorba Linda and Anaheim Hills, the OCFA was still able to sustain response coverage for other portions of its service area.

Emergency crews from throughout the state respond to the request for mutual aid

Incident Narrative

Summary

The following is a chronological perspective of the firefighting efforts that took place in the cities of Corona, Yorba Linda, Anaheim, Brea, Chino Hills, and Diamond Bar on November 15 through 19, 2008. The event is now known as the Freeway Complex Fire. This report is as accurate and complete as possible. Since the specifics of this incident are complex and it occurred so rapidly, the actions of every fire company, the events that took place in every community, or the circumstances that surrounded every loss cannot be described in detail. Personnel from all ranks and assignments were interviewed, hundreds of documents were reviewed, and several hundred radio transmissions were listened to in the development of this narrative.

Though it started as a wildland urban interface fire, the Freeway Complex Fire quickly became an urban conflagration. Destroyed structures included 203 residences, 2 commercial structures (one in Yorba Linda and one in Brea), and 17 out-buildings. Damaged structures included 117 residences, 6 commercial structures, and 36 out-buildings. In total, 30,305 acres of watershed were consumed across six cities and four counties. Suppression costs exceeded $16.1 million, and property loss has been estimated at nearly $150 million.

Preplanning

The Freeway Complex Fire occurred in a designated mutual threat zone. The original vegetation fire in this jurisdictionally contiguous area received initial attack responses from multiple agencies, including the OCFA (ORC), Corona Fire (COR), Anaheim Fire (ANA), CAL FIRE, and the United States Forest Service (USFS). The high degree of coordination behind this emergency response was not accidental. Three weeks prior to the incident, a tabletop exercise scenario was conducted with these and other area responders. Predicted fire spread, values at risk, operational trigger points, communications, and other related issues were discussed and modeled. This tabletop exercise was greatly responsible for some of the quick decision making behind early resource ordering, including additional engine strike teams and aircraft.

The Freeway Complex Fire destroyed or damaged approximately 320 residences, 8 commercial structures, and 53 out-buildings.

Based upon the predicted weather patterns, which included strong Santa Ana winds and low humidity for the weekend, the OCFA had placed a special staffing pattern into effect on Friday, November 14, 2008. To prepare for the weather pattern, the OCFA had one Type 3 engine strike team (ORU 9329C), consisting of five wildland engines and a Chief Officer (Hawkins), staged at the OCFA Regional Fire Operations and Training Center (RFOTC). In addition to ORC Helicopter 41 (HC41) that was already on duty, ORC Helicopter 241 (HC241) was staffed with a pilot and crew chief. Also, five fire engines located at stations near wildland areas were up-staffed from three firefighters to four. An additional dispatcher was also added to the Emergency Command Center (ECC).

A day earlier, on November 13, ten engines from the OCFA (ORC Strike Team 1400A and ORU Strike Team 9328C) were sent to the Tea Fire in Santa Barbara County. In addition, the Office of

Emergency Services (OES) engine strike team based in Orange County was activated. It was sent to the Tea Fire along with three Type 1 engine strike teams from non-OCFA fire departments in Orange County. At 12:40 a.m. on November 15, five additional OCFA engines (ORC Strike Team 1402A) were sent to the Sayre Fire in Los Angeles County. Prior to the start of the Freeway Fire, all vacancies created within OCFA fire stations by these deployments were filled.

Day 1 - November 15, 2008

At 9:01 a.m. on November 15, the Corona Fire Department (COR) received reports of a vegetation fire on the north side of the 91 Freeway, east of Green River Drive. COR Dispatch sent units, including a Battalion Chief (COR B3 [Samuels]) and three engines (COR BR1, BR3, and E2).

At 9:03 a.m., the OCFA ECC received the first of many 911 calls reporting the same fire along the north side of the westbound 91 Freeway east of Green River Drive. The first caller reported the fire to be approximately one-half acre but building rapidly. Subsequent calls gave varying descriptions and locations, indicating to the dispatchers the fire was moving rapidly west along the freeway toward the Green River Golf Course. **Incident Narrative – Map 3** shows the point of origin of the Freeway Complex Fire

The ECC entered a *High Watershed Dispatch* into the Computer Aided Dispatch (CAD) system at 9:07 a.m., sending units to the fire's reported location. This initial dispatch was comprised of the following:

- One Division Chief (ORC D5 [Fleming])
- Three Battalion Chiefs (ORC B2 [Reeder], ORC B3 [Aubrey], and ANA B1 [Pilar])
- Seven, single increment engines (ORC E10, E15, E53, and E832 and ANA E8, E9, and E10)
- One ORU Strike Team 9329C (ORC B27 [Hawkins]; ORC E247, E250, E307, E318, and E339)
- Two hand crews (ORC Crew 1 and Reserve Crew 18)
- Three helicopters (ORC HC41 and HC241; OCSD Duke)
- Two patrols (ORC P10 and P32)
- One fire bulldozer (ORC Dozer 2)
- Three water tenders (ORC W7, W10, and W16)

In **Table 6**, Freemont Canyon RAWS indicated responding personnel had to contend with mild temperatures of 75°F, low relative humidity of 8 percent, and strong east/northeast winds sustained at 43 mph, gusting up to 61 mph. Winds were higher than expected based on the recent National Weather Service (NWS) predictions and morning briefing on statewide fire conditions.

Freemont Canyon RAWS

Table 6: Freemont Canyon RAWS—Santa Ana Mountains

Time	Temperature (°F)	Wind Speed/Gust Speed (mph)	Relative Humidity (%)
9 a.m.	75	43/61	8
3 p.m.	80	25 /45	7

ORC Battalion 2 (Reeder) was on the initial dispatch and, while responding to the fire, was monitoring the radio traffic of the COR units already on the scene. At 9:19 a.m., Battalion Chief Reeder relayed to the ECC that COR units were on scene and reporting an immediate threat to structures. Battalion Chief Reeder requested two Type 1 engine strike teams ten engines and two Chief Officers stage at OCFA Station 53 in Yorba Linda; this anticipated the fire's possible move into Orange County. He also requested fixed wing aircraft air tankers be dispatched.

The first order for air tankers was placed at 9:19 a.m. They were dispatched at 9:35 a.m. and arrived over the fire at 10:10 a.m.

The order for aircraft was placed by the OCFA ECC to the CAL FIRE Perris ECC; however, the order was not immediately filled. Shortly before 9:12 a.m., COR Dispatch contacted CAL FIRE Perris ECC and discussed the need for ground resources and a helicopter. Air tankers were not ordered by COR Battalion 3 (Samuels) when the initial equipment request was made. When Chief Reeder's order was delivered to CAL FIRE Perris ECC, there was some confusion regarding the actual need for fixed wing aircraft. More calls between COR Dispatch and CAL FIRE Perris ECC resulted in confirmation for the air tanker request only after COR E5 was reported to be surrounded by fire. The air tankers were dispatched at 9:35 a.m. out of San Bernardino Airport. The first air tanker arrived at 10:10 a.m.

A minute after Battalion Chief Reeder made his requests, Anaheim Fire Engine 10 (ANA E10) reported COR was on scene. Approximately one acre of grass was burning along the north side of the 91 Freeway. At 9:21 a.m., two strike teams from OCFA were dispatched to stage at Fire Station 53. ORC Strike Team 1403A included ORC Battalion 44 (Cruz) and ORC E8, E23, E34, E35, and E53. ORC Strike Team 1404A included ORC Battalion 7 (Whitaker) and ORC E27, E31, E38, E55, and E826. While en-route to Station 53, the strike team leaders heard the requests for immediate need resources and diverted to the City of Corona with the hope to help stop the fire there. This decision left the original request unfilled to have two strike teams stage at ORC Station 53.

Palm trees show how strong the wind blew during the fire

COR Battalion 3 (Samuels) arrived on scene about the same time and assumed the Freeway Fire Incident Command. This information was provided to the ECC at 9:23 a.m. and was relayed to responding units. ANA Battalion 1 (Pillar) arrived a few minutes later and was assigned Structure Protection Group (SPG) responsibility. Around 9:30 a.m., Pillar placed an order to the Incident Commander for three additional engine strike teams 15 engines.

Firefighting resources arriving on scene experienced Santa Ana winds blowing between 40 to 60 mph. Homes located on Penny Royal Drive and Feather River Road in Corona were identified by ORC Battalion 2 (Reeder) as immediately threatened. Units on scene attempted to take tactical positions to best facilitate structure protection. Incident Commander Samuels faced a rapidly escalating wind-driven wildland fire that was extending into a nearby residential neighborhood. With limited resources on scene, he directed a flanking attack on the wildland fire. With assistance coming from CAL FIRE Riverside County, the United States Forest Service (USFS), and Orange County, the opportunity for control was hopeful.

Approximately 9:27 a.m., a tragedy almost occurred when COR E5 became surrounded by fire and experienced a burn-over event. When the Freeway Fire began, COR E5 was on scene of a medical aid in a neighborhood less than a mile away. Once COR E5 cleared the medical call, it contacted COR Dispatch and was assigned to the fire. COR E5 chose to access the fire from a service road between the fire origin and the threatened homes. This decision put COR E5 in a dangerous position between the main fire and the threatened homes, with unburned vegetation between the crew and the fast moving head. Within minutes, the COR E5 Captain radioed they were being overrun by fire and were unable to escape. COR BR1, supported by multiple water drops from ORC HC41 and HC241, rescued the trapped firefighters and averted a tragedy. This event resulted in minor burns and smoke inhalation to two firefighters assigned to COR E5. **Incident Narrative – Map 4** is a map showing the near miss entrapment.

By 9:30 a.m., CAL FIRE Battalion Chief Deyo arrived on scene and briefly spoke with the Incident Commander. He also met with CAL FIRE Battalion Chief McBride, who had been sent to the fire as the CAL FIRE Agency Representative. Chief Deyo was directed to assume the role of Operations Section Chief for the Freeway Fire. Subsequently, he conducted a reconnaissance of the fire and established control objectives.

During Chief Deyo's reconnaissance, radio communication problems between agencies on two different radio systems became critical. CAL FIRE was operating on the statewide VHF frequencies, while COR, Anaheim Fire, and OCFA units were operating on their 800 MHz radios. Operating on a single compatible radio system is the safest and most preferred communication methodology. ANA Battalion 1 (Pilar) provided Chief Deyo with an 800 MHz portable radio, enabling him to communicate with other command-level personnel. Later that day, Orange County Communications (OCC) was asked to initiate a patch between the VHF and the 800 MHz systems to establish one common command frequency.

Aerial view of the fire's path along the Green River Golf Course and homes bordering the Santa Ana River riparian

Around 9:30 a.m., the OCFA ECC became the Central Ordering Point for the fire. This was done to ensure all resource orders for personnel, supplies, and equipment were properly placed and tracked. The effectiveness of the central ordering point is crucial to the success of the fire control efforts. As the need grew, resource orders were entered into the Regional Ordering Support System (ROSS), which allowed access to firefighting and support resources from multiple regions in Southern California.

Shortly after assuming the Central Ordering Point responsibility, an order for additional aircraft was placed to South OPS. Orders for engine strike teams, hand crews, and bulldozers would soon follow. A recent change in the resource ordering rules, which was a result of lessons learned in the 2007 fire siege, allowed for 5 engine strike teams—25 engines—to be directly requested from neighboring mutual aid regions. These 25 engines from the CAL FIRE – Riverside County immediately responded without processing delays. Around 10:30 a.m., the first of these strike teams arrived at the fire. The others arrived around noon.

The first ORC fire engine arrived in Corona and moved into the fire area at 9:23 a.m. The fire was uncontrolled and unpredictable. In response, ORC Battalion 3 (Aubrey) directed ORC E27—assigned to ORC Strike Team 1404A—to take independent action upon arrival. Indicating the fire was moving rapidly, the threat to structures was such that individual company officers had to rely on their situation to dictate tactics and operational priorities. This is a departure from desired and normal command and control strategy, but it necessary when confronted with a wide and rapidly progressing fire front. For the next 30 minutes, resources responding into Corona were directed into the threatened residential areas between the fire origin and the Green River Golf Course.

OCFA helicopter makes a water drop over fire

The fire was bordered by a golf course, an active river, and a multi-lane freeway. All set up the best potential containment opportunity for the Freeway Fire. Unfortunately, at 10:00 a.m., a spot fire was reported west of the Green River Golf Course. Hand crews and bulldozers were staged nearby and quickly encircled the spot, containing it to a small area. At 10:08 a.m., while returning to the golf course to pick up a load of water, ORC HC241 noticed another spot fire west of the golf course, approximately 1.1 miles from the nearest burning structure. In less time than it took for HC241 to snorkel a load of water from the golf course pond—about 45 seconds, this spot fire, coupled with the topography and the wind, headed at high speed for the City of Yorba Linda. HC241 attempted to slow the fire by dropping its load of water, but the impact was negligible. When interviewed, a helicopter crew member described the water drop as "a thimble of water in a firestorm." **Incident Narrative – Maps 5 and 6** are maps showing the multiple spot fires caused by erratic fire behavior.

ORC Division 5 (Fleming) arrived on the scene at 10:05 a.m. and proceeded to establish a unified command with Chief Officers from COR, CAL FIRE, Anaheim Fire, and Chino Valley Independent Fire District. The location of this initial command post, established at 10:12 a.m., was at the Jack in the Box parking lot at Crest Ridge and Green River Drive, Corona.

The BNSF railcars left on tracks were not threatened by fire and did not contain any hazardous cargo.

While firefighters were working near the railroad right-of-way, Burlington Northern Santa Fe (BNSF) Railroad was requested to stop all rail traffic through the fire area as a safety precaution. The outcome of the request inadvertently resulted in several railcars being abandoned on the tracks, prompting concerns from citizens and firefighters that some railcars may have been carrying hazardous materials. OCFA Safety Officer Hutnyan was sent to the area and tasked to examine the situation. He quickly determined the railcars were not directly threatened by fire and, in fact, did not have hazardous cargo. The railcars were eventually removed from the area by BNSF employees.

At 10:10 a.m., Air Attack and the first fixed wing air tanker were reported to be flying over the fire. This began the coordinated air assault to protect homes along the wildland interface. It also began establishing perimeter control lines to help direct the fire's spread away from other inhabited areas. Air assets would prove to be critical in establishing these control lines and protecting firefighters and threatened structures. In total, 17 firefighting helicopters flew approximately 108 hours and dropped in excess of 278,357 gallons of water. Twelve fixed wing air tankers and four lead airplanes fueled and re-supplied out of Hemet Ryan and San Bernardino Air Bases, flew approximately 110 hours and dropped 308,435 gallons of retardant on the fire. This figure includes the work of Tanker 910 (DC-10 aircraft). It made ten drops eight on November 15 and two on November 16 in the Yorba Linda/Chino Hills area for a total of 109,445 gallons of retardant.

At 10:20 a.m., ORC Battalion 2 (Reeder) reported the fire would reach the city limits of Yorba Linda within 30 minutes. Recognizing the threat to Yorba Linda, Battalion Chief Reeder placed an immediate need request for four more Type 1 engine strike teams 20 engines and 4 Chief Officers to stage at OCFA Station 53 in the City of Yorba Linda. He also requested the Brea Police Department and the City of Yorba Linda be notified of the impending arrival of the fire. They were to start evacuations. Battalion Chief Reeder predicted the fire would impact homes located in the Brush Canyon community within map page 741 grids E4, F4, and G5 (Thomas Brothers 2009 Edition). The ECC made contact with the Brea Police Department and City staff shortly thereafter.

Although a collaborative decision, the responsibility for evacuation is statutorily a law enforcement function. This allows fire departments to focus on control efforts. The number of citizens who evacuated at any one time in any single area of the City is unknown; however, nearly 9,000 dwellings were impacted in Yorba Linda by the evacuation order as a result of the Freeway Complex Fire. At the height of the firefight, an estimated 24,000 citizens of Yorba Linda were evacuated or kept from returning to their homes due to safety concerns.


Evacuations Underway

At the onset of the evacuation, traffic gridlocked in some areas as emergency apparatus tried to enter the neighborhoods while residents tried to exit. The Brea Police Department and other assisting law

enforcement agencies took control of the traffic flow, which helped firefighters gain access to threatened homes. In any firefighting effort, rescue is the first priority. However, in this case, resident self-evacuation was in effect assuring rescue from an active fire front would be minimized. Notably, with such an expansive and escalating evacuation boundary, the residents stayed calm and followed evacuation directions. Throughout the morning, reports of orderly—but slow—evacuations were relayed to the ECC.

ORC Assistant Chief 2 (Kramer) responded to the fire at 10:23 a.m. Assistant Chief Kramer assumed the role of ORC Incident Commander as part of the unified command. The responsibility of the Operation Section Chief position for the Freeway Complex Fire was assigned to ORC Battalion 2 (Reeder). To provide strong leadership and incident management, the fire area was divided into manageable geographical and functional areas of responsibility. The highest level of these responsibilities were branches, of which two were initially established for the Freeway Complex Fire. Branch I was the Yorba Linda Branch assigned to ORC Division 5 (Fleming) and included all structure threats in Yorba Linda. Within the Branch, smaller geographical divisions and functional groups were established. Several Structure Protection Groups were tasked first to protect those homes at the greatest threat of burning and second, wherever possible, to extinguish already established fires in structures, vehicles, and vegetation. **Incident Narrative – Map 7** shows a map of the Freeway Complex Fire Branch and Division boundaries.

Branch II was assigned to CAL FIRE Battalion Chief Deyo, who initially had been assigned Operations Section Chief when the fire was in Corona. Branch II included the wildfire control efforts that eventually burned through the Chino Hills State Park. This front raced into the City of Chino Hills through Tonner and Carbon Canyons to the Los Angeles County line—burning into the city limits of Diamond Bar. Divisions Y and Z were established within Branch II. The primary objective focused on establishing perimeter control to minimize the spread of the fire. Battalion Chief Deyo also faced the challenge of ensuring firefighting efforts were continuing in Corona, while trying to release as many resources back to Orange County.

With the fire burning out of Aliso Canyon and backing into Brush Canyon, it now headed toward Big Horn Mountain Way, Blue Ridge Drive, Merryweather Circle, Evening Breeze Drive, Pine Meadow Way, Camino de Bryant, Kodiak Mountain Drive, and Brush Canyon Drive. Any available fire units were moved to these and other threatened neighborhoods. The Operation Section Chief (Reeder) placed a call to the ECC ordering 20 engine strike teams—100 engines—of various configurations. Orange City Division Chief Eichoff assumed the Yorba Linda Structure Protection Group from ORC Battalion 3 (Aubrey), who was assigned to assist Branch I. Division Chief Eichoff recognized the community of Hidden Hills was going to be overrun by the fire and instructed unassigned units to move there.

With the fire advancing into the City of Yorba Linda, the Operations Section Chief ordered an additional 20 engine strike teams—100 engines and 20 Chief Officers.

At 10:43 a.m., a 911 caller reported a second fire to the ECC. This one was burning near the Olinda Alpha Landfill, located off Valencia Avenue near Carbon Canyon. The Brea Fire Department (BRE) confirmed they were responding to a fire reported near the landfill. The OCFA sent a modified high watershed dispatch response, including:

- Two Battalion Chiefs (ORC B23 [Phillips] and B8 [Wells])

- Four engines (ORC E47, E62, E223, and E817)
- One medic unit (ORC M26)
- Two patrols (ORC P23 and P26)

The same wind that was driving the Freeway Fire into Yorba Linda was now pushing the new fire through the east through the City of Brea toward Diamond Bar and the 57 Freeway. Brea Fire units arrived on scene at 10:49 a.m. and reported a one-acre fire moving quickly. ORC Battalion 8 (Wells) arrived on scene at 10:55 a.m. He reported the fire in Brea was two to three acres adjacent to the Olinda Alpha Landfill. He also reported there was a direct threat to structures and ordered three Type 1 engine strike teams—15 engines—and air support. Battalion Chief Wells assumed the Landfill Fire Incident Command and initiated communications with BRE units.

Within minutes, Battalion Chief Wells made contact with BRE Battalion Chief Montoya. A unified command, along with three structure protection groups, was established for the Landfill Fire. Additionally, units were assigned to begin perimeter control efforts. The highest concern was the Landfill Fire would eventually cross the 57 Freeway and destroy the homes west of it. The command post was subsequently moved to Brea Fire Station 3 at the intersection of Lambert Road and Kraemer Boulevard.

About 10:50 a.m., ORC Wildland 1 (Ewan) arrived at the Freeway Fire. To gauge the direction and speed of the wildland fire, he attempted to flank it and get far enough in front to predict its path. Ewan later reported he was unable to drive fast enough to keep up with the fire spread, which at times was estimated to be over 1,000 acres per hour. Motorists driving west on the 91 Freeway reported that at speeds of 50 mph, they were unable to stay ahead of the fire's main body.

The first two strike teams into Yorba Linda, XOR ST1424A (Espinoza) and XOR ST1425A (Hirsch), arrived about 10:56 a.m. They deployed along Alpine Lane, Big Horn Mountain Way, and Blue Ridge Drive. Facing fires driven by wind gusts up to 70 mph, these two strike teams and dozens of others moved from neighborhood to neighborhood throughout the day and into the night.

The Freeway Fire crossed the city limits of Yorba Linda at 10:58 a.m., destroying its first of hundreds of homes in Orange County. After racing through Brush Canyon, the fire burned the residence at 27185 Merryweather Circle before fire crews were able to mount a defense. At the same time, ORC HC241 reported seeing small fires in the area of the Black Gold Country Club. This was several miles downwind from the main body of the Freeway Fire and upwind from the Landfill Fire. Due to the location of the fires, HC241 reported these as new fires, not spot fires from either the Freeway Fire or the Landfill Fire. With a water drop from HC241, golf course personnel were able to contain the small spots with garden hoses. **Incident Narrative – Map 8** shows a map of the first homes impacted by the Freeway Fire in Yorba Linda.

At the same time, the ECC received multiple reports of a fire on the hillside below the Robert Diemer Water Filtration Plant. ORC E9, E37, and E61 and Staff 2 were deployed to that location. ORC E61 arrived at 11:13 a.m. and reported that this appeared to be a new vegetation fire. In less than 30 minutes, the units on scene were able to get the fire under control. These units were then redeployed to the Freeway Fire.

In Branch II, CAL FIRE Division Chief Toups was assigned Division Y at 11:30 a.m. Chief Toups was tasked to determine where control lines could be established and how firing operations might

be used to provide containment. Highway 71 was to be a key holding point, wanting to keep the fire south of Aliso Canyon. By noon, the wind had pushed the fire well past Aliso Canyon, heading for Chino Hills State Park and the thousands of acres of vegetation that would subsequently be consumed before any control was attained.

The fire moved through residential neighborhoods from Brush Canyon to the San Antonio neighborhood a 5.5 mile span in less than five hours.

As the fire progressed into Yorba Linda and grew to be a threat to more neighborhoods, the unified command also grew. The unified command for the Freeway Fire now included representatives from OCFA, CAL FIRE, Corona Fire, Chino Valley Independent Fire District, Anaheim Fire, and the Brea Police Department.

The unified incident commanders established initial control objectives, which were to hold the fire east of Aliso Canyon and Yorba Linda Boulevard, south of North Ridge Trail, and north of the 91 Freeway. Initial objectives also were to evacuate east of Yorba Linda Boulevard and La Palma Avenue and to establish a Chino Hills State Park Contingency Plan.


Ember shower in advance of flame front

In Yorba Linda, decorative vegetation, palm trees, and even ground cover on center medians served to fuel the fire's progression. Embers were driven into attic vents, underneath roof tiles, and into any unprotected openings. Firefighters employed a firefighting tactic known as "bump and run" moving from home to home and street to street after knocking down visible fire. Dispatchers continued to relay reported structure threats to the Operations Section Chief, and available units were deployed.

With every major incident or disaster, the OCFA Department Operations Center (DOC) is activated. The DOC supports the needs and demands of the incident, directs the recall of personnel, coordinates the backfill of apparatus, and monitors other operational needs. At 11:30 a.m., ORC Division 3 (Robinson), who had assumed the Duty Officer assignment from Chief Fleming, arrived at the ECC. The DOC was activated and staffed by noon. Once opened and staffed, incident communications and incident ordering was moved into the DOC. As soon as possible, Fire Management Activity Grants (FMAG) were submitted to the State of California Office of Emergency Services (OES) for each fire. Both were subsequently approved, thereby establishing reimbursement criteria for the cost of fighting the fires.

A primary function of the DOC was to ensure available relief apparatus were staffed and made available for emergency response and/or station coverage. The paramedic engine reconfiguration procedure was implemented. Twelve advanced life support (ALS) paramedic engine companies were divided and then reconfigured to either (1) a basic life support (BLS) engine company or (2) a paramedic assessment engine company (PAU), plus six paramedic vans. This allowed for more engines to be deployed, while maintaining ALS medical coverage in the unaffected areas.

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Department manpower coordinators (MPC) were organized and directed to hire personnel for all un-staffed apparatus. During the incident, 36 relief/surge engine companies and a truck company were staffed and placed into service. Some of these units were sent to the incident, and others were used to provide station coverage. While searching for relief apparatus, several engine companies thought to be in reserve were discovered to have been placed into service by off-duty personnel. They were self-dispatched to the Freeway Fire. This was done outside the normal command and control systems. Personnel on these units injected themselves into the firefight without checking in with fire ground commanders or notifying them where they were operating. Some units also lacked proper communication equipment. These actions created serious personnel safety and fireground accountability concerns.

Critical decisions were made by the assigned Duty Officer regarding coverage of empty OCFA fire stations. Given the continued weather and an uncertainty as to the causes of the Freeway and Landfill fires both of which were burning in the most northern portions of Orange County and directly upwind from structures a conservative coverage pattern was maintained for all remaining OCFA response areas. All reserve companies were staffed, dispatch criteria was modified for selected call types, and surge apparatus was outfitted for service.

As the fire moved into Yorba Linda, the Incident Command Post (ICP) was relocated to Yorba Linda Regional Park. A Logistic Section Chief, ORC Battalion 13 (Runnestrand), was dispatched to the park to begin the establishment of a formal base camp. Later, the location and size of this park was determined to not be well suited to handle the necessary long-term logistical needs of an incident this size. The base camp was relocated to Irvine Regional Park at midnight the first day. This facility, better suited to support a large incident, was within a reasonable travel distance to the fire. Branch V was considered too remote to be adequately supported from the base, so a spike camp was established.

Palm tree ignites by flying embers

By 11:30 a.m., ORU Strike Team 9329C Hawkins had been released from the Corona area and was fully engaged in Box Canyon. As the fire moved toward the Hidden Hills community, these engines and others protected homes along Foxtail Drive and Via Lomas de Yorba. Because the fire had moved into the area so quickly and without warning, residents in these areas were trying to evacuate while firefighting resources were attempting to gain access. It soon became evident the residents were in significant danger from the fire. The Brea Police Department was called to expedite the evacuation. Reports were also received that fire was impacting homes near Los Monteros and Los Adornos. ORC Patrol 23 reported to the Incident Commander that the Archstone Apartments located at River Bend and Cross Creek Roads were also immediately threatened. The fire continued its rapid and uncontrollable assault on multiple fronts. **Incident Narrative – Map 9** shows a map of the Freeway Fire progression into the Hidden Hills community.

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At approximately 11:45 a.m., several units were deployed into the Savi Ranch commercial district. The units followed up on numerous reports of automatic fire alarms and also extinguished fires that had moved into the trees and ornamental vegetation. Flying embers found openings and combustible material at several of the businesses. These fires were extinguished as they were found. For the next several hours, units were committed to the area to ensure commercial losses were kept to a minimum.

In Brea, at the Landfill Fire, additional structure protection groups (SPG) were established. Brea Battalion 2 (Wood) was assigned the Kraemer SPG and given engine resources (XOR ST 1427A) to protect the homes surrounding Brea Fire Station 3. Brea Engine 2 reported the fire was within 200 yards of Brea-Olinda High School, and a request was made to the Brea Police Department to close Wildcat Way to all public traffic. In Brea, four homes were destroyed; six others damaged. The Brea Olinda School District sustained major damage around its high school campus, including the loss of several secondary buildings at Brea Canyon High School. **Incident Narrative – Map 10** shows a map indicating the perimeter of the Freeway and Landfill Fires.

Los Angeles County Fire Department Assistant Chief Watson and Deputy Chief Bryant arrived at the Landfill Fire command post. They discussed their concern that the north flank of the fire presented a threat to the Tonner Canyon, Diamond Bar, La Habra, and Hacienda Heights communities. With limited available resources, Battalion Chiefs Wells and Montoya asked if Los Angeles County Fire Department would be able to provide tactical support to those communities.

Battalion Chiefs Montoya and Wells reorganized the Landfill Fire firefighting effort. They created two branches and four structure protection groups. Single increment initial attack resources were formed into a strike team to better coordinate firefighting efforts and fire ground accountability (ORC Strike Team 1406A [Brice]). During this meeting, Battalion Chief Reeder contacted Battalion Chief Wells and advised of the anticipated merging of the Freeway Fire and the Landfill Fire sometime that evening. The decision would ultimately be made to manage the two fires as a Complex, and establish the Landfill Fire as Branch III of the Freeway Complex Fire.

A Yorba Linda neighborhood as the fire consumed the hills nearby.

The unified incident commanders determined an Incident Management Team (IMT) would be required to assist in this emerging disaster. CAL FIRE IMT 6 was on standby in Riverside County and was activated at noon. Team members began to arrive at 1:00 p.m., with the team ultimately assuming full command of the fire at 7:00 p.m. on November 15.

The strong Santa Ana winds did not allow smoke from this massive fire to rise rather, it created a shearing effect. This resulted in a thick, gray blanket of smoke cutting off aerial views and lowering the ground level visibility to just a few feet in front of firefighters. ORC Battalion 15 (Boyle), responding as part of CAL FIRE IMT 6, was assigned to provide an update on the fire

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location and progression. Due to the smoke conditions and continued rapid rate of fire spread, Chief Boyle was unable to provide this valuable intelligence to the command team and commented, "It seemed like the fire was everywhere."

> The main body of the Freeway Fire was preceded by a broad ember shower distributed by the Santa Ana wind.

The main body of the Freeway Fire was preceded by a broad ember shower distributed by the Santa Ana winds. Embers crossed the 91 Freeway into Anaheim Hills at 12:46 p.m. The Helicopter Coordinator (HELCO) reported the fire was well established within the vegetation south of the 91 Freeway. Wind driven, the fire flashed toward several residential streets in Anaheim, including Rimwood Road, Canyon Vista Drive, Larkwood Street, South Morningstar Drive, and Laurel Tree Drive. The fire reached East Whitewater Drive and the Cascade Apartments at approximately 1 p.m. Overall, the City of Anaheim sustained loss or damage to 25 single-family homes and 60 apartment units.

MetroNet Dispatch received 911 at 12:46 p.m. as the fire jumped the 91 Freeway. First reports questioned if this was a spot fire from the Freeway Fire or a new fire within the City of Anaheim. Initial attack resources were dispatched apart from the command and control of the Freeway Complex Fire. This limited the resources available for deployment into Yorba Linda as Anaheim Fire worked to control the new threat. Eventually, this fire would be identified as Branch IV in the fire organization, but was frequently referred to as the Anaheim Branch.

The fire's potentially devastating impact on Anaheim homes and businesses required the incident command's immediate attention. This historical fire corridor was well-known. Had the fire in Anaheim escaped containment, one flank potentially could have followed the path and eventually matched the destruction of the 1967 Paseo Grande Fire. This could have extended fire through Anaheim Hills and into the cities of Villa Park, Orange, and Tustin devastating the communities of Orange Park Acres, Santiago Hills, and Cowan Heights.

To minimize the threat, most of the helicopters operating on the Freeway Fire were directed to concentrate control efforts on the Anaheim side of the 91 Freeway. Dozens of water drops were made and in combination with the efforts of the assigned ground units containment was achieved. **Incident Narrative – Map 11** shows a map of the spot fire across the 91 Freeway into the City of Anaheim.

Firefighters fill a Water Tender at a lower elevation to take to engines fighting fires at higher elevations due to the lack of hydrant pressure.

By 1:00 p.m., the fire was well established in the Yorba Linda community of Hidden Hills. Fire engines (ORC Strike Team 1403A), a Patrol/CAFS task force led by ORC Battalion 22 (Antrim), along with Water Tenders 16 and 40, and engines from Anaheim engaged in the fight. Fire units encountered low or no water pressure on Hidden Hills Road, Mission Hills Lane, High Tree Circle, Fairwood Circle, Green Crest Drive, Skyridge Drive, and other streets. With homes burning on multiple streets and no

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water, strike team leaders directed engine companies to move to areas that had available water. However, because the Patrol/CAFS task force was supported by the water tenders, it was able to effectively operate with less water than that required by an engine. Unfortunately, due to rapidly diminishing water pressures, even the water tenders were driven further down the hill to be refilled. These resources remained in the Hidden Hills community to protect houses that had not burned and to ensure extinguished homes did not rekindle. The availability and use of the CAFS was a direct result of recommendations made in the 2007 Santiago Fire After Action Report.

The water supply issue was reported to the Yorba Linda Water District (YLWD) through the City of Yorba Linda EOC at approximately 2:00 p.m. YLWD personnel responded to the area and were able to make adjustments to improve the water delivery in several areas. Due to the fire threat, water district personnel were unable to access the Santiago booster pump station. When YLWD personnel were initially able to make access to the pump station, they determined there had been sufficient heat to cause the pump station for the Santiago Reservoir to automatically shut down. Once this occurred, the continued water use eventually drained the Santiago Reservoir responsible for supplying water to the Hidden Hills and other nearby communities. YLWD personnel spent several hours completing repairs. They worked into the night and the next day to ensure a steady supply of water.

Daytime seems like night under extreme smoke conditions

The water supply for this area was further impaired unknowingly by fire suppression units and some of their fire control tactics. Faced with multiple structures fully involved in fire, many engines resorted to the use of master streams to contain the fire spread. This meant a single fire engine could have pumped more than 1,000 gpm. On some streets, multiple master streams were used. This limited water availability for engines arriving later. Additionally, the 4-inch diameter hose lines that were laid in the street to supply engines physically blocked later arriving units' access to neighborhood streets. These tactics were modified, and the master streams were shut down. Water tenders were also deployed into the impacted areas to help mitigate the water deficit.

In Branch II, plans were also underway to contain the fast-moving brush fire. Retardant drops from air tankers were directed along South Ridge Trail. They had a minimal effect, and the wind pushed the fire into Chino Hills State Park. A contingency plan was enacted in the likely case the fire would reach the community of Chino Hills. The Chino Hills Structure Protection Group was established, but it was not staffed until later that evening when more resources were available. The immediate goal was to keep the fire within the boundaries of South Ridge Trail, Water Canyon Ridge, and Slaughter Canyon. This plan was subsequently supported with the use of engines, bulldozers, hand crews, and aircraft.

Reports of the Landfill Fire crossing the 57 Freeway at Lambert Road east of State College Avenue were received at 1:21 p.m. A request was made to the California Highway Patrol (CHP) to close the freeway due to smoke and fire conditions. The fire was actively spotting in multiple directions, and on-scene resources moved from neighborhood to neighborhood protecting structures. By this time, Los Angeles County (LACO) Fire ground and air resources had been

moved into to reinforce the Tonner Canyon flank. These resources would eventually be used to support the contingency and control objectives for Branch V. LACO helicopters were used to suppress and contain the fire north of Brea Olinda High School and the neighborhoods west of the 57 Freeway.

At 1:30 p.m., homes adjacent to the Eastside Community Park located on Heatheridge Drive and Hidden Hills Road were reported to be burning. ORC Strike Team 1404A (Whitaker) and XOR Strike Team 1425A (Hirsch) had at least five, fully involved structures on Heatheridge Drive. Fifteen minutes later and a mile away, homes in the Village Center area on Willow Tree Lane, Ridge Park Drive, Juniper Avenue, Alder Avenue, and Deodar Drive were burning.

ORC strike teams assigned to the Tea Fire in Santa Barbara County and the Sayre Fire in Los Angeles County were reassigned to the Freeway Fire. ORC Strike Team 1400A (Valenzuela) arrived around 2:00 p.m. and joined the other units already engaged in Yorba Linda. ORC Strike Team 1402A (Kinoshita) returned at 4:30 p.m. ORU Strike Team 9328C (McCoy) was released late that evening from the Tea Fire and arrived sometime around midnight, the first day.

The three Orange County MetroNet strike teams (XOR) were also released from Tea and Sayre Fires and reassigned to the Freeway Fire. XOR Strike Team 1421A (Head) arrived about 3:45 p.m. and began working in the Anaheim Hills area. XOR Strike Team 1422A (Duncan) arrived at 3:30 p.m. and was assigned to structure protection in the community of San Antonio. XOR Strike Team 1423A (Thomas) started working in the Fairmont area soon after arriving at 4:45 p.m.

Aerial view of the fire's aftermath on a neighborhood in east Yorba Linda

A critical point in time for the Freeway Complex Fire was 2:30 p.m. No less than 15 homes were simultaneously burning on Juniper Avenue, Deodar Drive, and other streets in the San Antonio community. By this time, sufficient strike teams had arrived to allow a switch from the "bump and run tactic" to a more offensive "anchor and hold strategy." This ensured damage and loss of homes would be minimized.

At 2:30 p.m., Branch II (Deyo) and Division Y (Toups) met with Branch I resources in the San Antonio community. With numerous homes threatened, strike teams were requested to provide structure protection. By this time, several out-of-county strike teams had reported to the fire. As many strike teams as possible were directed into the area between Village Center Drive and San Antonio Road. **Incident Narrative – Map 12** shows a map of the Freeway Fire impacting the San Antonio community.

By 3:00 p.m., the weather began to change in favor of the fire control efforts. The temperature remained in the mid-70s and the relative humidity at 7 percent. However, the change in sustained wind speed to below 40 mph—sometimes as low as 10 mph in some areas—began to make the greatest difference. The advancing structure loss was stopped within the San Antonio neighborhood. Although a positive sign for fire ground commanders, the threat to—and the loss of—structures did not end. Over the next several hours, dozens of new fires were reported, or fires

thought to be extinguished rekindled within communities along the Freeway Complex Fire's path. Fire crews returned hours later to streets previously thought clear of fire, only to find multiple homes burning anew. Many of these latent fires occurred from embers intruding into concealed spaces within homes and smoldering undetected.

> The change in sustained wind speed to below 40 mph sometimes as low as 10 mph in some areas began to make the greatest difference.

A reconnaissance flight was conducted for the Landfill Fire at approximately 3:00 p.m., and a decision was made to change strategy from a defensive posture to an aggressive offensive tactic. This resulted in controlling the spread of the fire and keeping it from repeatedly jumping the 57 Freeway and spreading uncontrolled into residential neighborhoods. The Landfill Fire would ultimately result in the loss of four homes and damage to six others. The Brea Canyon and Brea Olinda High Schools also sustained fire damage and 980 acres of vegetation were burned.

Sometime between 4:00 and 4:30 p.m., the fire in Branch II that was burning down slope against the wind into Yorba Linda became realigned with the topography and wind. Numerous spot fires were reported at Condor Ridge. Control efforts with retardant drops proved unsuccessful, and at 4:45 p.m., the fire continued driving westward into Telegraph Canyon.

Around 5:00 p.m., a second spot fire was reported on the south side of the 91 Freeway at Coal Canyon. ORC Superintendent 1 (Hanson) led an aggressive ground effort with bulldozers and handcrews to contain the new threat. Containing this fire closed the back door and kept the Freeway Complex Fire from reaching Sierra Peak and making the run at Windy Ridge, which could have threatened additional communities.

By 5:30 p.m., the wildland fire was continuing to move through Upper Waterman Canyon at an incredible rate. Within minutes, another tragic outcome was narrowly avoided. Earlier in the day, CAL FIRE Crew Strike Team 9387G was assigned to this area in Branch II. The crew buses were parked in an unburned area of San Juan Hill located in Upper Waterman Canyon. As the fire burned across the canyon, the crew buses were going to be overrun. The crew bus drivers took tried to relocate their vehicles ahead of the quickly approaching front. Orders were given for all personnel to seek safety by entering the already burned area known as "entering the black." Eight of the inmate crew members inadvertently took off through the unburned fuel known as "the green." Two firefighters assigned to CAL FIRE Strike Team 9410C were sent to retrieve and direct them into a safe area. After the fire front passed, all personnel were accounted for. No injuries were sustained, but the two crew buses sustained minor damage from being so close to the flames.

Cityscape of Yorba Linda during the first night

The decision to merge the Landfill and Freeway Fires into a Complex occurred between 5:00 and 5:30 p.m. A complex is comprised of two or more fires in a geographically adjacent area. When implemented, managing an incident as a complex allows for shared incident management and logistical support with a central base of operations for continuity and efficiency. As the fire grew, the

branch assignments expanded to accommodate the vast boundary of the fire. The Landfill Fire was subsequently identified as Branch III and assigned to BRE Battalion 1 (Montoya) and ORC Battalion 8 (Wells). Branch IV was established when the fire subsequently jumped the 91 Freeway and moved into the City of Anaheim. This branch was also referred to as the Anaheim Branch. With the addition of LACO to the unified command, Branch V was later identified to include parts of Tonner Canyon and the City of Diamond Bar. Additional control objectives were established including keeping the fire east of the 57 Freeway and south of the City of Diamond Bar. LACO units would establish in this area to help make a stand.

At 5:50 p.m., Incident Command received a request from YLWD personnel to provide engines to assist with water supply problems. Three engines—ORG E2, STA E2, and GGVE5—were assigned and were able to sustain water availability by pumping water from one supply grid of the system to another. These engines pumped through the night until the YLWD brought in a high-volume portable pump to take over for fire engines. According to the YLWD After Action Report, the water shortage was primarily caused by fail-safe actions of pumping equipment and the high demand on the system caused by firefighting efforts. These two situations resulted in a complete emptying of the Santiago Reservoir.

By 7:00 p.m., firefighters were advancing into all neighborhoods affected by the Freeway Complex Fire. Strike teams from all over Southern California were still arriving to help. CAL FIRE IMT 6 officially took responsibility for the management of the Freeway Complex Fire. Formal briefings were taking place, and logistical needs such as food and water were supplied to personnel. Fuel as ordered for vehicles that had been at working all day. A unified communication plan was initiated resulting in significant radio communication improvement by the following morning.

At an earlier briefing for the Landfill Fire, the Freeway Fire was predicted to burn into Carbon Canyon and make a direct run at the community of Olinda Village. Olinda Village sits in a confluence of canyon sides creating a "bowl" where residents have built homes, businesses, a church, and a school. Olinda Village is heavily lined with pine, eucalyptus, and a variety of ornamental vegetation. The Hollydale Mobile Estates is a large mobile home park where many village residents live.

At 8:30 p.m. on this first day, a strike team of engines—ORC Strike Team 1405A (Brown)—was assigned to the Olinda Village area. He developed control objectives to keep the fire south of Carbon Canyon Road, east of the eastern most boundary of Olinda Village, west of Copo de Oro, and north of Verbena Lane. Tactical priorities included the protection of the Hollydale Mobile Estates and the Carbon Canyon Christian High School. A special emphasis was placed on protecting the power lines along Carbon Canyon Road—as these supplied the main power to Olinda Village and the water supply pumps for the area.

At the same time, in Branch II, the perimeter control efforts remained active. The fire continued to burn on multiple fronts through canyons aligned with the wind. The Rolling M Ranch presented a new structure protection challenge. Two crew strike teams and a Chino Hills engine were assigned to this area. Other strike teams of bulldozers and hand crews were working to build a control line at Bane Canyon. However, at 9:00 p.m., the fire was spotted one-fourth of a mile away in Slaughter Canyon. The plan was abandoned. By midnight, the Freeway Complex Fire had reached the City of Chino Hills and was burning behind homes located near Butterfield Road and the Los Serranos Golf and Country Club. **Incident Narrative – Map 13** is a map of the local canyons.

On November 16 around 2:00 a.m., the wind direction shifted from off-shore to a sustained on-shore direction. This was reported by personnel at Olinda Village and Branch II in Aliso Canyon. At 3:30 a.m., the Freeway Complex Fire had progressed through the Chino Hills State Park into Telegraph Canyon. It then had moved into the Carbon Canyon area. Highly erratic burning conditions were seen with flame heights reported up to 50 feet and visibility at near zero. **Incident Narrative – Map 14** shows a fire progression map of the Freeway Fire advancing into Olinda Village.

As the Freeway Complex Fire moved toward the Olinda Village area, an evacuation plan was implemented. Engines were moved to protect structures as the fire was burning directly into the Hollydale Mobile Estates. Largely due to the significant amount of preparation made by engine crews earlier in the day, the flame front was repelled and the community of Olinda Village was spared significant loss. One mobile home in Hollydale and a home on Olinda Drive were destroyed. By 7:00 a.m. on November 16, the threat to Olinda Village had passed.

The wind shift had an impact on fire control actions in the Chino Hills area. At 3:00 a.m., the fire burned freely near the upper end of Aliso Canyon. Branch II ordered evacuations of hundreds of homes south of Soquel Canyon and west of Highway 71. An extensive firing operation was conducted as part of the structure protection effort. Fifteen engines worked until sunrise to ensure there were no losses. Another large firing operation from Euclid to Carbon Canyon Road was completed by 9:00 a.m.

Chief Toups (Division Y) was relocating Branch II resources into the Sleepy Hollow area off Carbon Canyon Road when he encountered engines assigned to Branch V. These local government engines had just completed a firing operation around homes bordering the Saint Joseph's Hill of Hope off Carbon Canyon Road in what they called a structure protection effort. Chief Toups asked the Strike Team Leader to cease from any additional firing as the wind direction and terrain were not properly aligned for this type of operation. The reason given for the firing operation was structure protection, but the unintended consequence was to create a condition which drew the main body of the Freeway Complex Fire deeper into Tonner Canyon. Once established within the canyon, the fire would be aligned and head toward the Los Angeles County line and the city limits of Diamond Bar. **Incident Narrative – Map 15** shows a map of the Freeway Fire progressing into Tonner Canyon.

Smoke column rising through the inversion layer

Day 2 - November 16, 2008

The Freeway Complex Fire was battled through the day on November 16. Aircraft, bulldozers, hand crews, and engine companies worked throughout the day to establish a control perimeter around the fire. By midnight on that second day, the goal was achieved. Overhaul and line improvement continued over the next couple of days.

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The re-population of evacuated areas was a priority for Incident Command. Residents of areas that were not under mandatory evacuation were allowed to return to their homes at their choosing. Those under a mandatory evacuation order had to wait until a determination was made that the threat was fully abated. After conducting an aerial reconnaissance of the Complex, Incident Commanders decided at 3:00 p.m. on November 16 that most areas under the evacuation order could be repopulated. OCFA Occupant Liaison personnel assisted homeowners in gaining access to homes to recover personal property and by listening to and answering questions.

Days 3-5, November 17-19, 2008

Neighborhoods that had been impacted by the fire had fire companies assigned to ensure burned homes were properly overhauled and no new fires would occur as a result of hidden or smoldering embers. Neighborhoods, homes, and cars that were not burned but may have received a covering of fire retardant were washed to minimize damage.

On November 19, 2008, at 7:00 a.m., the Freeway Complex Fire was declared to be fully contained. At its peak, more than 3,800 firefighting and support personnel were assigned to the incident. More than 360 structures were destroyed or damaged, and over 30,000 acres of valuable watershed were consumed. The extinguishment effort for the incident is estimated to cost $16.1 million, with property loss exceeding $150 million. Injuries were few and relatively minor. Most importantly, no lives were lost to either civilians or firefighters.

The fire contained; damage assessment begins in a Yorba Linda neighborhood

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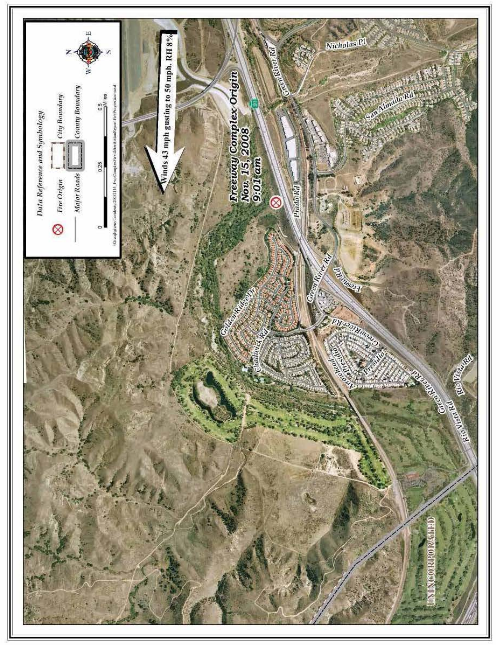
Freeway Complex Fire – November 2008

Incident Narrative – Map 3
Freeway Complex Fire—Origin 9:01 a.m.



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Freeway Complex Fire – November 2008

Incident Narrative – Map 4
Corona Fire Engine 5—Near Miss Entrapment

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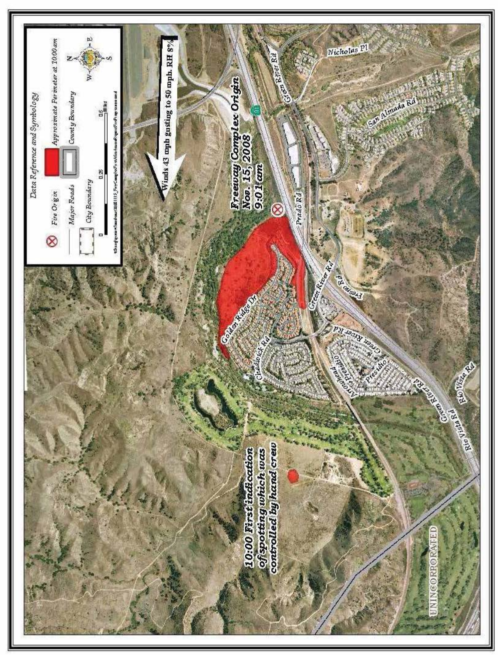
Freeway Complex Fire – November 2008

Incident Narrative – Map 5
First Indication of Spotting—10:00 a.m.



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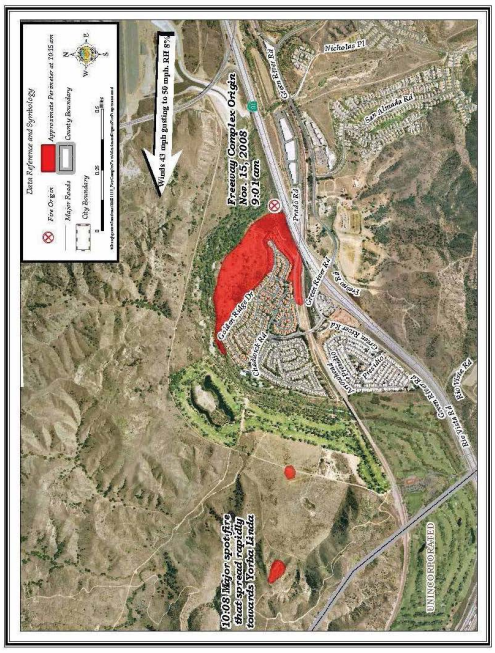
Freeway Complex Fire – November 2008

Incident Narrative – Map 6
Second Spot Sighted—10:08 a.m.



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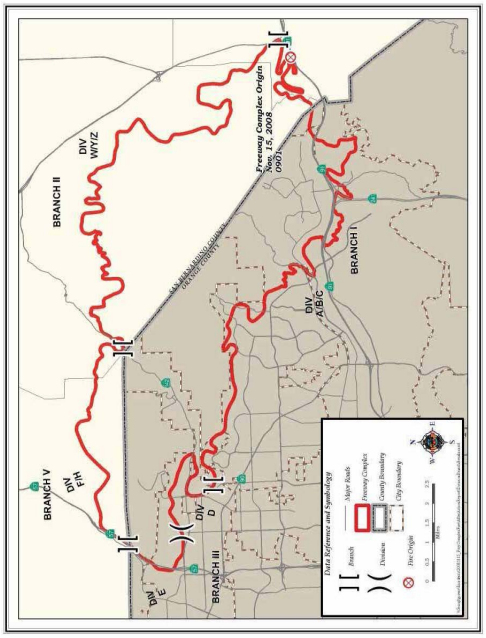
Freeway Complex Fire – November 2008

Incident Narrative – Map 7
Freeway Complex Fire—Branch and Division Map



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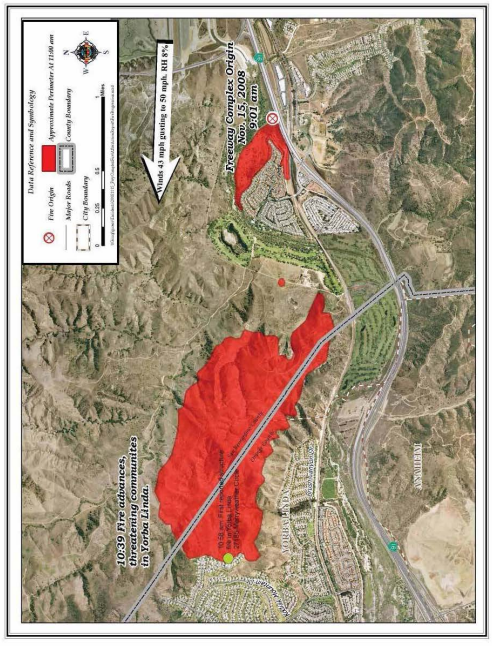
Freeway Complex Fire – November 2008

Incident Narrative – Map 8
Freeway Fire Reaches Structures in Yorba Linda—10:39 a.m.



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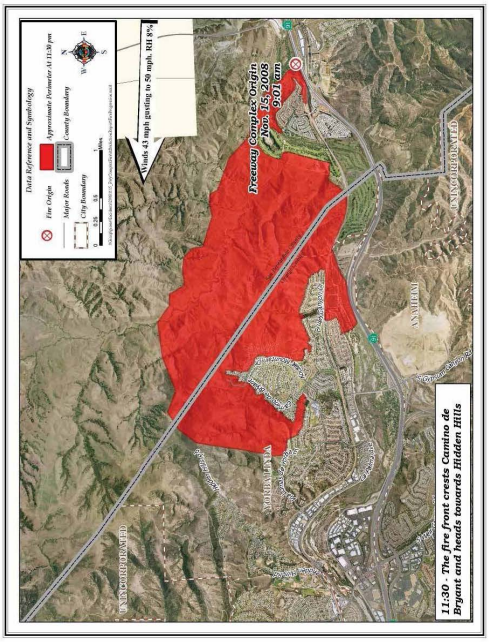
Freeway Complex Fire – November 2008

Incident Narrative – Map 9
Freeway Fire Moves Towards Hidden Hills—11:30 a.m.



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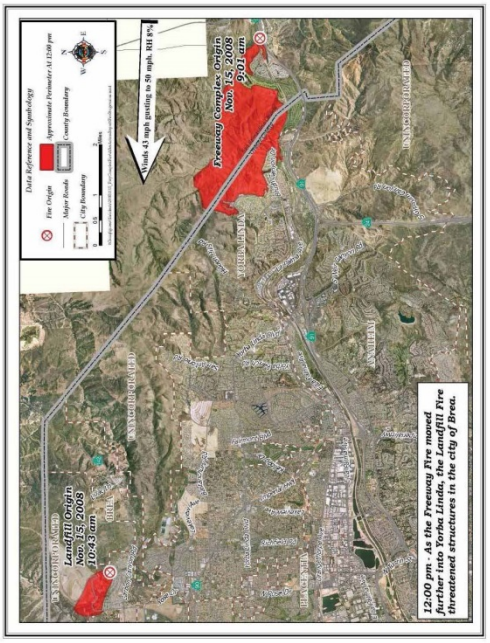
Freeway Complex Fire – November 2008

Incident Narrative – Map 10
Perimeter of the Freeway and Landfill Fires—12:00 p.m.



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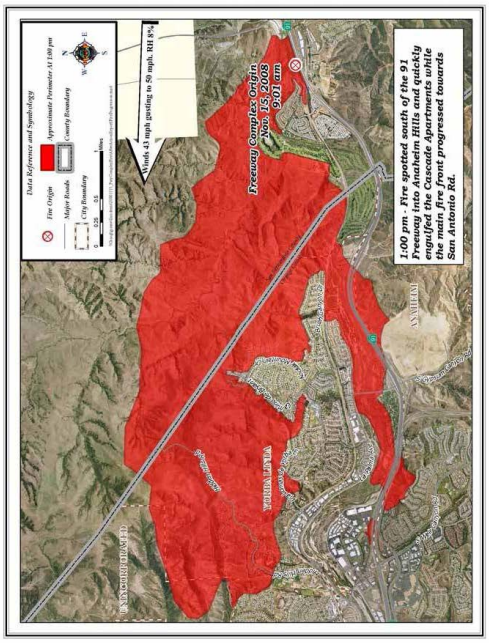
Freeway Complex Fire – November 2008

Incident Narrative – Map 11
Freeway Fire Spots Across the 91 Freeway into Anaheim—1:00 p.m.



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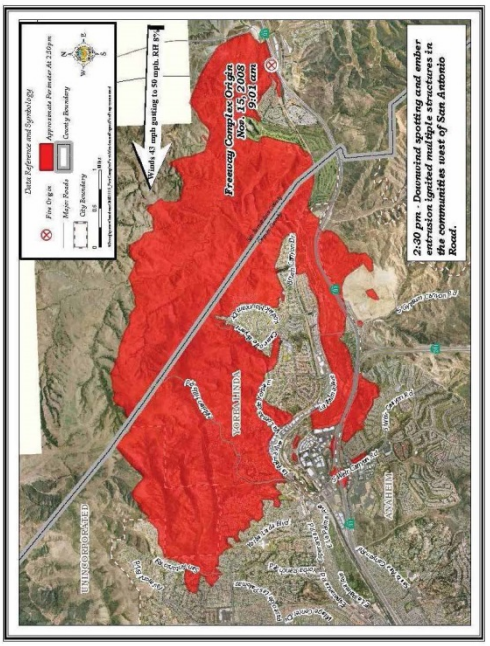
Freeway Complex Fire – November 2008

Incident Narrative – Map 12
Freeway Fire Reaches the San Antonio Community—2:30 p.m.



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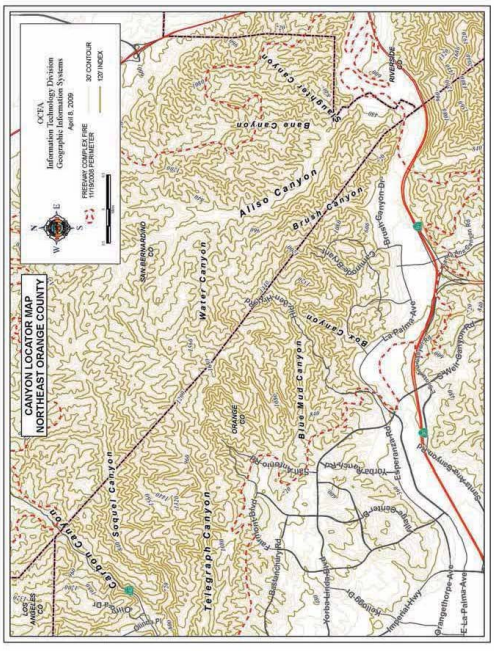
Freeway Complex Fire – November 2008

Incident Narrative – Map 13
Canyon Locator



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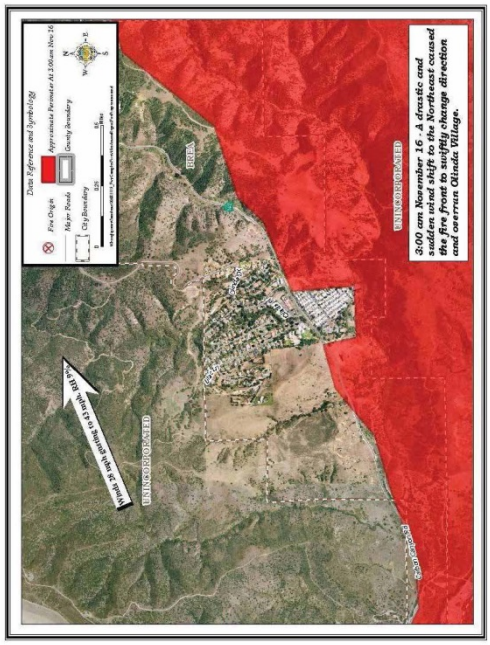
Freeway Complex Fire – November 2008

Incident Narrative – Map 14
Freeway Fire Reaches Olinda Village—3:00 a.m.



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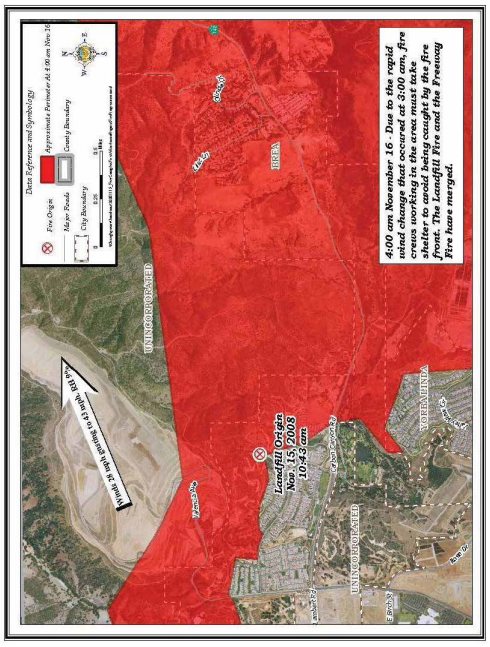
Freeway Complex Fire – November 2008

Incident Narrative – Map 15
Freeway Fire Moves Towards Tonner Canyon—4:00 a.m.



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Freeway Complex Fire November 2008

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Freeway Complex Fire – November 2008

Notification, Evacuation, and Repopulation

The first indication that residents of the City of Yorba Linda were about to be seriously threatened by the Freeway Fire came at approximately 10:20 a.m. on November 15. After estimating the fire's rate of spread, OCFA Battalion 2 Chief (Reeder) projected the fire would impact the community of Brush Canyon within 30 minutes. He directed the OCFA ECC to notify the Yorba Linda City Manager and advise the Brea Police Department to begin mandatory evacuations of the Brush Canyon area. At 10:22 a.m., Brea Police began evacuations of the eastern portion of Yorba Linda (Thomas Brothers Map page 741, grids E4, F4, and G5).

Ten minutes later, at 10:32 a.m., the Freeway Fire threatened the neighborhood of Big Horn Mountain Way in Yorba Linda. At 10:39 a.m., ORC Helicopter 41 confirmed homes on Bighorn Mountain Way, Blue Ridge Drive, and Evening Breeze Drive were under direct threat. Nineteen minutes later, the first of hundreds of homes lost in Yorba Linda burned on Merryweather Circle.

Although a collaborative decision, the responsibility for evacuation is statutorily a law enforcement function, which allows the fire department to focus on fire control efforts. Brea Police had a Supervisor assigned to the Unified Command early in the incident. One of their primary responsibilities was the rapid assembly of officers to meet the evacuation needs of this fast-moving fire. The Orange County EOC After Action Report estimates the evacuation orders impacted over 9,000 dwellings in the City of Yorba Linda. During the height of the fight, and estimated 24,000 citizens were evacuated or kept from returning to their homes in the City of Yorba Linda. The City of Anaheim began evacuations when the Freeway Fire crossed the 91 Freeway. A few miles away, the City of Brea initiated evacuations in residential areas in the path of the Landfill Fire. These extensive evacuation demands put a strain on local law enforcement, requiring mutual aid resources from agencies across the County to assist with evacuation needs. Refer to http://www.ocfamedia.org/_uploads/PDF/fcfaarybl.pdf for the **City of Yorba Linda After Action Report** for additional details.

Traffic gridlocked as evacuating residents and incoming emergency apparatus tried to access the same neighborhood streets. Officers at the various roadblocks and checkpoints took action to remedy the congestion—enabling fire apparatus to access the most impacted neighborhoods.

The weekend and mid-morning timing of the Freeway Fire were major factors complicating the evacuation. Since the Freeway Fire occurred on a Saturday—instead of a weekday—more residents were home, instead of at work or school. Notably, even with such a large and escalating evacuation boundary, the majority of residents remained calm and followed evacuation orders. Although slow, reports were received during the morning that evacuations were orderly and without incident.

Law enforcement agencies possess the legal authority to conduct evacuations of populated areas. However, even when a mandatory evacuation is declared, law enforcement does not have the legal authority to force residents from their homes. Officers may restrict the return of residents once they leave their property. Determining when and where to evacuate is often difficult since each evacuation decision brings with it a set of risks and rewards. The greatest risk to permitting residents to remain with their homes is the potential threat to safety.

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Freeway Complex Fire – November 2008

Evacuation of residents is one of the challenges created by a wildland-urban interface fire. The Freeway Fire spread so rapidly emergency responders could only estimate the direction and the time of impact to a given neighborhood. Within minutes of ignition, spotting was reported one mile downwind from the main body. Although a fire's rate of spread is typically measured in acres per hour, the Freeway Fire was driven by 40 mph winds and required measurement in acres per minute. Motorists driving on the 91 Freeway reported they could not keep up with the fire as it spread through wildland areas even while driving at speeds of 50 mph.

Simulation training conducted on October 27, 2008, for a WUI fire in the mutual threat zone along the 91 Freeway provided incident commanders some possible trigger points of when and where to call for evacuation. During the fire, these same trigger points were utilized to make the evacuation decisions. When the potential existed for the fire to escape planned, control boundaries, evacuations were ordered.

The Brea Police Department conducting evacuations.

The manner and timeliness in which residents were notified is being reviewed. After the 2007 Santiago Fire, the County of Orange led in the development and implementation of a public notification system. The AlertOC notification program has been adopted and implemented in many cities throughout the County. The City of Yorba Linda was in the beginning stages of implementing the program. Since the fire, the Alert OC program has moved into the next phase of implementation and is now capable of making public notifications.

Deciding when to repopulate an evacuated neighborhood is one of the most difficult made by law enforcement and incident commanders given the unpredictable nature of a WUI fire. Although a frustrating ordeal for residents, evacuation orders are to prevent homeowners from entering the dangerous conditions usually present in fire-burned areas.

The OCFA uses an Occupant Liaison Program to keep homeowners informed; to assist them in retrieving items such as medication, money, or clothing left while evacuating; and to provide emotional support. When appropriate, Occupant Liaison Teams may escort residents to their property. These efforts are to prevent homeowners from independently returning to their property and into a potentially dangerous situation.

After a reconnaissance flight deemed most areas to be safe, the mandatory evacuations were lifted on November 16 at 3:00 p.m. Even then, law enforcement officers were directed to allow only verified residents or those who had legitimate business insurance adjusters, clean-up crews, etc. into the impacted neighborhoods.

Even though the fire was extinguished, fire crews needed to maintain a presence within the impacted neighborhoods for several days. Firefighters conducted patrols looking for new fire

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Freeway Complex Fire – November 2008

starts, as well as overhauled burned structures. Fire apparatus needed to be able to move freely from street to street as crews cleaned off fire retardant that drifted onto unburned homes and vehicles. Wildland engines, handcrews, and helicopters conducted mop-up operations in the wildland and where necessary removed hazards adjacent to homes created by partially burned trees and vegetation.

The orderly evacuation of residents during a WUI fire can be challenging and may create delays for fire apparatus.

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Water Supply

The demands of a single structure fire can tax a well functioning water system. Normal firefighting efforts often involve one fire engine connected to a fire hydrant. The water is supplied directly to the fire or to one or more fire engines. In contrast, in an urban conflagration such as the Freeway Complex Fire, multiple engines move into threatened neighborhoods to extinguish flames and defend multiple homes on numerous streets.

Water systems must incorporate "fire flow" as an element of system design and functionality. Needed fire flow is the amount of water available for providing fire protection at selected locations throughout a community. The OCFA Planning and Development Services Section reviews all plans for new development to ensure an adequate fire flow is provided according to the City's adopted Fire Code. Like all California jurisdictions, the City of Yorba Linda is required by State law to adopt the California Fire Code (CFC). The latest Fire Code edition was adopted in 2007. This newly adopted code allows for doubling of the required fire flow in areas where "conditions indicate an unusual susceptibility to group fires or conflagrations." This should be considered in all new developments within a city that is adjacent to a wildland-urban interface or within a designated High Hazard Zone.

Using the fire code tables, a typical street with homes not exceeding 3,600 square feet would be protected by fire hydrants capable of delivering 1,500 gpm for a minimum of two hours with no less than 20 pounds psi of residual pressure. For homes between 3,600 and 4,800 square feet, fire hydrants must deliver 1,750 gpm for two hours with no less than 20 pounds psi of residual pressure. Locally adopted amendments require fire hydrant spacing of 300 feet along the street. The typical fire flow demand is based on fighting a single structure fire and protecting the immediate exposures.

Faced with multiple structures, many fully involved in fire, some Company Officers resorted to the use of master streams to contain the fire spread. This meant a single fire engine may have pumped more than 1,000 gpm—affecting the available water supply. On some streets, multiple master streams were deployed. Once water demand issues were identified, tactics were modified. The master streams were shut down in favor of smaller hand lines.

Around 2:00 p.m. on November 15, several radio transmissions were received from fire companies reporting low or no water pressure in various sections of Yorba Linda. Some areas were Hidden Hills Road, Mission Hills Lane, High Tree Circle, Fairwood Circle, Green Crest Drive, and Skyridge Drive. With homes burning on multiple fronts, Strike Team Leaders had to make critical decisions. They directed fire companies to areas that had available water, thereby giving firefighters a chance to protect and save homes.

To provide structure protection and ensure rekindles were minimized, a Compressed Air Foam System (CAFS) Task Force with five Patrol units remained in the Hidden Hills area. The CAFS Task Force, under the direction of OCFA Battalion Chief Antrim, extinguished fires and laid protective foam on unburned structures for several hours. Two water tenders were ordered to the impacted area to shuttle water to the fire companies. These tenders systematically began checking fire hydrants until one was found with enough pressure to fill the tanks. Eventually, water tenders had to fall back to the hydrants at the lowest point in the system to refill.

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According to the YLWD After Action Report, the water demand use for the first two days of the fire was nearly 20 million gallons above normal.

A request for service was placed to the Yorba Linda Water District (YLWD) through the Yorba Linda EOC about 2:00 p.m. YLWD personnel responded quickly and were able to make adjustments to improve the water delivery in several areas. According to the YLWD After Action Report, YLWD personnel were initially unable to access the Santiago Pump Station because of the extraordinary fire conditions. When they were able to make access, personnel determined there had been sufficient heat to cause the pump station for the Santiago Reservoir to automatically shut down. Once this occurred, the continued demand eventually drained the Santiago Reservoir, the supply for Hidden Hills and other nearby communities.

At 5:50 p.m., the YLWD requested three fire engines assist them in supplementing the water grid system at Manzanita Avenue and Smoke Tree Avenue. Additionally, two mobile water pumps were brought in from the Laguna Beach County Water District and the Santa Margarita Water District. They supplemented water supplies at the reservoirs serving the impacted areas. YLWD's efforts took several hours to complete; its personnel worked through the night and into the following day to ensure a secure water supply.

Water District Task Force

On January 20, 2009, the OCFA's Emergency Planning and Coordination Battalion Chief (Ferdig) attended the first meeting of a task force organized by the Water Emergency Response Organization of Orange County (WEROC). This organization coordinates and supports comprehensive emergency preparedness programs for the Orange County water industry.

The task force is to create a Water Utility and Fire Department Coordination Template for water agencies along the WUI. The template would include—but would not be limited to—areas such as water pressure zones, fire hydrant specifications, types of available equipment, necessary equipment, and identification of critical infrastructure in need of protection during a disaster. Some of the participating agencies on the task force are:

- Laguna Beach County Water District
- Yorba Linda Water District
- Moulton Niguel Water District
- South Coast Water District
- Irvine Ranch Water District
- City of Orange Water Department
- Orange County Fire Authority
- OC Emergency Management Bureau

The task force's goals are (1) to develop a stronger working relationship between water districts and fire agencies; (2) to develop implementation standards for use during red-flag conditions; (3) to develop a water district liaison program; and (4) to develop a standard template for providing fire agencies information about the water supply available during firefighting efforts.

The water supply template will assist each water district within the WUI to create an agency-specific plan. These plans will be tested using a tabletop exercise simulating multiple wildland fires impacting Orange County simultaneously. Refer to the **YLWD After Action Report at** http://www.ocfamedia.org/_uploads/PDF/fcfaarylwd.pdf for additional details.

Mutual Aid

The California Fire and Rescue Emergency Mutual Aid Plan is an extension of and supportive document to the California Emergency Plan. The plan provides for systematic mobilization, organization, and operation of necessary fire and rescue resources of the state and its political subdivisions in mitigating the effects of disasters, whether natural or man-caused.

Valley View Conservation Camp handcrew from Elk Creek, Ca

No community has the resources sufficient to cope with any and all emergencies. Thus, fire officials must preplan emergency operations to ensure the efficient use of available resources. Basic to California's emergency planning is a statewide system of fire service mutual aid. Each jurisdiction first relies upon its own resources with mutual aid resources being available from other agencies to augment local response when conditions warrant. The master Mutual Aid Plan outlines and governs what is commonly referred to as the Mutual Aid System for fire service in California.

The Mutual Aid System for fire service in California has been described by the United States Fire Administration as "unparalleled in the United States." The system is founded on the principle of fire departments providing resources to one another during times of major emergencies when a local agency is overwhelmed and does not have the ability to handle the incident on its own. The system allows resources committed to an incident to escalate from a few engines to hundreds. The State is divided into six mutual aid regions to facilitate coordination of mutual aid. Coordinators are identified at the local and national levels, under the umbrella of the Governor's Office of Emergency Services (OES) Fire and Rescue Branch.

Emergencies may reach such a magnitude as to require mutual aid resources from adjacent local, County, and State levels. Specific requests for mutual aid are processed from the local agency to the County Operational Area Coordinator. OCFA is the coordinator for the Orange County Operational Area. From the County, the request goes to the Regional Coordinator (LACO) and then to the State Coordinator (OES), if necessary. Each ascending level has access to greater numbers of firefighting resources from throughout the State.

During most wildland fires, mutual aid resources are requested and assembled in preparation for anticipated strategic actions. However, with fires that rapidly turn into WUI conflagrations such as the Freeway Complex Fire little time to plan for strategic actions is available, and resources are needed immediately. This is compounded further when multiple major fires occur simultaneously. Delays can be disastrous. Oftentimes, different fires are requesting the same resources.

When the Freeway Complex Fire began, only two fires of significance were blazing in Southern California: the Tea Fire in Santa Barbara County and the Sayre Fire in Los Angeles County. These fires were burning out of control, and numerous homes were already lost when the Freeway

Complex Fire began. Numerous mutual aid requests to both fires had been filled or were pending when the Freeway Complex Fire began. The OCFA had sent a Type 1 and a Type 3 strike team 10 engines to the Tea Fire while MetroNet cities sent three Type 1 strike teams 15 engines. Additionally, the Orange County-based Office of Emergency Services (OES) strike team 5 engines was activated and sent to Santa Barbara County. The OCFA staffs one of the OES engines with the other four being staffed by MetroNet cities. The Sayre Fire in Los Angeles County, having started after the Tea Fire, only received one Type 1 strike team from the OCFA and one Type 1 strike team from the MetroNet cities.

Riverside County fire crews protect homes in Yorba Linda

Prior to the Freeway Complex Fire being reported, all vacancies created by the deployment of OCFA fire engines to Santa Barbara and Los Angeles Counties had been filled. This was achieved by activating the OCFA relief engine fleet and "recalling" off-duty personnel or personnel reporting for normal duty at 8:00 a.m. on November 15.

At the onset of the Freeway Complex Fire, immediate resource requests were placed for Type 1 and Type 3 strike teams beyond what could be provided by the OCFA and local agencies. In total, 35 strike teams 175 engines of various types were ordered within the first four hours of the incident. The OCFA and other Orange County cities provided seven Type 1 strike teams and one Type 3 strike team 40 engines total. By noon, six strike teams 30 engines had arrived from Riverside County. By 1:30 p.m., a total of 19 strike teams 95 engines and 1 task force 6 engines were operating on the fire. This was in addition to the 58 engines, 3 trucks, 8 patrols, and 5 water tenders that responded as single increments to the Freeway and Landfill Fires. While some resources were coming from an extended distance, prior to 2:00 p.m., 159 engines were assigned to and operating on the Freeway Complex Fire.

The early ordering of resources made it possible for 159 engines, 3 trucks, 8 patrols, and 5 water tenders to be operating on the Freeway Fire by 1:30 p.m.

The availability of resources was largely due to the lack of competition for resources from other fires. A change in the resource ordering policy after the 2007 fire siege also proved to be beneficial. This change allowed for Operational Area and Regional Coordinators to directly request up to five strike teams 25 engines across operational area boundaries based on the closest resource concept. This was in contrast to the previous rule that permitted only one strike team to be obtained outside the regional ordering system.

Air Resources

Unless owned and operated by local government, air resources helicopters, fixed wing air tankers, lead planes, and air attack platforms are coordinated by CAL FIRE and the United States Forestry Service (USFS). In Southern California, the Southern Region Operations Center in Riverside is the base for this joint operation.

Air resource requests are prioritized based on factors, including threat to life and property. New fire starts receive the highest priority for aircraft, because the greatest opportunity for control is during the initial attack phase. Aircraft assigned to active fires may be diverted to a new incident unless a "no divert" order has been established. No divert orders are only established when aircraft are on fires where structures are burning or immediately threatened and there are no higher priority fires in the region.

On Friday, November 14, 2008, CAL FIRE pre-positioned four air tankers, two helicopters, and two air attack aircraft in Southern California. These aircraft augmented CAL FIRE resources of two air tankers, one helicopter, and one air attack already in place at the Hemet and Ramona airbases. The net effect of the pre-positioning of Northern California-based aircraft to Southern California was to double the number of available aircraft at each airbase.

Air Tanker dropping retardant along a ridgeline

To prepare for the Red Flag Warning expected across parts of Southern California, CAL FIRE signed a one-week contract for the DC-10 Air Tanker 910 based out of the San Bernardino International Airport. The Federal airbase in San Bernardino was also up-staffed with four air tankers, two lead planes, and two air attack aircraft. On Saturday, November 15, all State and Federal aircraft were assigned an 8:00 a.m. start time. The initial attack aircraft for the Freeway Complex Fire were dispatched at 9:35 a.m. with the first aircraft arriving at 10:10 a.m.

OCFA Helicopters 41 (HC41) and 241 (HC241) were dispatched to the Freeway Complex Fire from Fullerton Airport at 9:08 a.m. on November 15. The winds at Fullerton Airport were light and blowing offshore. After lift-off, the flight crews saw the smoke column rising from the fire in Corona was building and beginning to bend. The Santa Ana wind was having a strong influence. A 30 40-knot headwind was measured by an airspeed indication of 110 knots and a ground speed reading of 70 knots. Wind turbulence, coupled with the building low level smoke, made it difficult for the helicopter pilots to maintain visual flight conditions and make effective water drops.

Orange County Sheriff's Department (OCSD) helicopter Duke 1 also responded on the initial dispatch with the ORC helicopters. Duke 1 arrived over the fire about 9:30 a.m. but had to land to

deploy its 170-gallon bucket prior to engaging in the firefight. Duke 1 and the ORC helicopters were initially using the lake and water hazards of the Green River Golf Course as their water source. The buffeting wind soon made hovering to fill the bucket and water tanks too hazardous. A ground-based water point was established, so the helicopters could land and be filled safely.

OCFA helicopter uses a snorkel to refill its water tank.

Incident commanders on the ground quickly recognized the need for additional aircraft. At 9:19 a.m., they ordered one air attack, two air tankers, and two additional Type 2 helicopters. At 10:10 a.m., these air resources arrived over the Freeway Complex Fire. The aircraft order was augmented once again at 10:10 a.m., with an order for one lead plane, three air tankers, and four Type 2 helicopters.

Helicopters may fly at sunrise and up to 30 minutes after sunset. On the first day, all initial attack aircraft flew the maximum possible hours. Around 8:30 p.m., the aircraft were released to their home bases. Mandatory work-rest cycles for pilots demand they receive eight hours of uninterrupted rest before flying again. This meant the earliest a pilot could take off to return to the fire on Sunday, November 16, was about 6:00 a.m. With the preflight inspection time, flight time to the helibase, and briefing time once there, an 8:00 a.m. start time was projected for all assigned helicopters. By 9:00 a.m., all assigned helicopters were flying over the fire.

OCFA helicopter coming in for another load of water.

By the conclusion of the Freeway Complex Fire, 17 firefighting helicopters had been assigned. These were supplied from local, state, and federal agencies, as well as helicopters from private vendors that were on a call when needed (CWN) contract basis. During the first six hours of the Freeway Complex Fire, OCFA helicopters dropped 48,400 gallons of water and foam. By the end of the second day, a total of 88,000 gallons had been dropped. During that same two-day period, 12 fixed wing air tankers with four lead planes operating from the San Bernardino and Hemet air bases dropped 208,791 gallons of retardant. The DC-10, Air Tanker 910, made a record-setting ten air drops applying a total of 109,445 gallons of retardant in the Yorba Linda and Chino Hills areas.

All aircraft orders were filled for the Freeway Complex Fire. However, one Federal helicopter was diverted to a new fire start while it was awaiting demobilization from its base. The availability of air resources greatly differed in comparison to the 2007 Santiago Fire, where much of California's airborne fire suppression resources were already actively engaged in firefighting efforts or were grounded due to severe wind conditions.

Air tanker lays a retardant line in front of the fire to slow its forward progress.

Logistics Support

The Incident Command System (ICS) has proven itself valuable in managing emergency incidents worldwide. ICS is a flexible, scalable response framework where firefighters from various agencies, who may not routinely work together, can fight major incidents through standard response and operation procedures. A critical component of ICS is the logistical support function. This effort can be compared to establishing and maintaining a small, temporary city designed for the sole purpose of supporting all the needs of an incident. In the case of the Freeway Complex Fire, the proximity of the fire to several hundred Yorba Linda homes and the near 70 mph winds made it apparent that the logistical needs for this incident were going to be significant and challenging.

The Incident Base takes shape in Irvine Park.

The extreme weather conditions and the potential for loss of lives and structures made it clear full implementation of the Logistics Section (LOGS) would be required. ORC Battalion Chief Runnestrand was ordered as the Logistic Section Chief for the Freeway Complex Fire. Personnel from the OCFA Service Center provided much-needed logistical support with water, food, and deployment of a logistical cache that is stocked and ready for immediate use. The cache included 10,000 feet of wildland hose, foam, tools, and medical supplies. Within the first hour, an order was placed for 500 sack lunches. This order was increased to 2,000 within the next hour.

The Logistics Section from CAL FIRE Incident Command Team 6 eventually assumed all logistical needs for the Freeway Complex Fire. The Logistics Section Chief, his Deputy, and the leaders for each of the six logistics units blended effortlessly with OCFA personnel who had already begun the logistic coordination. The decision was made to keep this blended effort throughout the fire, which was another lesson learned from the 2007 Santiago Fire.

Initially, the Yorba Regional Park was designated as the incident base due to its proximity to the fire. As the fire threatened the City of Yorba Linda, and before the base had been completely established, the decision was made to move it to Irvine Regional Park. This facility had been used in previous incidents and was familiar to the OCFA logistics team. Additionally, the park's size, parking, and convenient access to major freeways better met the demands of the nearly 4,000 personnel and equipment assigned to the incident. Overall, the support needs were met in an effective and efficient manner.

The success of LOGS on the Freeway Complex Fire was largely the result of the support, cooperation, and hard work of individuals representing the Orange County Sheriff's Department, Irvine Regional Park staff, Citizens Emergency Response Teams (CERT), and numerous vendors

and businesses throughout the area, along with the exemplary training and professionalism of the firefighting personnel.

The following six units combine to make the Logistics Section for a major incident such as the Freeway Complex Fire:

The **Food Unit** set up a mobile kitchen, allowing the serving of breakfast by the second morning. Until that was established, a mobile catering vendor was used to provide hot meals. Separate contract vendors provided sack lunches to meet the demand for on-the-line feeding of suppression crews and base personnel. Due to the more than 3,800 firefighters needed for this fire, the kitchen was unable to meet the meal demands in a timely manner and was augmented by the catering vendor. This solution met the needs of the incident efficiently and effectively.

The **Medical Unit** is tasked with providing everything from basic First Aid to advanced life support for incident personnel. A Medical Plan was published in the Incident Action Plan (IAP) and was followed successfully. No deaths or major injuries were reported on this incident. Contributing to the smoothness of this operation was the proximity to urban medical facilities and the training of many firefighters as Emergency Medical Technicians or Paramedics.

The **Communication Unit** provides the radio, pager, and Internet communication needs of the incident. Because of the mix of resources from within the County and beyond, a communications radio frequency patch was established allowing for shared radio communications with those having VHF radios and those with 800 MHz radios. This greatly enhanced communications and contributed to the safety of on-the-line resources in the early portion of the incident. Once the radio cache of 200 radios from the National Interagency Fire Cache (NIFC) arrived, the communication plan was transitioned to VHF radios for the remainder of the incident. The OCFA Logistics/Communications trailer was useful as a mobile office space to secure, protect, and deploy the equipment. Later, it became the on-site dispatch facility for the incident.

The OCFA Communications trailer supports incident communications.

The **Supply Unit** orders and disburses supplies necessary for the incident. Everything from the requests for fire engines and aircraft to the purchase of sleeping bags and batteries is funneled through this unit. Staff from the OCFA Service Center was invaluable in providing early support and assistance. The wildland cache a predetermined complement of tools, equipment, and supplies stocked by the OCFA and available for immediate use was brought to the base. It provided needed resources until the larger cache from South Operations arrived.

The **Facilities Unit** creates and maintains the physical layout of the incident base camp. Consideration must be given to all aspects of supporting the incident. Included are the staging of operations; maintaining and repairing of apparatus; feeding and housing of assigned personnel,

including the special needs of inmate crews; providing suitable working space for the administrative and support positions including but not limited to the Incident Command Post (ICP); and providing showers, laundry, and other support functions for personnel assigned for extended periods.

The Facilities Unit on the Freeway Complex Fire benefited from several factors in creating an efficient base camp. A pre-existing agreement with Irvine Regional Park and the familiarity with the layout coupled with the outstanding cooperation with the park staff, made for a quick and painless setup. The close proximity to the OCFA's RFOTC allowed for a sharing of assets especially early on that normally would not be considered. The CERT personnel filled many roles within this unit and clearly contributed to its success. Finally, the Orange County Sheriff's Department's command vehicles (Samantha 1 and 2) were put to good use and were greatly appreciated.

The Facilities Unit on the Freeway Complex Fire created an efficient base camp to support the needs of more than 3,800 personnel.

Incident Communications

During the first 24 hours of the Freeway Complex Fire, incident radio communications were initiated using the County of Orange 800 MHz Countywide Coordinated Communications System (CCCS). The fire service in Orange County has been on the 800 MHz System for the past 20 years. Since 1999, it has been the countywide network shared by all public safety agencies in Orange County. Over 16,000 mobile, portable, and base station radios are on the system servicing fire, law, public works, and lifeguard agencies throughout the County. All mobile and portable radios have common channels for inter-agency communications.

The 800 MHz CCCS has proven to be a highly sophisticated and reliable communications system for the public agency users in Orange County. Several other fire and law agencies throughout Southern California use radios with common national 800 MHz frequencies—the same as those used on the Orange County system.

The 800 MHz radio system was well-used by all first responders. A total of 78,892 transmissions were conducted midnight-to-midnight on November 15. This represents the seventh busiest day in the history of the 800 MHz CCCS. Only one "busy" event—all channels were busy—occurred during this time. On November 16, usage dropped to about 63,000 transmissions, as fire agencies transitioned much of their radio communications to the VHF (Very High Frequency) radio channels provided by the CAL FIRE IMT. All 800 MHz radio systems remained operational, although some fire damage was sustained at two radio sites.

During the fire, the 800 MHz system was never at full capacity. Despite the intense communication needs, the 800 MHz system's design assured excess capacity was always available. The system was designed and built to handle high volume radio traffic as experienced during the 2007 Santiago Fire. **Table 7** below provides a comparison of a normal daily 800 MHz radio system number of transmissions. The comparison date of November 15, 2007, was chosen simply as the same time of year and a non-major fire day.

Table 7: Total Number of 800 MHz CCCS Transmissions
(All Disciplines Countywide)

Date – 2008	Number of Transmissions	Date – 2007	Number of Transmissions
November 15	78,892*	November 15	57,184
November 16	63,719	November 16	56,522
November 17	58,099	November 17	52,601
November 18	57,552	November 18	44,703
November 19	58,474	November 19	50,141
November 20	54,951	November 20	53,615
November 21	59,878	November 21	52,769

*This day represented the seventh busiest day in the history of the 800 MHz CCCS.

As indicated in the table above, the first 24 hours of the incident were the busiest. An approximate 38 percent increase in radio traffic occurred on the 800 MHz Radio system as compared to the

same dates in 2007. This activity level started to decrease as the CAL FIRE IMT arrived. The IMT used the VHF radio system for major incident radio communications. As the incident continued to expand, an order was placed for the National Incident Fire Cache (NIFC) to support the large number of resources responding from various agencies throughout the state.

The NIFC cache includes radios, repeaters, and common frequencies standard to all fire agencies throughout the country. All Orange County fire agencies maintain radios common to the system used with the NIFC radios on VHF spectrum. The NIFC cache maintains over 40,000 radios available for use during major incidents, such as Hurricane Katrina, earthquakes, and multiple fires as in the October 2007 fire siege. Resources responding are also required to have VHF radios as part of their mutual aid response equipment. Standard training on the operation and support of the NIFC system assigned to major incidents is provided throughout the year and throughout the country. The change in radio systems occurred on Sunday, November 16, at 7:00 a.m., the second day of the fire, during the morning shift change.

As of Sunday, November 16, 800 MHz radio transmissions were slightly higher than normal and remained at that level throughout the duration. As the fire progressed and more out-of-area resources arrived, most of fire communications had been moved to the VHF radio channels. Although, the 800 MHz radios was still being used by the OCFA and other Orange County agencies for supplementary communications.

A radio "patch" had been initiated between the VHF "Orange County Access" channel and the 800 MHz "4C" talk group on November 16. Radio patches connects two different radio systems operating on different frequency bands, allowing for seamless communication. This allowed any VHF radio being used at the incident to communicate with command staff operating on the Orange County 800 MHz system (Channel 4C). This patch remained operational on the command channel until the end of incident. Feedback from communications staff assigned to the incident indicated this worked well, including in places where the incident radio repeaters did not work.

Personnel using VHF radios made early reports indicating they were unable to make contact with those using 800 MHz radios. This was mainly due to the radio "patch" frequencies not yet being in place. The problem was corrected once the patch was established. This concern and others regarding user familiarity and training are being addressed by an After Action Communications Committee comprised of representatives from CAL FIRE and OCFA.

Additionally, a number of reports of VHF radios not being able to cover specific areas in Carbon Canyon were received by the communications staff. This problem is inherent in the area for all wireless communications, due to the deep and narrow canyons. This problem was corrected by placing a manual repeater in the Carbon Canyon area of Sleepy Hollow. Coverage and interoperability is always a safety concern when mixing radios from different systems with different users. Commanders and supervisors had to take extra precautions to ensure any emergency radio traffic would be heard and acknowledged.

Several of the 2007 Santiago Fire After Action Report communications recommendations were implemented for the Freeway Complex Fire with good success:

- A total of 32 relief engine/strike team communications kits were in place. Each kit contained the necessary radios and pagers for use by emergency crews assigned to surge fire engines activated during the incident.
- Every OCFA first responder apparatus was provided with VHF radios compatible with state and federal resources communications.
- An 800 MHz to VHF radio patch was set up on the Command Channel for interoperable communications among all agencies responding.
- Satellite data communications was set up at the incident base in the early stages of the incident.

Emergency Operations Center

The Freeway Complex Fire impacted a vast geographical area, including several cities and counties. The cities of Anaheim, Brea, Chino Hills, Diamond Bar, and Yorba Linda activated their Emergency Operations Centers (EOC) as the fire moved into their communities.

The Yorba Linda Assistant City Manager activated the EOC at approximately 12:45 p.m. on November 15. City personnel with EOC responsibilities were called back to help staff the center. The OCFA dispatched Battalion Chief Valbuena to the Yorba Linda EOC at 12:30 p.m. to serve as an Agency Representative to provide fire information and situation status in support of EOC operations. Two OCFA Fire Prevention personnel were also sent to assist the Agency Representative and help with structure damage assessment. Additionally, the Yorba Linda Water District (YLWD) sent a representative to act as liaison to the City of Yorba Linda's EOC. Both OCFA and YLWD representatives worked jointly to address the water supply problems that occurred during the fire. These jurisdictional EOCs assisted with coordinating local issues in cooperation with the County EOC, such as evacuation of residents, coordination of evacuation centers, street closures, coordination with school districts and businesses, and coordination of local government resources.

With the initial activation of the City of Yorba Linda and the City of Orange EOCs, and the predicted fire activity of the Freeway Fire, the County of Orange Operational Area EOC was activated on Saturday, November 15, 2008, at 11:00 a.m.

Early in the incident, the Operational Area EOC was activated to support the roles and responsibilities of the County of Orange. This activation requires personnel pre-identified to the policy group and other personnel trained in support functions to be contacted. The personnel responds to the EOC located at the Orange County Sheriff's Department's Loma Ridge Communications Facility near the City of Orange. Representatives from the County Executive Office, Orange County Public Works, Orange County Sheriff's Department, Probation, OCFA, Orange County Waste and Recycling, Health Care Agency, Social Services Agency, and the County Emergency Manager make up the policy group. An EOC Liaison, Public Information Manager, and various staff supported the policy group. This group was faced with several decisions during the EOC activation, including health issues related to air quality, evacuation of residents, closure of major roadways, and identification of shelter needs.

The County EOC- Policy Room

One of the first tasks completed by the Emergency Management staff was to notify the Chair of the Board of Supervisors, the Emergency Management Council, the Operational Area Executive Board, Operational Area Members, County agencies, and the State Office of Emergency Services of the incident.

The general public was kept informed through press releases, media interviews, and jurisdictional websites. This was the first test of the new Operational Area EOC website. The website served as a critical point for information distribution. Public information was actively managed via the website, including the dissemination of 25 news releases and/or media advisories and regular press briefings.

An additional method of releasing pertinent information to the public was the new County mass notification system, AlertOC. AlertOC was used during the EOC activation on behalf of the City of Yorba Linda. The request for the County to activate this system came at 3:52 p.m., and the message was issued at 4:09 p.m. The system was used to alert residents in the immediate path of the fire to evacuate the area.

The Orange County Social Services Agency, American Red Cross, and the Orange County Department of Education all collaborated and helped coordinate the opening and management of evacuation shelters for residents affected by the fire. The shelter locations included Katella High School, Valencia High School, and the Brea Community Center. Two other shelters Travis and Esperanza were initially opened, but they had to be closed due to the impact of smoke. Over the three days these shelters were opened, they registered over 919 individuals with 229 evacuees staying in the shelters overnight and nearly 1,320 meals provided.

A Local Assistance Center was established near the affected population of the Freeway Complex Fire. The City of Anaheim graciously hosted the Local Assistance Center at the East Anaheim Gymnasium. This location was large enough for public, private, and non-profit agencies to come together and provide assistance to the local residents and businesses.

Orange County Community Resources, Animal Control Division, assisted with the establishment of animal shelters. The Orange County Animal Shelter was opened to accept small animals, while the Los Alamitos Race Course and the Huntington Beach Equestrian Center were opened to accept large animals.

Early on, the EOC Manager requested County counsel to create an emergency proclamation in accordance with County of Orange ordinance and the Operational Area Emergency Plan. The local proclamation was signed on Saturday, November 15, 2008. The State of California was informed of the signed emergency proclamation and that Orange County was requesting a State Gubernatorial Proclamation and Federal Declaration of Emergency. The Governor issued a State Proclamation late Saturday, November 15; however, a federal declaration was not issued until Monday, November 17.

Governor Schwarzenegger receives a briefing

The 2008 Freeway Complex Fire challenged the County Emergency Operations Center on a different level than the 2007 Santiago Fire. During the Freeway Complex Fire, the County's main responsibility revolved around operational area coordination and mutual aid support. The lessons learned during the Freeway Complex Fire will improve the County's coordination of information

and resources during a major incident or catastrophic event. As staff to the Emergency Management Council and the Operational Area Executive Board, the Sheriff's Department Emergency Management Bureau will ensure enhancement of existing plans, procedures, training, and response.

By the end of the incident, the cities of Yorba Linda, Brea, Anaheim, and Chino Hills and the County of Orange Operational Area had all declared a local emergency. Additionally, due to fire and/or smoke conditions, the Brea Olinda Unified School District, Placentia Yorba Linda School District, Anaheim Hills Montessori, Calvary Christian School, St. Angela Merici Catholic School, St. Francis of Assisi Catholic School, Christian Preschool and Elementary School, and the St. Joseph Catholic School and Preschool were closed for one or more days.

The cost for the response to the Freeway Complex Fire for the County's EOC, Orange County Sheriff's Department field response, and Orange County Public Works Storm Center and field response along with the damages sustained to the Brea Olinda Landfill are currently estimated at $3,585,000. The Operational Area EOC was officially deactivated at 7:00 p.m. on Monday, November 17. Refer to the **Orange County Sheriff's Department After Action Report** at http://www.ocfamedia.org/_uploads/PDF/ocfaarocsd.pdf for additional details.

Media and Public Communications

The Corporate Communications Section was responsible for disseminating information and handling public relations during the Freeway Complex Fire. This included the responsibility for the activation of the Media Center, conducting the Public Information Officer (PIO) function for the incident command, updating of the OCFA website, and handling inquiries from elected officials. OCFA Board of Directors and City Managers were issued advisories via email. The advisories kept board members informed and allowed them to make inquiries to the Corporate Communications Battalion Chief. With the extreme fire behavior, rapid spread, and threat to homes, the OCFA new there would be great media interest.

The OCFA Media Center was activated soon after the start fire. Personnel were called back to duty and were answering telephone calls by 10:00 a.m. Staffed by four personnel from Community Relations and Education in the first couple of hours, additional professional staff from Finance, Fire Prevention, and Human Resources were put into service answering calls by noon the first day. The Media Center staff was further supplemented with two personnel from CAL FIRE. Their PIO experience was invaluable as they were able to assist OCFA personnel in handling media inquiries and by answering calls from the public. From the onset on November 15 until the fire was declared fully controlled on November 19, the Media Center received over 6,000 calls from the public and the media.

Communications between the OCFA Media Center and the Orange County Emergency Operations Center (EOC) was efficient throughout the incident. A total of 25 press releases and media advisories with information on evacuations and road closures were issued in a coordinated fashion between the Media Center and the EOC.

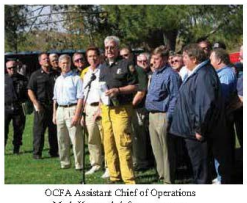
Reporting the Fire

OCFA was able to assign a Community Education Specialist to the Disaster Center established for Yorba Linda residents. The Education Specialist distributed informational fliers and was able to answer questions from the community. On the third and fourth day of the incident, the Community Education Specialists also conducted school programs for the entire school population of two of the elementary schools in Yorba Linda. The programs educated the children on the disaster in their community and helped to allay their fears. The school programs were very well received by the students and faculty.

The OCFA website (www.ocfa.org) received almost 1.4 million inquiries during the first day of the incident. Nearly 5 million inquiries were made from November 15 through November 25, 2008. Prior to November, the average number of inquiries to the website was 25,171 per day. The website was a key source of information about the fire. OCFA personnel provided updates to the website as often as possible. A fire progression map was uploaded every 12 hours. Only a small number of personnel were available to perform website updates, and the updating was a slow and cumbersome process. At times, fire and evacuation information needed updating, but qualified personnel were not available. Complaints were received about the freshness of website

information and the difficulty of navigating through the site as well as conducting information searches.

OCFA was also in the midst of a PIO transition at the time of the Freeway Complex Fire. The newly selected PIO was not scheduled to start his assignment and was on vacation at the beginning of the incident. The Corporate Communications Battalion Chief served as the initial point of contact for media inquiries. To gather information, he responded directly to the Incident Command Post that had been established at the Green River Golf Course. All media inquiries were referred to him, and the number of cell phone calls being received was overwhelming. This made it extremely difficult to communicate with the Media Center and delayed getting updated information relayed. Around noon, a Fire Prevention Specialist was assigned to answer calls and handle all communication with the Media Center while the Battalion Chief provided media interviews.



OCFA Assistant Chief of Operations Mark Kramer briefs news crews.

The rapid spread of the incident and the difficulty in communications between the field and the Media Center lead to some confusion. Incongruent information ended up being disseminated to the media. Additionally, the media became aware of water supply issues on the incident prior to field PIOs and the Media Center; this contributed to the confusion and inaccurate information.

The Incident Management Team PIO arrived early in the afternoon the first day. The PIO transition meeting was attended by the Chino Hills Fire District PIO, CAL FIRE Riverside County PIO, Anaheim City PIO, and Anaheim Police Department PIO. Coordination between CAL FIRE Riverside County, the IMT PIO, and OCFA was good throughout the incident.

The OCFA PIO returned from vacation upon learning of the Freeway Fire and arrived at the incident at around 10:00 p.m. the first day. Since the incident had already been transitioned to the IMT, the OCFA PIO was assigned to the base camp and worked with the pool of PIOs who were already assigned. The OCFA PIO worked the night shift. However, it would have been more advantageous to have the OCFA PIO work during the day because of his knowledge and familiarity with the local media. After the first day, most of the media inquiries came during the day.

Fire Investigation

The Freeway Fire originated in Riverside County near the 91 Freeway and the Green River off-ramp in the City of Corona. The area of origin is the jurisdiction of CAL FIRE; therefore, CAL FIRE investigators assumed the responsibility for the fire investigation. The preliminary fire cause is reported as accidental. The preliminary cause may be the result of a vehicle exhaust system igniting roadside vegetation. The fire investigation report is expected to be complete by the end of March 2009.

CAL FIRE arson investigators search the area of origin of the Freeway Fire for evidence.

The Landfill Fire, investigated by the Brea Police Department along with investigators from the OCFA, was determined to have been caused by inadequate maintenance of power lines supplying electricity to equipment in an oil field. The electrical lines are owned by Breit-Burn Management Company in Los Angeles. Investigators believe arcing or a discharge of current from the power lines caused the brush near the lines in the fields northeast of Valencia Avenue and Carbon Canyon Road to ignite.

The origin of the Landfill Fire is seen behind the homes in the City of Brea.

Volunteer Groups and Resources

Many volunteer groups assisted during the Freeway Complex Fire in various capacities. Major volunteer groups included:

- American Red Cross
- Salvation Army
- Community Emergency Response Team (CERT)
- OCFA Chaplains
- Trauma Intervention Program (TIP)

These volunteer groups provided invaluable assistance to a wide variety of non-suppression and incident support activities. The positive attitude, helping nature, and initiative of these groups were recognized and appreciated by OCFA staff, the Incident Command staff, and those who responsible for supervising and managing various support functions.

The American Red Cross is the lead agency responsible for establishing and staffing evacuation centers during disasters and other major emergencies requiring evacuation of large numbers of residents. During the Freeway Complex Fire, three evacuation shelters were established. The first was at Valencia High School in the City of Placentia; the second at Katella High School in the City of Anaheim; and the third at the Brea Community Center. While these shelters were in operation, 202 volunteers and staff worked, 919 people registered, and 1,320 meals were served along with numerous snacks. All three shelters were opened Saturday, November 15 and closed Monday, November 17.

Evacuated residents are served dinner at one of the local high school evacuation centers.

The Community Emergency Response Team (CERT) Program educates people about disaster preparedness for hazards impacting their community. CERT trains people in basic disaster response skills such as fire safety, light disaster and rescue, team organization, and disaster medical operations. Using classroom and field exercise training, CERT members assist others in their neighborhood or workplace following an event when professional responders are not immediately available to help. CERT members also are encouraged to support emergency response agencies by taking a more active role in emergency preparedness projects in their community. CERT is part of the Federal Government's Citizen's Corp Program. More than 150 volunteers and 38 partner agency staff assisted with the American Red Cross response.

The CERT Mutual Aid Program (CMAP) is an organization of Orange County CERT jurisdictions and citizen volunteers. They are dedicated to collaboration and coordination of volunteer activities in a disaster response. Jurisdiction coordinators and volunteers are governed and supported by a mutual aid agreement, approved in August 2008 by the Orange County Executive Committee and

added to the County's emergency response plan. The mutual aid agreement identifies the CMAP organization and outlines the course of action to be taken to activate Orange County volunteers.

The request for the activation of CERT volunteers for the Freeway Complex Fire was based on a previous use of volunteers during the October 2007 Santiago Fire. In the early morning hours of Sunday, November 16, a request from the Orange County EOC was received to activate mutual aid volunteers to the Irvine Regional Park base camp. Calls were made to CMAP Coordinators to begin the process of volunteer and equipment activation. Agencies affected by the fires (Anaheim, Fullerton, and Placentia) activated CERT members within their own jurisdictions.

CERT volunteer assists in directing resources at the Freeway Complex Fire Incident Base.

During the Freeway Complex Fires, 254 civilian volunteers covered 168 hours of activation at the Irvine Regional Park base camp. Volunteers worked shifts ranging anywhere from 4 to 12 hours. Coordinators were present for all shifts. Support roles included traffic safety management at base camp and assisting in strike team demobilization. A request was made to fill CMAP volunteer shifts from Sunday, November 16, to Wednesday, November 19, with a possibility of expanded volunteer coverage to Friday, November 21. CMAP operational periods were selected by CERT Coordinators. The CERT Coordinators worked 12-hour shifts (4:00 p.m. 4:00 a.m. and 4:00 a.m. 4:00 p.m.), and the CMAP volunteers were assigned 12-hour shifts (5:00 p.m. 5:00 a.m. and 5:00 a.m. 5:00 p.m.), with an additional 4-hour shift in the morning and evening to assist with volunteer changeover.

CMAP representatives from Newport Beach, Seal Beach, Garden Grove, San Juan Capistrano, Huntington Beach, Costa Mesa, and Anaheim responded as Technical Specialists from November 16 to November 21. Coordinators from Newport Beach, Seal Beach, San Juan Capistrano, Huntington Beach, and Garden Grove filled the 12-hour on-site shifts. Huntington Beach and Costa Mesa representatives coordinated volunteer scheduling.

Representation of CERT members included Costa Mesa (43); Newport Beach (34); Garden Grove (60); San Juan Capistrano (22); Irvine (11); Huntington Beach (24); Dana Point (10); Santa Ana (2); Anaheim (1); and West Orange County CERT, which included the cities of Seal Beach, Westminster, Cypress, Los Alamitos, La Palma, and Buena Park (47).

The CMAP organization has worked with the Urban Area Security Initiative (UASI) Grant Program since 2005. Its goal is to create regional equipment caches to support CERT programs countywide and to respond upon request. The cities of Seal Beach, Dana Point, Fullerton, and Anaheim have dedicated supplies for CMAP response. Seal Beach provided the response equipment trailer and tow vehicle for this activation while the Garden Grove CERT program provided a volunteer rehab vehicle and radios.

On Sunday, November 16, OCFA implemented its Occupant Liaison Program. OCFA personnel with fire department vehicles were assigned to the American Red Cross Centers and went into the fire areas to support the citizens of Yorba Linda. The Occupant Liaison Program provides customer service for information, coordination, and comfort to individuals experiencing emergency incidents such as fires, floods, mudslides, or any other type of incident resulting in the displacement of the occupants from their residences or places of business. Four Occupant Liaison Teams—comprised of an OCFA Fire Prevention Inspector, a Trauma Intervention Program (TIP) representative, and an OCFA Chaplain were available.

The Trauma Intervention Program (TIP) is a non-profit volunteer organization of specially trained citizen volunteers. They provide immediate emotional and practical support to victims and their families following a tragedy or traumatic event. TIP provided volunteers to the OCFA Occupant Liaison Teams. They were invaluable in assisting with counseling residents who had been evacuated or whose homes were damaged or destroyed.

The Salvation Army is a non-profit organization with a history of providing services and programs during times of disaster in Orange County over the last 100 years. Its community services also include transitional housing, emergency shelters, counseling, and responding to emergency disasters. Over the last couple of years, the Salvation Army has responded to many local disasters including the Santiago and Freeway Complex Fires. Through the mobilization of over 100 volunteers, the Army provided assistance to those affected by the disasters with food, clothing, and counseling, as well as services provided to first responder fire and law enforcement personnel. The Army mobilized its Emergency Disaster Canteens providing food, beverages, water, and a variety of personal items. The Salvation Army responds to emergency disaster events by providing a myriad of equipment, supplies, and volunteers.

OCFA has a long-standing and very active volunteer Chaplain Program. Members of the Chaplain Program were an important piece of the Occupant Liaison Team. They were on-hand and available to support and assist residents with their spiritual needs during this crisis. They also helped with other non-suppression support duties.

Many other accounts of individual volunteers providing assistance during the Freeway Complex Fire abound. Having trained, qualified, and eager volunteers who are capable of assisting in non-suppression activities freed up full-time firefighting personnel. In turn, they could focus solely on fire suppression efforts. Additionally, they assisted in providing human services, aid, and comfort to evacuated residents and those whose homes were damaged or destroyed. The contributions and assistance of all volunteer groups and the individual volunteers were invaluable.

Fiscal Impacts

Each year, the OCFA establishes cost reimbursement rates. They are used to bill for personnel and equipment resources requested on an assistance-by-hire basis by state, federal, and other agencies needing OCFA services. The personnel rates are based on budgeted salary and benefit costs. Also included are indirect costs such as financial services, purchasing, and human resources. Equipment rates are based on rate schedules provided by CAL FIRE and the Federal Emergency Management Agency (FEMA). These rates recover OCFA's costs when assisting other agencies or when an OCFA incident is declared a major incident subject to public assistance funding.

Public assistance funding is authorized by the Stafford Act and funded through FEMA. The Stafford Act:

- Gives the President the authority to administer federal disaster assistance.
- Defines the scope and eligibility criteria of the major disaster assistance programs.
- Authorizes grants and direct assistance to the states.
- Defines the minimum federal cost-sharing levels.

As of January 31, 2009, OCFA's costs from the Freeway Complex Fire are estimated at $2.3 million. Due to the magnitude of the fire, both FEMA and the State's Office of Emergency Services (OES) declared the Freeway Complex Fire as a major incident. They offered to provide public assistance funding to the participating agencies.

Following guidelines for federal public assistance, on November 20, 2008, a Local Government Fiscal Responsibility Agreement was made between CAL FIRE, FEMA/OES, and OCFA concerning reimbursement of resources for the Freeway Complex Fire. Based on the Local Government Fiscal Responsibility Agreement, OCFA expects reimbursement of approximately 94 percent of costs associated with the fire. **Table 8** below shows costs and the source of anticipated reimbursements.

Table 8: OCFA Cost Reimbursement

Reimbursement	FEMA	CAL FIRE	OES	Total
Claim Submitted	$527, 210.20	$1,575, 775.84	$184,670.07	$2,287,656.08
Estimated Percent of Reimbursement (%)	93.80	100	100	
Estimated Total Reimbursement	$494,523.17	$1,575,775.84	$184,670.07	$2,254,969.08
OCFA's Share	**$32,687.03**	**$0.00**	**$0.00**	**$32,687.03**

Recovery Efforts

As the Freeway Complex Fire was being controlled, efforts began to address the post-fire risk to lives and property that could arise during the coming rainy season. The combined effects of vegetation loss and the effect on soils from fire, created conditions greatly increasing the threat of floods, erosion, and debris flow in the impacted areas.

To prepare for the winter, the OCFA, along with the California State Office of Emergency Services (OES), coordinated assessments of the burned areas with Burn Area Recovery Teams (BART). These teams consisted of representatives from CAL FIRE, California Geological Survey, Department of Water Resources, Department of Fish and Game, Department of Parks and Recreation, and Regional Water Quality Control Boards. Refer to the **Burn Area Recovery Team Report** for more details http://www.ocfamedia.org/_uploads/PDF/fcfaarbart.pdf.

The BART members conducted a rapid assessment of the fire area to identify hazards and subsequent mitigations including:

- Identifying on-site and downstream threats to public health or safety from land sliding, debris torrents, flooding, road hazards, and other fire-related problems.
- Identifying threats to watershed resources, including excessive erosion; impaired water quality; threats to wildlife, fisheries, and botanical values; and cultural resources.
- Determining measures needed to prevent or mitigate identified threats.

Sand bags in place west of Banyon Rim.

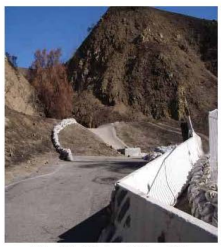
The BART report provides mitigations to reduce but not entirely eliminate risk from the identified hazards. Suggestions such as straw mulching and erosion control fabric or blankets, straw wattles to provide a mechanical barrier to water flow and trap sediment, hydro-mulching in selected areas, and K-rails to direct water run-off, if used properly, are very effective.

The following are some of the recommendations for specific areas from the BART report:

- Where possible, drainage basins be expanded and cleaned of all debris. Adequately sized culverts should be placed within the debris basins so flood waters will be discharged effectively. Residents are discouraged from using plastic ground covers: they cause an acceleration of water runoff within the burn area.
- The Ranch in the Olinda Village area will require a large soil berm, K-rail, or rip-rap to direct watershed discharge around the threatened property.
- In general, residences located at the base of the hills in Chino Hills, Yorba Linda, and Brea should take precautions to limit impacts of future rainfall through the use of K-rail,

sandbags, or other flood prevention barriers. Additionally, keeping existing culverts free of debris would be a priority to ensure proper drainage.

- Expect higher than normal watershed discharges with possible debris flow in all rain events for the next two or more rain seasons.
- Specific areas along the BNSF railroad were addressed: Box Canyon and Horse Shoe Bend. An early warning monitoring system with various monitoring points along the hillside above the railroad is advised. Additionally, a minimum of three debris basins should be constructed around Horse Shoe Bend. This will ensure debris is collected prior to making contact with the railroad tracks.
- Emergency evacuation plans should be implemented for all communities within the burn area.
- Any dead/fire burned trees and vegetation and live standing trees that could cause damming or choking of debris in creeks or drainage basins should be removed immediately. A plan should be developed and approved by appropriate agencies to remove problem vegetation for any remaining downstream areas.
- All county, private, and state roads and trails should be monitored for washout and debris flow during and after precipitation events.
- The Chino Hills State Park should be monitored for debris and sediment flows during and after rain events, as large amount of debris may flow into the sediment basin reservoir and cause erosion along roads, bridges, and trails.



Use of K-rail to channel future debris flow around homes.

Resident's preparation for possible mud and debris flow proved to be beneficial.

A moderate to heavy rainstorm was predicted for the Orange County area on November 26 27, 2008. Predicted rainfall amounts ranged from 1.5 inches to 2.5 inches. The OCFA began preparations for the possibility of mud and debris flows by working closely with the local communities of Yorba Linda, as well as the Santiago Fire areas. Evacuation plans were coordinated with local government and law enforcement in the areas directly impacted by fires.

The three main objectives for the OCFA were to (1) provide incident management and support if significant flooding and debris flow occurred in the burn areas, (2) coordinate weather-related calls for service with the City of Yorba Linda, and (3) assist with the timely and orderly evacuation of residential areas as necessary.

The following OCFA resources were pre-staged to reduce reaction time and get needed help to any impacted areas quickly. The augmented resources were staged at the Yorba Linda Community Center.

- An Incident Management Team
- One Bulldozer
- Two Swift Water Rescue units
- One Handcrew
- One Type 3 Strike Team
- Two Reserve Patrols: 10 and 32

Dozer clearing mud off the street following the rains that hit the fire consumed areas of Yorba Linda.

The City of Yorba Linda and its residents played a significant role in preparing for the rain event. While fire crews were continuing to overhaul the burn areas, community efforts were underway to fill, distribute, and place sandbags, straw bales, and other mitigation efforts. This effort also drew volunteer participation from across the city, as well as from other cities across the county.

Major Challenges

- Over the last decade, Southern California has experienced eight years of drought conditions, contributing to an increase in dead fuels, explosive and dryer fuels, and more intense fire behavior.[2]
- A sustained Santa Ana wind event contributed to two significant fires starting less than two hours apart in the same area of Orange County. The extreme winds, rapid fire spread, and urban interface environment created a wide fire front. This had a major impact on resource availability.
- Houses with unprotected vents and other openings became vulnerable to ember intrusion. Raging winds turned burning fuel into an "ember-storm," threatening at-risk homes in the fire's path.
- The OCFA, pursuant to a Board-adopted policy, dispatches a minimum of 18 firefighters to a single "working structure fire" (4 engines, 1 truck company, and 1 paramedic) as the necessary "Effective Firefighting Force." That ratio of firefighters to working structure fire was not possible to achieve during the Freeway Complex Fire.
- While conducting structure protection during the Freeway and Landfill Fires, interior firefighting was often needed. A Federal mandate and best practice, the "Two-in and Two-out Rule" demands that in the absence of a life safety or rescue scenario, two or more firefighters are required to conduct interior firefighting with a minimum of two additional firefighters on standby outside the occupancy ready to conduct firefighter rescue. To comply with this safety rule, four-person staffing is required on a single engine company. Since most OCFA engines are staffed with three firefighters, they were not safe nor within legal guidelines to conduct interior operations without support from a second company.
- Wind blown embers, carried aloft by the fire's thermal column, created spot fires more than a mile ahead of the main fire front. These spot fires then merged with the main flame front. This rapidly compressed the transformation time from brush fire into urban conflagration.
- The Freeway Fire and the Landfill Fire began in rapid succession and made resource tracking, command and control, and communications more difficult during the initial attack phase. Many responding agencies converged on the incident simultaneously making resource accountability extremely difficult.
- Two additional brush fires—the Landfill and Diemer Fires, in western Yorba Linda—along with the Freeway Complex Fire jumping the 91 Freeway in two places, further stretched the already taxed resources.

[2] US Geological Survey. *Water Watch Past Stream Flow Conditions*. Accessed http://water.usgs.gov/waterwatch/?m=statesum&r=ca&w=statesum%2Cmedian on March 6, 2009.

- Two strike teams were requested by ORC Battalion Chief Reeder to stage at Station 53 in preparation of the fire's arrival to Yorba Linda. These strike teams self-diverted to Green River and the 91 Freeway.
- The incident impacted two Office of Emergency Services regions, four counties (Los Angeles, Orange, Riverside, and San Bernardino), and five emergency dispatch centers. Impacting these major geographical areas created communication, operational, and command challenges.
- The lack of common radio communications presented significant challenges. Some local agencies do not have VHF high band capability as required by FIRESCOPE. Many agencies continued to use their own radio systems or failed to follow the established communications plan. This further exacerbated the fire-ground communications problem. Additionally, the terrain in the fire area was extremely broken and mountainous--hampering radio transmissions.
- Self-dispatching of off-duty firefighters on relief apparatus to the fire presented challenges to personnel accountability and safety. In some instances, these resources were not discovered to be at the fire for 12 hours or more.
- Many mutual aid resources had difficulty navigating through unfamiliar local communities. Resources lacked a reliable mapping method of locating specific fire-impacted areas.
- The incident was run as a unified complex. It started as two fires in the same general area, and a central ordering point was established for both fires through the OCFA. The large incident culture and command structure are unfamiliar to many local agencies, creating confusion.
- An initial challenge occurred in working with law enforcement to form a unified command structure and to have a single decision maker. Prior experience on the part of the participating agencies facilitated this process.
- The conflict between state (SEMS) and national (NIMS) definitions for evacuation terminology continues to cause confusion for the media and public (mandatory vs. order/warning).
- The loss of water pressure in the Hidden Hills community and in other neighborhoods was a major challenge for the ground forces protecting threatened structures.
- More than 375 law enforcement personnel from various agencies assisted the Brea Police Department during the fire. Providing them with accurate and timely information on areas to be evacuated or repopulated was challenging.
- A rapidly developing fire that stretched over a large urban area made it difficult for the OCFA Media Center to stay current on fire conditions and information.

- Fire extinguishment efforts placed an extreme demand on the water system. Whether due to the use of master stream devices, the numerous firefighting hose lines, and/or the scores of garden hoses left running at individual homes, the demand on the system taxed the water capacity and deliverability.
- Homeowners—those remaining within the fire perimeter and those who evacuated—created traffic challenges inhibiting the movement of fire apparatus.
- The speed and unpredictability by which the fire moved through the urban interface made it challenging to stay ahead the fire and rapidly identify areas to be evacuated.
- Ornamental vegetation provided an unexpected source of fire brands the wind was able to carry deep into residential neighborhoods. Palm trees were a significant contributor to this problem.
- Wooden decks, balconies, and other unprotected structures provided an entry way for embers and flames to enter homes.
- Due to the demand to keep pace with a rapidly moving fire, a "bump and run" tactic was employed. In some cases, structures had to be left unattended after initial extinguishment, resulting in some rekindles and the loss of structures. This may not have occurred had there been sufficient units to employ an "anchor and hold" strategy.
- Fire retardant "drift" from air tankers created a major safety and post-fire clean-up challenge. Large amounts of fire retardant from aircraft was either dropped on homes or drifted far from the target due to the winds.
- The Department Operation Center (DOC) was not established until OCFA Division Chief Robinson arrived at the OCFA Emergency Command Center (ECC) at approximately 11:30 a.m. on November 15. This led to difficulty in receiving, placing, and tracking orders early in the fire.
- The presence of private fire protection services created operational challenges and a level of confusion among residents. These resources, normally sponsored by homeowners' insurance companies, currently have no operational guidelines, certification standards, and no common communications with the incident commanders.
- A Red Flag Warning or a Red Flag Fire Weather Watch had not been issued for Orange County. Wind prediction for the day was significantly different than experienced. This resulted in the OCFA not implementing its Extreme Weather Plan (SOP 209.13) or the Red Flag Alert Program (SOP 209.12). Either or both would have increased public awareness and implemented operational procedures in response to the extreme weather conditions.
- Due to the size and rapid growth of the incident, meeting all logistical needs in the early stages was challenging.

Successes

- Importantly, no loss of life occurred. Reported injuries were few and considered minor.
- Hundreds of structures were successfully protected. Low humidity and high winds made this a very dangerous time for fires in the wildland urban interface (WUI). Although structures were lost and damaged, if not for the excellent work of the firefighters and citizens who protected their homes, the losses would have been greater.
- The Unified Command Incident Management Team worked well together. Although the team was large, each agency was mindful of the others' needs. This helped create common ground on difficult issues. As challenges arose, all the agencies worked toward the common goal of meeting the incident needs.
- Coordination with law enforcement was excellent. The early integration proved to be extremely advantageous for citizen evacuation. Additionally, the placement of law enforcement personnel within Operational Branches helped reduce the lag time for evacuations.
- The advance planning and tabletop exercise given in preparation for an incident in the mutual threat zone provided for a more effective command and control.
- A smooth transition occurred from the initial attack incident commanders and the incident management team. This can be attributed to an attitude of cooperation and respect.
- Despite the radio communication problems, water supply issues, and the time required to assemble the required firefighting assets to meet the demand of this urban conflagration, personnel worked hard to contain this incident and to minimize loss.
- Interagency cooperation was effective in solving issues and obtaining necessary resources. Operationally-related activities such as traffic control, evacuation, and repopulation were easy to implement due to the close coordination between the involved agencies.
- The integration of OCFA personnel into all general staff positions provided the CAL FIRE IMT 6 with local knowledge and expertise essential to the successful conclusion. Local agency participation in strategy meetings helped obtain agency support and "buy in" for the operational plan.
- The Orange County Access Channel was used as the Incident Command Net. Thus, all ORC 800 MHz radio users, and VHF high band users, could communicate on one common channel.
- The use of OCFA's new Compressed Air Foam System (CAFS) units was highly successful. The high mobility of the units allowed for quick pick-up and redeployment. The foam lasted longer than expected and freed other resources for other assignments.

- The OCFA was able to quickly provide representatives to the County and City Emergency Operation Centers. This enabled a direct line of communication between the impacted jurisdictions and the incident command team.
- Using Community Emergency Response Team (CERT) personnel—to perform various functions within the incident base—freed fire personnel for other assignments.
- The incident was able to provide three structural engines to support the local water supply system.

Recommendations

Mitigation and Preparation

1. Continue regional planning efforts. Establish interoperable communication plans for mutual threat zones. *In Progress*
2. Develop regional operating plans (similar to Silverado Canyon Fire Plan) for high fire severity zones. *In Progress*
3. Develop a rapid attack mobilization plan that facilitates dispatch, mobilization, and situation management practices during major emergencies or Red Flag Warning conditions. *In Progress*
4. Work with local water agencies to evaluate potential threats and weaknesses to the water distribution systems and facilities housing critical infrastructure. Assist in the development of a mutual aid plan between water agencies permitting inter-agency cooperation during major emergencies. Develop contingency plans and practical exercises to test for vulnerabilities. *In Progress*

Prevention and Public Education

1. Facilitate the development and enforcement of applicable building and fire codes for fuel modification and building construction in the wildland-urban interface (WUI) environment. *In Progress*
2. Develop informational material for ornamental vegetation planting and maintenance to reduce flame spread and ember production.
3. Provide sufficient Occupant Liaison personnel to assist residents when returning to evacuated areas. Selected OCFA professional staff, when trained, may fit this role appropriately.
4. Ensure the terminology used in regard to public evacuation is commonly understood and is in conformance with SEMS/NIMS and/or FIRESCOPE to minimize confusion between public agencies.

Operations and Response

Resources

1. Complete development of a formal plan for placing "surge capacity" engines in service. The plan should address storage of the units, outfitting, communications, and staffing. *In Progress*
2. Complete the modification of five patrols to compressed air foam system (CAFS) units. Develop use and response configuration plans. *In Progress*

3. Establish a full-time fire handcrew. Handcrews are needed to meet our wildland fire suppression mission. Fire crews are consistently listed as critical resource needs during every wildland fire. *Delayed due to budget*
4. Develop and consider alternatives for staffing additional fire bulldozers when needed.
5. Develop internal staffing criteria for water tenders, patrols, and other critical resources when Reserve personnel are unable to respond. *In Progress*
6. Develop a policy pertaining to the use of privately-owned resources such as water tenders, earth moving equipment, and other support resources that may be used when offered during emergency situations.
7. Follow through with the staffing recommendations from the Santiago Fire to increase the staffing at stations with a Type III engine to four personnel. In the interim, achieve this through the use of back-fill for two months during the peak of fire season as a reasonable stopgap until this can be achieved. *In Progress*
8. Work with law enforcement to develop more effective evacuation and repopulation procedures.

Communications

1. Increase CAL FIRE Command Net radio coverage in Orange County by adding two or more additional radio repeaters. *In Progress*
2. Exercise radio interoperability in Orange County regularly. Radio users must be familiar with VHF radio operations.
3. Establish a VHF frequency group for State Responsibility Areas (SRA) in Orange County, so all responding units can operate on this group. The command and tactical nets should be established before an incident occurs. *Complete*
4. Continue efforts to equip all resources in Orange County with VHF radio capability per FIRESCOPE. *In Progress*

Incident Command/Management

1. Develop a program to increase the availability of Incident Management Team(s) for year-round response within Orange County.
2. Continue to evaluate ICS training needs and offer appropriate courses to all personnel including Command staff. *In Progress*
3. Provide periodic refresher training on the use of firing operations to all chief officers.
4. Review and consider currently available technology, such as Toughbook laptop computers, for use in all command vehicles and eventually on every fire engine. These computers

should have mapping software installed and maintained. These tools have proven to be invaluable resources on fires and provide critical information for planning and firefighting purposes.

5. Continue the development and use of ICS trainee positions to facilitate succession planning and the development of incident management teams. *In Progress*
6. Identify additional potential assignments for OCFA professional staff on major incidents. *In Progress*
7. Develop a policy for interacting with private fire protection resources.

Air Operations

1. Develop best practice staffing and deployment model for the OCFA helicopter program.
2. Develop a policy on first and best use of law enforcement helicopters. Where appropriate, assist local law enforcement agencies to obtain red-card certification for pilots, fueling operations, and helicopter use on local government fires.
3. Train and qualify additional OCFA personnel as Air Ops Branch Director (AOBD), Air Support Group Supervisor (ASGS), Helicopter Coordinator (HLCO), and Helibase Manager (HEMB).
4. Complete night vision goggle training to provide night flying capability. *In Progress*
5. Research the feasibility and local use of unmanned aerial vehicles (UAV) to facilitate mapping during smoky conditions.
6. Pre-identify helispots and water source dip sites in fire prone areas.
7. Increase mobile refueling capability for helicopters.
8. Establish a land use agreement with Corona Airport for future deployments.
9. Develop best practices for aircraft use on wildfires. Aircraft are a proven asset and, unlike ground forces, are limited by daylight flying time. Practice and policy should be developed to ensure "first light" use of all air assets.
10. Provide periodic training to Chief Officers on the use of interagency radios and communications with the aircraft command and control elements (ATGS and HLCO).

Emergency Command Center

1. Develop an operations manual for the OCFA Department Operations Center (DOC). The manual should identify critical positions within the DOC and outline critical tasks needing to be completed during a major emergency or event. *In Progress*
2. Order ECC support personnel to support incident command teams and expanded dispatch as needed. This will help with ensuring orders are placed correctly and assist the plans section on arriving resources.
3. Provide managerial support in the absence of the ECC Chief. The DOC Manager must be able to provide managerial support and operational and tactical guidance to the ECC Supervisor.
4. Empower ECC Supervisors to modify normal dispatch procedures to meet operational needs and station coverage during major emergencies.

Logistics

1. Ensure adequate fuel and equipment support is available during major emergencies.
2. Identify and pre-plan additional base camp locations for WUI fires. *In Progress*

Training

1. Provide *S-215 - Fire Operations in the Wildland/Urban Interface* course to all OCFA company officers. Include annual refresher on the use of firing operations. *In Progress*
2. Continue to train with law enforcement personnel in the complexities of extended attack incidents and unified command procedures.
3. Conduct on-site training of the Freeway Complex Fire for Chief Officers of the affected agencies.
4. Train OCFA Fire Prevention personnel to be able to function as a City EOC Agency Representative.
5. Provide training to selected professional staff to assist the Public Information section.
6. Provide WUI structure protection tactics training to all operations personnel.
7. Initiate a training program with the water districts that includes ICS/NIMS/SEMS, and with tabletop exercises.

Volunteer Groups

1. Continue the use of Community Emergency Response Teams (CERT) for logistical support. Seek additional duties they may safely perform during major emergencies.

2. Develop a policy and procedure for accepting community support and offers to help or provide resources.

Public Information

1. Improve the OCFA website so incident information is easily and readily available. The site should incorporate technology to allow for interactive maps and data search.
2. Develop procedures for initiating frequent community briefings. Topics should include incident status, evacuation information, repopulation expectations, and other relevant information of interest.
3. Conduct training with Cities regarding Emergency Operations Center activities such as evacuation and repopulation procedures, media information distribution, and public notification.

As a result of the 2007 Santiago Fire, a detailed After Action Report was written that included its own set of recommendations. Prior to the Freeway Complex Fire, many of these recommendations had been implemented and proved to be beneficial. Others are being developed and worked on by established work groups. The use of these work groups should continue, and the recommendations within this report should be distributed among them.

Glossary

AGENCY REPRESENTATIVE – Individual assigned to an incident from an assisting or cooperating agency. He/she has been delegated authority to make decisions on matters affecting that agency's participation at the incident. Agency Representatives report to the Incident Liaison Officer.

AIR ATTACK – Airplanes flying over an incident, providing tactical coordination with the incident commander on the ground, and directing air tankers and helicopters to critical areas of a fire for retardant and water drops.

ANCHOR AND HOLD STRATEGY – Structure protection tactic often used in a wildland urban interface fire. Firefighting forces engage the fire and then remain in selected areas to ensure no or limited fire starts after the passing of the fire front.

ARCING – Luminous discharge of current—formed when a strong current jumps a gap in a circuit or between two electrodes.

BASE CAMP – Location at which primary logistics functions for an incident are coordinated and administered—only one base camp per incident.

BRANCH – Organizational level having functional or geographic responsibility for major parts of incident operations. The Branch level is organizationally between Section and Division/Group in the Operations Section, and between Section and Units in the Logistics Section. Branches are identified by the use of roman numerals or by functional name (e.g., medical, security).

BUMP AND RUN STRATEGY – Structure protection tactic often used in a wildland urban interface fire where firefighting forces must keep moving ahead of the advancing fire. They attempt to control spot fires and/or provide initial knock-down of fires established within a structure.

BURN AREA RECOVERY TEAM (BART) – Team comprised of multi-agency and multi-disciplined resource specialists assembled to assess fire damage and suppression effects and to prepare mitigation measures. Upon development of a rehabilitation plan, the team makes recommendations on hazard mitigation.

BURN OVER – Wildfire situation where—because of wind-shift, topography, and/or poor planning—a person (firefighter) is caught in an inescapable fire and literally has fire burn over, under, and around him/her; this is the leading cause of firefighter deaths during wildfires.

CENTRAL ORDERING POINT – Facility or dispatch center where all personnel, supplies, and equipment requests are placed and tracked.

CHIEF OFFICERS – Agency Administrators, Fire Chiefs, Deputy Chiefs, Assistant Chiefs, Division Chiefs, and Battalion Chiefs with executive and/or management-level responsibilities.

COMPLEX – Two or more individual incidents located in the same general area that is assigned to a single Incident Commander or to Unified Command.

COMPRESSED AIR FOAM SYSTEM (CAFS) – Used in firefighting to deliver fire retardant foam for the purpose of extinguishing a fire or protecting unburned areas from becoming involved in flame. CAFS units are effective when used to pre-treat structures and vegetation with foam in advance of the fire to protect it from heat and flames.

CONFLAGRATION – Uncontrolled burning or fire that moves across natural and man-manmade barriers and threatens human life or property and the environment.

CONTAINMENT – Fire is contained when it is surrounded on all sides by some form of boundary, line, or clearance but is still burning and has the potential to jump or escape the containment line.

CONTROLLED – Fire is controlled when no further threat of it escaping outside the containment line exists.

COOPERATING AGENCY – Agency supplying assistance including—but not limited to—direct tactical or support functions or resources to the incident control effort.

DEFENSIBLE SPACE – Creating a fire safe landscape for at least 30 feet around homes—out to 100 feet or more in some areas—to reduce the chance of a wildfire spreading to structures. – Essentially, an area helping to protect a home and provide a safety zone for the firefighters battling flames.

DEFENSIVE – Firefighting mode primarily focusing on the protection of exposures through the confinement of the fire to a selected area.

DEPARTMENT OPERATIONS CENTER (DOC) – DOC provides agency dispatching capability independent and separate from routine emergency dispatch. The DOC is activated and staffed for large or complex incidents allowing personnel to focus efforts solely on the incident: maintaining situation status, processing orders for resources, and maintaining a direct link with EOCs.

EMERGENCY COMMAND CENTER (ECC) – Dispatch Center, an ECC is the center of an agency's information and communication capability. It is tasked with receiving and processing incoming calls for help. ECC personnel determine the nature of the request and forward it to the appropriate resource.

EXTREME FIRE BEHAVIOR – "Extreme" implies a level of fire behavior characteristics ordinarily precluding methods of direct control action. One or more of the following is usually involved high rate of spread, prolific crowning and/or spotting, presence of fire whirls, and/or strong convection column. Predictability is difficult since such fires often exercise some degree of influence on their environment and behave erratically and dangerously.

FIRE LINE – Area where the vegetation has been removed to deny the fire fuel—or a river, a freeway, or some other barrier expected to stop the fire. Hose lines from fire engines may also contribute to a fire being surrounded and contained.

FIRE MANAGEMENT ASSISTANCE GRANT (FMAG) – Federal assistance program

managed by FEMA through the State Office of Emergency Services (OES). Program is designed to help state and/or local jurisdictions impacted by high cost, high damage wildland fires.

FIRE PERIMETER – Entire outer edge or boundary of a fire.

FIRING OPERATIONS – Setting a controlled fire with the intent to create a fire break so the path of the fire will be impeded.

FIXED WING AIRCRAFT (AIR TANKERS) – Aircraft designed for the purpose of picking up and depositing fire retardant on a fire while in mid-air.

FUEL MODIFICATION – Modification and irrigation of combustible vegetation to reduce fuel energy output. Highly flammable wildland vegetation is replaced with managed areas of light or fire resistive fuels and thereby allowing firefighters the ability to control a fire while relatively small.

FUELS – Combustible material or vegetation.

GREY BOOK – Agreement between CAL FIRE and the six contract counties that addresses direct fire protection of State Responsibility Area (SRA) within each of the contract counties. Orange County, along with the other contract counties, receives funding from the state to provide protection to the SRA

HANDCREW – Team of wildland firefighters primarily assigned to fire line construction activities. Handcrews also mop up hot-spots, burn out vegetation to provide fuel free zones, and assist with hose lays.

HIGH WATERSHED DISPATCH – Level of dispatching ensuring the appropriate type and number of wildland firefighting resources based on current weather conditions.

INCIDENT COMMAND SYSTEM (ICS) – Standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

INCIDENT COMMANDER – ICS position responsible for overall management of the incident. Reports to the Agency Administrator for the agency having incident jurisdiction.

INCIDENT MANAGEMENT TEAM (IMT) – Incident commander and appropriate general and command staff personnel assigned to an incident. Also known as an Incident Command Team.

INITIAL ATTACK (IA) – Aggressive suppression action taken by first arriving resources with the priorities of protecting life, property, and the environment.

INTERFACE ZONE – Area where the wildland comes together with the urban areas. This is often referred to as the I-Zone or the Wildland Urban Interface (WUI).

MASTER MUTUAL AID SYSTEM – Creates a formal structure in which a jurisdictions

personnel, facilities, and equipment can voluntarily assist other jurisdictions when capabilities are overwhelmed.

MASTER STREAM – Controllable, high-capacity water jet used for manual firefighting or automatic fire protection systems; also known as a monitor, deluge gun, or deck gun.

MUTUAL THREAT ZONE – Area in which two or more jurisdictions have responsibility to protect in case of a fire, flood, or other emergency.

OFFENSIVE ATTACK – Putting water directly on the flames with the intent to extinguish.

OFFICE OF EMERGENCY SERVICES (OES) – The California Governor's Office of the Emergency Services.

PATROL UNIT – OCFA fire apparatus designed for wildland firefighting built on a heavy-duty passenger crew-cab truck chassis. It carries 100 gallons of water in a pressurized tank. OCFA Patrols are assigned to fire stations adjacent to wildland interface areas.

RATE OF SPREAD (ROS) – Relative activity of a fire as it extends from the point of origin and the total perimeter of the fire. Usually expressed in acres per hour.

RED FLAG WARNING – Term used by fire weather forecasters to alert users to an ongoing or imminent critical fire weather pattern.

REGIONAL ORDERING SUPPORT SYSTEM (ROSS) – Computer software program, which automates the resource ordering, status, and reporting process during a wildfire; tracks all tactical, logistical, service, and support resources mobilized by the incident dispatch community.

REHABILITATION – Activities necessary to repair damage or disturbance caused by wildfire or the wildfire suppression activity.

REKINDLED – Act of catching on fire once again; usually caused by a fire not fully extinguished.

RIPARIAN AREA – Interface between land and a stream—usually an ecological area with the abundance of both plants and animals.

SANTA ANA WINDS – Type of Foehn wind—a warm, dry, and strong general wind that flowing down into the valleys when stable, high pressure air is forced across and then down the lee side slopes of a mountain range. The descending air is warmed and dried due to adiabatic compression producing critical fire weather conditions. Locally, it is called by various names such as Santa Ana and Sundowner winds.

SOUTH OPS – Formally known as the Southern California Geographic Area Coordination Center (OSCC), it is the focal point for coordinating the mobilization of resources for wildland fire and other incidents throughout the Geographic Area. Located in Riverside, the Center also provides Intelligence and Predictive Services.

SPECIAL STAFFING – Persons put in place on assigned fire apparatus in addition to the normal staffing—usually done in case of an emergency such as a fire, wind event, or flood.

SPIKE CAMP – Remote camp usually near a fireline and lacking the logistical support a larger fire camp would have.

SPOT FIRE OR SPOTTING – Small fire ahead of the main fire—caused by hot embers being carried (generally by winds) to a receptive fuel bed or structure. Spotting indicates extreme fire conditions.

STATE RESPONSIBILITY AREA (SRA) – The California Board of Forestry and Fire Protection classifies areas in which the primary financial responsibility for preventing and suppressing fires is that of the state. CAL FIRE has SRA responsibility for the protection of over 31 million acres of California's privately-owned wildlands.

STRIKE TEAM – Engine strike team consisting of five fire engines of the same type and a lead vehicle. Strike team leaders are usually a Captain or a Battalion Chief. Strike teams can also be made up of bulldozers and handcrews. A strike team comprised of structure engines is designated with the letter "A"; i.e., 1400A. A strike team comprised of wildland engines is designated with the letter "C"; e.g., 9329C.

STRUCTURE PROTECTION GROUP – Two or more fire apparatus capable of pumping water for the purpose of preventing homes in a designated area from being burned by wildfire nearby.

UNIFIED COMMAND – Unified team effort allowing all agencies with jurisdictional responsibility for the incident, either geographical or functional, to manage an incident by establishing a common set of incident objectives and strategies.

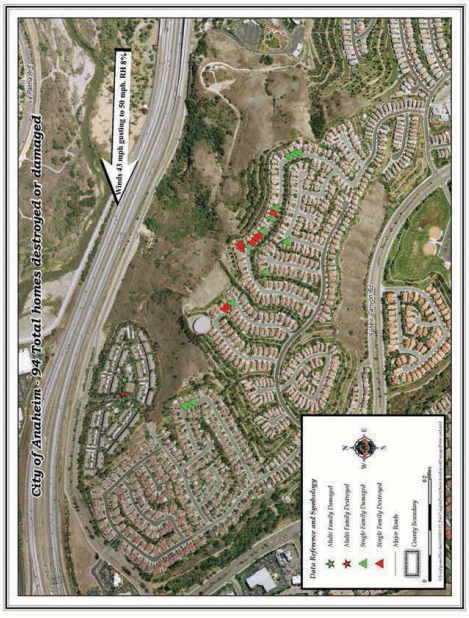
WATER TENDER – Specialized firefighting apparatus capable of transporting a minimum of 1,000 gallons of water from a water source directly to the fire scene.

WILDLAND ENGINE (Type 3) – Fire engines designed for the wildland firefighting environment. Constructed on heavy-duty commercial truck chassis with high ground clearance and often equipped with four wheel drive. Type 3 engines carry 500 gallons of water and have a minimum pump capacity of 120 gpm at 250 psi.

WILDLAND URBAN INTERFACE (WUI) – Line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

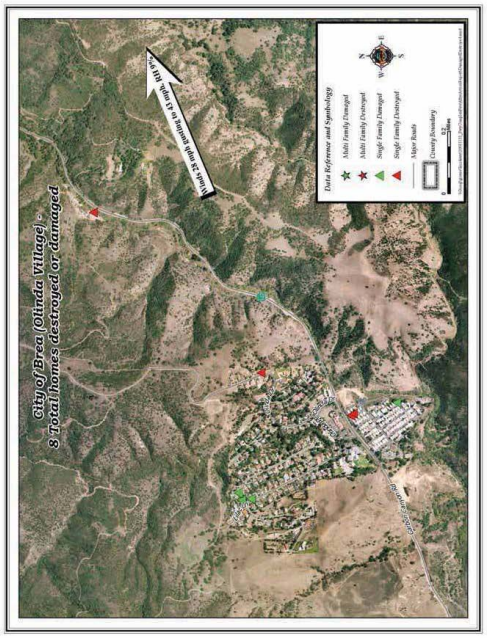
Appendix Homes Destroyed or Damaged

Map 16: City of Anaheim—Homes Destroyed or Damaged



Freeway Complex Fire – November 2008

Map 17: City of Brea—Homes Destroyed or Damaged



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Freeway Complex Fire – November 2008

Map 18: City of Corona—Homes Destroyed of Damaged

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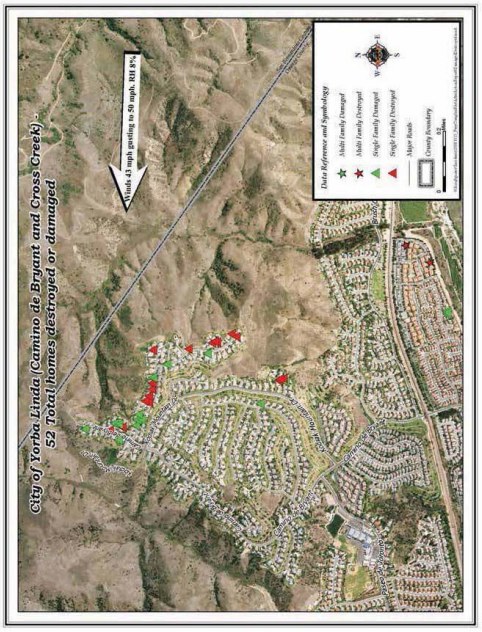
Freeway Complex Fire – November 2008

Map 19: City of Yorba Linda—Camino de Bryant and Cross Creek



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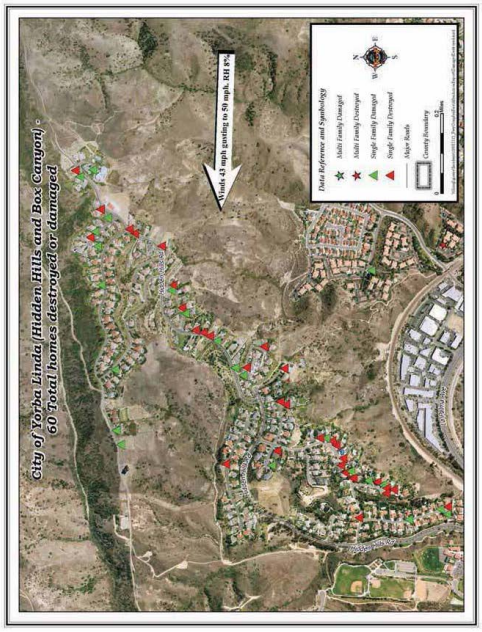
Freeway Complex Fire – November 2008

Map 20: City of Yorba Linda—Hidden Hills and Box Canyon



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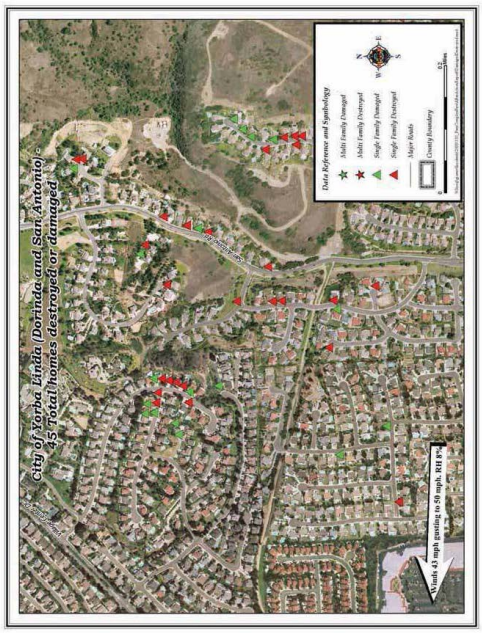
Freeway Complex Fire – November 2008

Map 21: City of Yorba Linda—Dorinda and San Antonio



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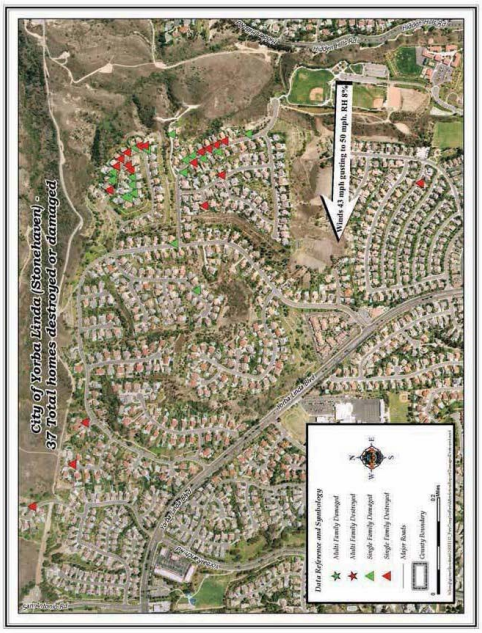
Map 22: City of Yorba Linda—Stonehaven



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Acknowledgements

A work of this type cannot be put together without the help and support of many people. The development and writing of this After Action Report has been a collaboration, drawing on the time and talents of personnel from every department within the OCFA. It is not possible to name every individual who played a role in the development of this document; however, it is appropriate to mention some of the key tasks and to thank those who are responsible for the the final outcome.

The following are thanked and commended for their contributions to this project. Those who completed After Action Surveys and documented their actions and observations. The Team Leaders who coordinated the gathering of information and compiling of data. The OCFA members who went into the impacted communities and spoke with residents and evaluated the damage to ensure accurate save and loss data. Those who listened to hours upon hours of radio traffic and phone calls to capture fire ground activity. The writers of the various report sections, and then to those who edited and proof read the Report over and over until it was just right. Technical specialists who created maps, charts, pictures, and graphics to support and to make the writing come alive. Allied agencies who provided critical review and submitted to interviews to ensure all actions were taken into account. Managers who provided oversight and ensured that personnel were always available to assist at a moment's notice and to those employees who had to carry an extra load so that a co-worker was able to help with the development of this document. The detail oriented people who worked on the layout of the final document, ensuring that indexes, pages and tabs all corresponded to each other. The OCFA Board Members and elected officials who took the time to provide critical review and commentary to ensure anticipated questions would be answered. The highly talented experts who worked to incorporate available technology to support the written document with an audio-visual record. The consultants and vendors who provided needed technical support, review, and publication of the final document.

A special thank you is extended to all those who responded to or supported the fire fighting and recovery actions that took place between 9:00 a.m. on November 15, and 7:00 a.m. November 19, 2008. The Fire Chief and the Executive Management Team are equally thanked for their leadership and guidance.

A most important thank you to the readers of this Report, who by taking time to study the actions and outcomes of the Freeway Complex Fire will be better prepared to respond to, support and manage emergency incidents that threaten communities, disrupt lives, and consume natural and financial resources.

A final thank you and acknowledgment to all of the citizens who were affected by the Freeway Complex Fire. The men and women of the Orange County Fire Authority sincerely thank you for allowing us to be your fire department.

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FIRE ORANGE COUNTY CALIFORNIA AUTHORITY Est. 1995

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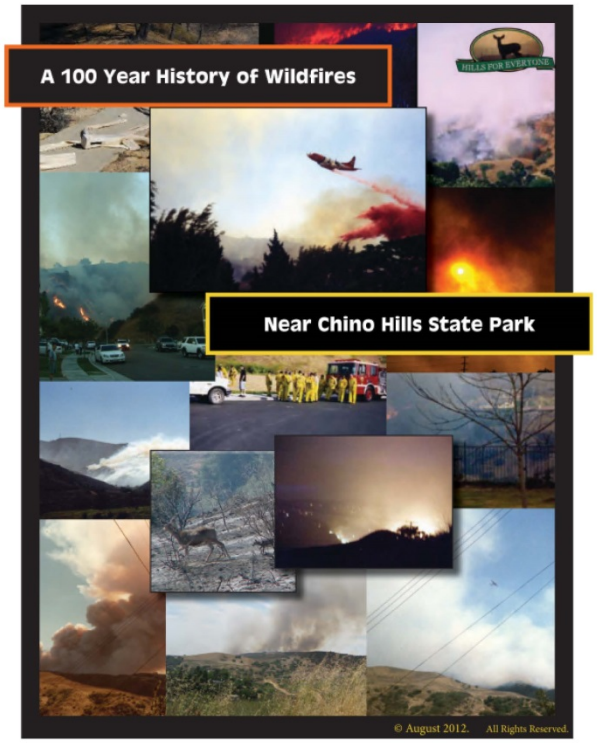
EXHIBIT G



HILLS FOR EVERYONE

Hills For Everyone (HFE) was formed in 1977 to protect, preserve, and restore the environmental resources and natural environs of the Puente-Chino Hills. These hills lie at the juncture of Southern California's four most populous counties: Orange, Los Angeles, Riverside, and San Bernardino. Our first goal was the creation of Chino Hills State Park which now covers 14,100 acres near the Cities of Anaheim, Brea, Yorba Linda, Corona, and Chino Hills.

While advocating for acquisition funding at the state level and receiving bipartisan support, volunteers also became involved in planning processes and land use decisions of local governments. Even today, HFE opposes projects that damage the still evolving Park and supports decisions that protect it.

With our increased understanding of the principles of conservation biology and the need to save large habitat to preserve the region's rich biodiversity, HFE began working with open space advocates on the western side of the hills in Whittier who had already saved 4,000 acres. Our goal now is to link the remaining critical parcels of undeveloped land across the Puente-Chino Hills Wildlife Corridor to provide a backdrop and backbone of open space for this highly urbanized region.

The Fire Research Study

This document "**A 100 Year Fire History Near Chino Hills State Park**" can be downloaded for free from HFE's website at: *http://www.HillsForEveryone.org/projects/fire-study.html*. Digital datasets viewable in Google Earth are also available for download on that page.

Copyright and the Right to Reproduce

Data Sharing

With an appropriate datasharing agreement in place HFE will share, at its discretion, its fire data from this study in GIS format with non-profits, local jurisdictions, and agencies. Please contact us to learn more or request the data from this study at: *FireStudy@HillsForEveryone.org*.

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ABSTRACT

After witnessing the devastation of the Freeway Complex Fire, the regional conservation non-profit Hills For Everyone undertook a study of fires in the region. Though fires are a natural part of the ecosystem, there is nothing natural about the size and frequency of the fires destroying our wildlands year after year. Data, mainly from fire agencies, the California Department of Parks and Recreation, and newspapers, have provided details on fire perimeters, points of origin, and fire causes. This paper is the culmination of research that documents a near 100-year fire history (1914-2011) in and around Chino Hills State Park. This paper articulates the problem months, weather conditions, and "hot spots" of fire ignition. Recommendations are included for residents, jurisdictions, and fire, transportation, and natural resource agencies to implement that would reduce the number of fires to a more natural fire regime. We will continue to work with fire and natural resource agencies to bring the necessary resources to this area.

INTRODUCTION

Fires are a natural part of the ecosystem. Many factors influence the natural fire regime: weather conditions, vegetation (fuel) types, vegetation moisture, and plant distribution, etc. The natural fire regime, however, has been drastically altered by humans who have caused many more fires than would have occurred naturally. "New" factors influencing this increased fire regime include the introduction and proliferation of flammable non-native vegetation (e.g., palm trees, pampas grass, *Arundo donax*, exotic annual grasslands, etc.), increased Wildland-Urban Interface (WUI), and roadways to name a few.

An article on global warming on the website of the State of California's Attorney General cites higher temperatures and decreased moisture in the vegetation will result in increased fires.[1] In fact, statistics show that the western United States now has a longer fire season (starting earlier and ending later) that is more intense than in previous decades.[2] A nearby example of a California landscape modified by wildfires is Chino Hills State Park in Southern California, where the dominant coastal sage scrub and chaparral vegetation is converting to highly flammable non-native annual grasses.[3]


Claire Schlotterbeck, Harold (2009)

Type conversion as seen after one fire.


Claire Schlotterbeck, Harold (2012)

In 2003 Southern California experienced 13 major wildland fires that swept through the region at an alarming rate.[4] The Cedar Fire (San Diego) was called the state's most devastating as it burned down entire communities, including historic buildings in Cuyamaca, and killed 15 people.[5] In 2007 the Santiago Fire (Orange County) burned 28,517 acres in the foothills of the Santa Ana Mountains, which damaged or destroyed 22 homes.[6] Just a year later, in 2008, two fires ignited at opposite ends of the hills and merged to create the Freeway Complex Fire which burned down 187 homes, damaged another 131 homes and other structures, burned 95% of Chino Hills State Park, and scorched a four-county region.[7]

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[1] Department of Justice. "Global Warming Impacts in California." Retrieved 28 Dec 2011 from the California Attorney General's website: http://www.ag.ca.gov/globalwarming/impact.php.

[2] Ibid.

[3] Ing, Alissa. Environmental Scientist, Department of Parks and Recreation. Personal communication approximately June 2010.

[4] CNN. "California Wildfires Burn Through 600,000 Acres." Retrieved 28 Dec 2011 from the CNN website: http://articles.cnn.com/2003-10-28/us/california.wildfire_1_blazes-cuyamaca-and-julian-firefighters?_s=PM:US.

[5] Ibid.

[6] Orange County Fire Authority. After Action Report: Santiago Fire. Retrieved 3 Aug 2012, from the OCFA website: http://www.ocfa.org/_uploads/pdf/aar_3-27-08.pdf.

[7] Fire Department Network News. "Orange County Fire Authority Declares Full Containment Today of Triangle Complex Fire." Retrieved 3 Aug 2012 from the Fire Department Network News website: http://www.fdnn.com/news.asp?Q_articleID_E_1868_A_title_E_Orange_County_Fire_Authority_Declares_Full_Containment_Today_of_Triangle_Complex_Fire.

After completing a lengthy review of the fires throughout the Chino Hills area, it is now known that the State Park and neighboring hillsides have experienced more than 100 fires in just as many years, though most of the fires have occurred since 1977. As a result of this information, conservation advocates are working with fire, transportation, and natural resource agencies to protect the landscape from continued wildfire assaults. Together through protective mitigation measures that can reduce the fire frequency toward a more natural fire regime, this approach will protect life and property, and ensure our human and natural communities are safer.

Chino Hills State Park — The Setting

The State Park sits at the juncture of four of Southern California's most urbanized counties: Los Angeles, Orange, Riverside, and San Bernardino. The Park has been assembled through more than 30 different acquisitions to grow to more than 14,100 acres. The Park's first acquisition was in 1981 and even 30 years later the Park continues to expand. Chino Hills State Park was secured to protect its many rare natural resources. Its gently rolling hills are covered in grasslands and dotted with oak and walnut trees. In the steep canyons of the interior, sycamore-lined streams and walnut woodlands abound.

Figure 1. *Chino Hills State Park is located at the juncture of four Southern California counties.*

In 1771 the area was used for extensive grazing operations and by the early 1870s individuals began purchasing the land and using it for sheep and cattle ranching.[8] This grazing damaged the native plants and allowed opportunistic non-natives to spread. Now that the land is protected as a State Park, the grazing has been stopped and habitat restoration is underway.

The Park protects five main plant communities: southern oak woodland (11%), native and non-native grasslands (70%), coastal sage scrub (13%), mixed chaparral (5%), and cottonwood riparian woodland and riparian zones (1%).[9] In fact, the Park "supports 14 different vegetation series defined in the California Native Plant Society's classification,"[10] and 10 are considered unique or significant in Southern California because of their importance as habitat and because they are rapidly disappearing due to development.[11] The State Park contains some of the best remaining stands of walnut woodlands in Southern California. Similarly, the northern most stand of the rare tecate cypress tree is found in Coal Canyon in the State Park and neighboring Ecological Reserve.

[8] Department of Parks and Recreation. Chino Hills State Park General Plan. February 1999.
[9] Department of Parks and Recreation. Chino Hills State Park General Plan. August 1986. p. 21.
[10] Department of Parks and Recreation. Chino Hills State Park General Plan. (1999). p. 21.
[11] Ibid.

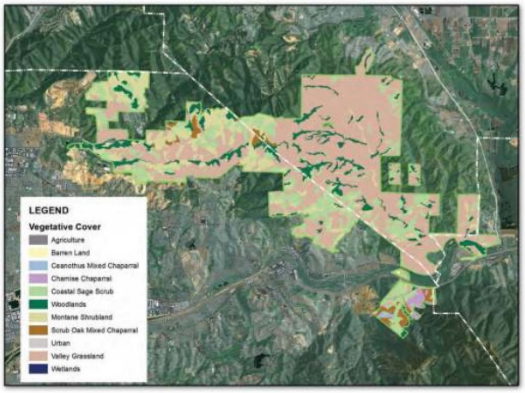

Figure 2. *Chino Hills State Park's vegetative cover provided by USDA Forest Service (EVEG Data) from 2002-2003.*

A wide variety of wildlife depend on the vegetative cover. Deer, bobcats, foxes, coyotes, raccoons, and the occasional mountain lion live in the hills. Falcons, hawks, owls, songbirds, and even golden eagles are protected in the Park. Several endangered birds are making a comeback as well.

Bicyclists, hikers, equestrians, photographers, campers, and other park enthusiasts frequent this natural area.

Ron Kruspe: Coal Canyon Underpass (2005)

Hills For Everyone (HFE), a regional non-profit conservation organization, founded Chino Hills State Park in the early 1980s and has been working over the last 30 years to connect and protect this anchor parcel with protected lands in the Puente-Chino Hills Wildlife Corridor. Due to the work of HFE and State Parks, along with many other non-profits, agencies, and jurisdictions, a permanent connection at Coal Canyon was secured in 2001. Coal Canyon links the Trabuco District of the Cleveland National Forest in the Santa Ana Mountains with Chino Hills State Park and the greater Puente-Chino Hills ecosystem. This linkage provides a critical connection that allows wildlife to move freely between the Santa Ana Mountains and the Puente-Chino Hills. It also provides a source to repopulate natural areas should a catastrophic event, like a fire or disease outbreak, occur.

THE STUDY

After three decades of witnessing fires race through the hills and, in the aftermath of the 2008 Freeway Complex Fire which devastated the State Park, HFE launched a study to try to understand why so many fires burned in or adjacent to the State Park and to see if any actions could be taken to reduce the number of fires, resulting in the protection of both houses and natural resources. The study has resulted in the digital history of more than 100 fires that have burned between 1914 and 2011.

The Study Area includes lands generally bounded on the west by the 57 Freeway, Grand Avenue to the north, the 71 Freeway to the east, and the 91 Freeway to the south. The region studied includes all of Chino Hills State Park, but due to the proximity of other protected natural lands, portions of the northern section of the Cleveland National Forest's Trabuco District, the northern portion of the Irvine Ranch Lands (OC Parks), and the Prado Wetlands were also reviewed. Numerous private ownerships in Orange, Riverside, San Bernardino, and Los Angeles Counties that abut these protected lands were also included due to proximity.

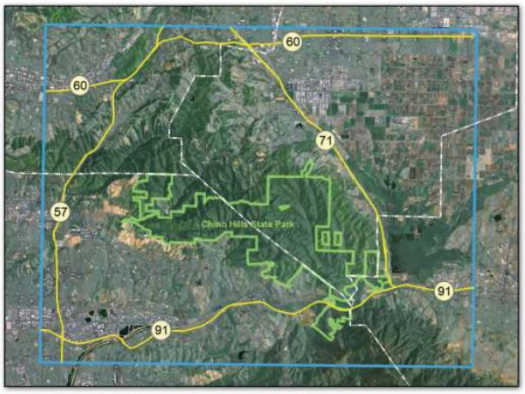

Figure 3. *The Study Area, shown in blue, includes Chino Hills State Park and surrounding hillsides.*

HFE had three main objectives in carrying out this study:

1. Using the data available document the fire perimeters, points of origin, causes, and weather conditions for each fire that burned in, adjacent to, or near Chino Hills State Park;
2. Analyze the results of the research and determine any fire-prone areas that needed particular attention; and
3. Provide general recommendations for residents and agencies to reduce the number of fires and impacts associated with wildland fires, and concurrently protect homes, people, and parkland from unnaturally frequent fires.

There are important terms used throughout this study and their meaning is useful to understand:

Cause: The confirmed or unconfirmed source of the wildland fire's ignition.

Fire Perimeter: The farthest geographical extent, also known as the outer boundary, of a fire. Note: Not all areas within the perimeter necessarily burned.

Fire Frequency: The number of times a specific geographic region has burned. This is similar to how population density is displayed, the darker the color the more frequent the area has burned.

Natural Fire Regime: The general classification of the role fire would play in the natural environment in the absence of modern human intervention.

Point of Origin: The approximate or exact location where the wildland fire ignited within the Study Area.

Study Area: Chino Hills State Park and environs.

Wildland-Urban Interface (WUI): The boundary between developed regions and the natural wildland areas.

Nancy Clifton Hawkes, Freeway Complex Fire (11/08)

Information Sources and GIS Analysis

HFE secured the shapefiles (digital data sets) of fire perimeters and points of origin from the California Department of Forestry and Fire Protection (CalFire), the Orange County Fire Authority (OCFA), and Chino Valley Independent Fire District (CVFD). Where appropriate, newspaper articles/maps, State Park Wildland Fire Reports, and personal accounts were used to digitally create a fire perimeter and/or point of origin. HFE used the ArcMap 10.1, a geographic information system (GIS) program, to assimilate the fire data. To enable wide distribution, the files were exported from ArcMap for use in Google Earth.

Through this research, HFE was able to piece together a digital dataset that outlines where known fires burned and where, and in some cases why, the fires started. Unfortunately, not all fires that burned in the Study Area were formally documented or no details about the perimeter or point of origin were complete enough to include in the study. Consequently, there are actually many additional fires that were not included in the study due to lack of adequate data. Historic record keeping for wildland fires wasn't as complete as it is now.

Fire Regime

HFE analyzed the fire regime (both natural and human-caused) of all documented fires that burned in, adjacent to, or had the potential to burn into Chino Hills State Park from 1914 – 2011. It seems in that 97 year history only two fires occurred naturally due to lightning strikes. This means the natural fire regime was one fire every 50 years. The balance of the fires (101) was caused by humans, either intentionally or unintentionally.

Fire Perimeters

HFE accumulated 71 separate fire perimeters in this study with 37 of those fires having known points of origin. The smallest fire is less than one acre, while the largest is over 41,000 acres.

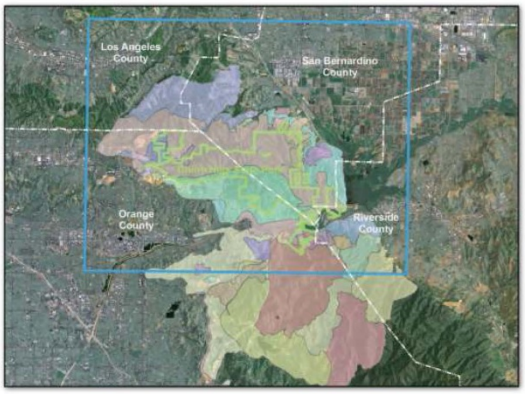

Figure 4. *The Study Area included 71 fire perimeters between 1914 - 2011.*

The three largest fires from the study include:

- Green River Fire - 41,285 acres
  November 1948
- Paseo Grande Fire - 39,872 acres
  October 1967
- Freeway Complex Fire - 30,306 acres
  November 2008

The first acquisition of parkland occurred in 1981 and since that date there has been increased pressure from residential development and road creation or expansions that have increased access to the undeveloped hills and the Park. It appears that the added housing developments at the WUI surrounding the Park have increased threefold the number of fires burning the Park. There were 26 fires between 1914-1980 and 76 fires between 1981-2011.

Claire Schlotterbeck, Freeway Complex Fire (11/08)

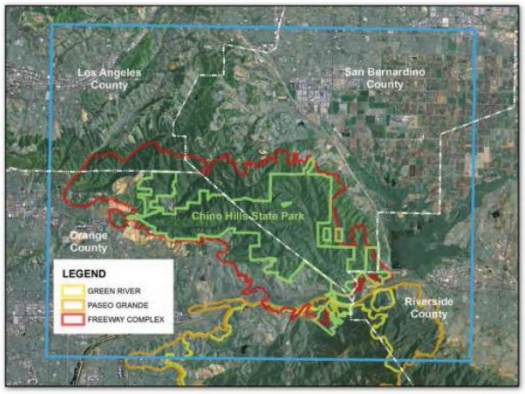

Figure 5. *The Study Area's three largest fires included the Green River, Paseo Grande, and Freeway Complex Fires.*

Fire Points of Origin

HFE documented 70 separate fire points of origin in this study, with 37 of the fires having known perimeters. The smallest fires are less than one acre in size, while the largest with a known point of origin is over 38,000 acres.

Claire Schlotterbeck, Green Fire (1914)

Claire Schlotterbeck, Corbin-Craven Fire (1919)

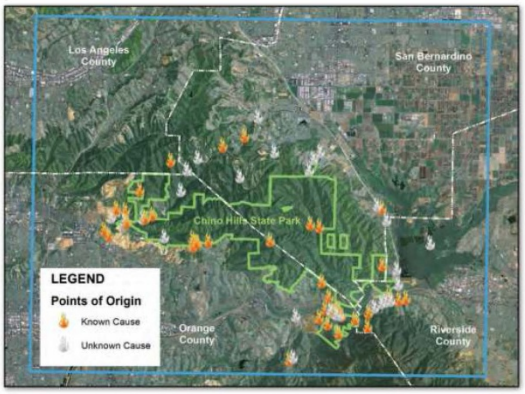

Figure 6. *The Study Area included 70 points of origin between 1914 - 2011, with some known causes and some unknown.*

The points of origin data indicate fires started due to a variety of causes. They are broken down as follows:

Table 1. *Fire causes, quantities, and total acreage burned.*

Cause	Number of Fires	Total Acreage Burned
Unknown	29	83,405*
Arson	9	9,349*
Power lines	7	53,048
Automobile	7	30,357*
Fireworks	5	10,316
Plane Crashes	5	829*
Machinery	4	393
Fire Agency**	2	14,150
Lightning	2	734
Total:	70	202,599*

* indicates some acreages are unknown and therefore the number is actually higher than shown.
** indicates a re-ignited prescribed burn.

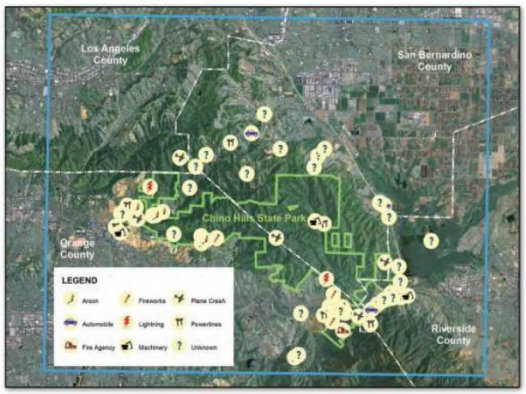

Figure 7. *The fire causes have been broken down into different categories with arson, power lines, and automobiles as the three main causes.*

Obtaining historic fire records was an issue during this study as 29 of the fires researched did not have a known or confirmed cause. The top three most identifiable causes of wildland fires in the Study Area are: arson, power lines, and automobiles.

Fire Frequency

By overlapping all the fire perimeters, HFE was able to determine the fire frequency in the Study Area. The lightest color on the map indicates that area only burned once. Whereas the darkest color on the map, a maroon color, indicates the area burned six or more times.

When one looks at the fire frequency and the points of origin there are obvious locations that have burned repeatedly. The data show the 91 Freeway Corridor (Santa Ana Canyon) between Anaheim and Corona, Carbon Canyon in Brea, and the Rim Crest entrance to Chino Hills State Park in Yorba Linda have burned the most. Later in this report, HFE will provide general recommendations for potential proactive steps to reduce the fire frequency at these known "hotspots."

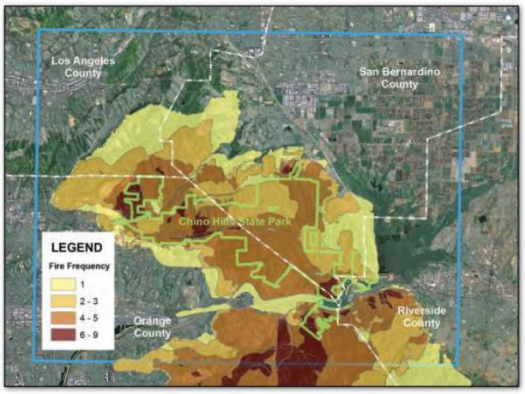

Figure 8. *The fire frequency shows three "hotspots:" the 91 Freeway Corridor, Carbon Canyon, and Rim Crest.*

Fires and weather Patterns

The prevailing wind for this region is a westerly onshore flow and the majority of the fires occur during those normal conditions. The Santa Ana Winds (which come from the east/northeast) are the exception and as these winds tend to be hot and dry, fires that start under these extreme conditions have a tendency to get out of hand. The relative humidity and temperature play a significant role in reducing the fuel moisture in the vegetation, especially the fine dead fuel (such as annual grasses and mustard). It was noted in the After Action Report for the Freeway Complex Fire that due to the winds (gusts above 60 mph) and heat, "over 10,000 acres were consumed in the first 12 hours—roughly 14 acres per minute. That's nearly the length of 14 football fields every 60 seconds."[32] Consequently, Santa Ana Wind events are known for helping spread the fires and therefore require expanded and rapid fire protection presence.

Briefly, the foehn winds, known locally as Santa Ana Winds, are caused when high pressure systems sit inland and a low pressure system sits off the coast. In our area, the foehn/Santa Ana Winds are generated when the high pressure system is positioned over the high desert (Mojave and Great Basin). The winds blow from the southern side of the high pressure system toward the low pressure system over the Pacific Ocean. Typically they are hot and dry with a very low relative humidity (10-20%).[33] This is due to the compression of the wind after going up and over the mountains. Relative humidity indicates the ratio between the moisture in the air and the amount of moisture needed to saturate the air—it is a function of both moisture and temperature. Moisture in vegetation can be rapidly depleted in Santa Ana Wind conditions. Generally the finer the vegetation (grass) the quicker it dries out compared to a mature oak tree with a thick bark and a thick trunk.

Also researched were the weather patterns from the fires included in the study. Weather Underground and The Weather Channel websites were used to collect the data, using Chino Hills as the location. HFE was unable to obtain weather data before 1977.

Table 2. *Weather features during fire events.*

Weather Features on Fire Days		
Average Temperature was: (Data was available for 58 fires)	90°F	
Average Relative Humidity was: (Data was available for 34 fires)	51%	
Average Wind Speed was: (Data was available for 78 fires)	6 mph	
Average Wind Gusts were: (Data was available for 26 fires)	28 mph	
Wind Direction was: (The direction the wind originates from) (Data was available for 78 fires)	North (N, NE, NW)	11 fires
	East (E, ENE, ESE)	6 fires
	South (S, SE, SW)	16 fires
	West (W, WNW, WSW)	45 fires

[32] Orange County Fire Authority. After Action Report: Freeway Complex Fire. November 15, 2008. Retrieved 3 Aug 2012 from the OCFA website: http://www.ocfa.org/_uploaddocs/ar_freeway.pdf

[33] National Oceanic and Atmospheric Administration. "Santa Ana Conditions - Southern California." Retrieved 20 June 2012 from the National Oceanic and Atmospheric Administration website: http://www.noaanews.noaa.gov/stories/santa_ana.pdf.

Fires and Seasonal Patterns

It is not surprising that in the hotter, drier months between May and November there are more fires than in the moister winter months between December and April. There is a clear correlation between fire frequency and the summer months as seen in the table below. The majority of fires occur in July. However, October and November have the largest average acres burned. This is likely due to the fact that this is the end of the dry season and these months are prone to Santa Ana Wind conditions.

Table 3. *Fires by month, acreage burned, and average acreage burned.*

Month	Known Fires	Total Acreage Burned	Average Acreage Burned
Unknown	10	18,526*	2,058** (9 fires)
January	2	175*	175** (1 fire)
February	2	12,740	6,370
March	3	1,628*	814** (2 fires)
April	3	926	309
May	7	188	27
June	10	8,958	896
July	22	18,386*	919** (20 fires)
August	10	2,685*	298** (9 fires)
September	11	5,529*	614** (9 fires)
October	11	85,407*	8,541** (10 fires)
November	10	97,526	9,753
December	2	4*	4** (1 fire)
Total:	103	252,678*	2,717** (93 fires)

* indicates some acreages are unknown and therefore the number is actually higher than shown.
** indicates acreages were averaged only where known fire acreages existed; if a fire acreage was unknown the fire was left out of the average.

CASE STUDY - THE 2008 FREEWAY COMPLEX FIRE

The power of zoning carries with it the responsibility for consequences.

Claire Schlotterbeck, Freeway Complex Fire (11:08)

The City of Yorba Linda has developed rapidly over the last 40 years. The data shows that Yorba Linda's population of 29,847 in 1980[14] had grown to 64,234 by 2011.[15] Despite the fact that many of the homes are relatively new and include fuel modification zones and other "ignition resistant" construction for the WUI, there was a tremendous loss of property in the 2008 Freeway Complex Fire. This case study outlines some of the fire statistics, anecdotes from Yorba Linda residents, and summarizes key points from the OCFA After Action Report.

The Freeway Complex Fire

On November 15, 2008 two fires started on opposite ends of the hills about two hours apart. The first fire ignited near the 91 Freeway on the eastern side of the hills in Corona by an automobile exhaust catching dry brush on fire, while the second fire began nearly 11 miles away to the northwest, in Brea, due to an unmaintained power line that also ignited dry brush.[16]

The weather conditions were ideal for a fire: 91°F, 4% relative humidity, sustained wind gusts at 35 mph (OCFA reports 43 mph with gusts at 60+ mph) coming from the northeast (a Santa Ana Wind event).[17] Due to the extreme weather conditions OCFA had ramped up its crews in the days preceding the fire.[18]

[14] City Data. "Yorba Linda, California." Retrieved 31 Jul 2012 from the City Data website: http://www.city-data.com/city/Yorba-Linda-California.html.

[15] United States Census Bureau. "State and County Quick Facts." Retrieved 31 Jul 2012 from the U.S. Census Bureau website: http://quickfacts.census.gov/qfd/states/06/0686212.html.

[16] Orange County Fire Authority. Freeway Complex Fire - After Action Report.

[17] Weather Underground. "Fullerton Weather Station." Retrieved 1 Aug 2012 from the Weather Underground website: http://www.wunderground.com/history/airport/KFUL/2008/11/15/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA.

[18] Orange County Fire Authority. Freeway Complex Fire - After Action Report.

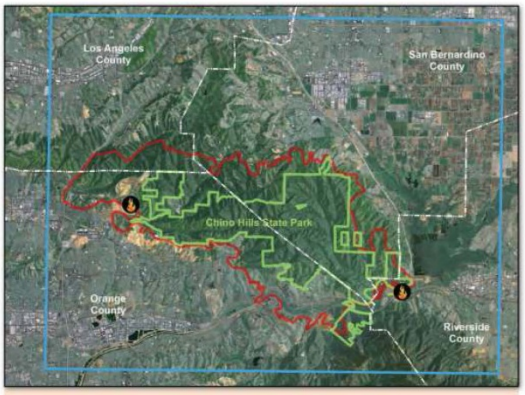

Figure 9. *The red outline indicates the fire perimeter for the Freeway Complex Fire of 2008 with its two points of origin.*

The Initial Timeline

The Corona Fire was reported at 9:01 AM. The first Orange County strike team arrived at 9:23 AM, and the first air assaults began at 10:10 AM. By 10:20 AM, OCFA reported the fire would reach the City of Yorba Linda within 30 minutes. The first 911 call to report the Brea fire arrived at 10:43 AM.[19] A personal account from a 911 caller revealed the dispatcher dismissed the notion that a new fire had started in Brea, stating the smoke the caller was seeing was from the Corona blaze. The caller relayed that flames could be seen from Carbon Canyon Road (in Brea), which is no where near the Corona blaze.

Nicholas Stokkin, Freeway Complex Fire (1:12:16)

[19] Ibid.

Firefighting crews arrived on scene for the Olinda Landfill Fire by 10:55 AM.[20] The presence of this second fire, which immediately threatened homes, shifted the firefighting strategy. By 10:58 AM Yorba Linda's first home had already been destroyed.[21]

Yorba Linda on Fire

With many residents at home on a Saturday morning, they were witness to the quick moving Corona Fire. Residents began self evacuating and quickly clogged traffic on the major thoroughfares. Evacuees streamed down from the higher elevations making it harder for those closest to the thoroughfares to enter the traffic flow. The flood of cars brought the main east-west traffic corridors of Imperial Highway and Yorba Linda Boulevard to a standstill. In addition, due to the Corona fire, traffic was stopped on the other east-west corridor, the 91 Freeway. Fire trucks struggled to get to the fire as residents struggled to leave from the oncoming flames.[22]

> *"The fire moved through residential neighborhoods from Brush Canyon to the San Antonio neighborhood—a 5.5 mile span in less than five hours."*
> *— OCFA After Action Report, p. 36*

Bob Kanne, Freeway Complex Fire (1:12:08)

Anecdotal accounts from Yorba Linda residents describe the chaos of trying to evacuate during the firestorm. One resident stated, "people can't get out on San Antonio... [it was] a huge, huge traffic jam."[23] When exiting their neighborhoods they also hit gridlock on the major arterial of Yorba Linda Boulevard. One resident who lost his home had no time to even drive his cars out of the driveway. With no car to drive, he ended up directing traffic at Via Del Agua and Yorba Linda Boulevard. Evacuees from his neighborhood couldn't leave because there was no traffic signal to stop the flow of traffic.

A Predictable Disaster

This disaster was predictable since large fires on Santa Ana Wind days on east-west trending terrain have occurred over and over again. Land use decisions in the City of Yorba Linda may have contributed to placing residents, their homes, and businesses at risk. In late 2002 the City of Yorba Linda approved the Shapell project which allowed a threefold increase over the General Plan density.[24] It is uncertain whether mitigations for traffic impacts on major thoroughfares, in times of emergency, were adequate.

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] The Weather Channel (Producer). Weathering Disaster: "Yorba Linda Fires" (Episode). (24 Sep 2011). Yorba Linda, CA: The Weather Channel.

[24] Los Angeles Times. "Yorba Linda Seeks to Rescind Development Vote." 5 Dec 2002. Retrieved 2 Aug 2012 from the Los Angeles Times website: http://articles.latimes.com/2002/dec/05/local/me-yorba5.

Melanie Schlotterbeck, Yorba Linda Twilight (12:08)

The Freeway Complex Fire burned down 187 homes, damaged another 131 homes and other structures[25] and burned 95% of Chino Hills State Park. According to the OCFA After Action Report: The Freeway Complex Fire burned "30,305 acres of watershed ... across six cities and four counties. [Fire] [s]uppression costs exceeded $16.1 million, and property loss has been estimated at nearly $150 million."[26]

Lessons Learned

If there are lessons to be learned, it seems there are opportunities for jurisdictions to revisit how their communities grow and where the most appropriate place for housing developments should be located. Cities and homeowners' associations must maintain defensible space at the WUI, buffering the homes from the edge of the WUI. When cities increase the density of a housing development but do not adequately increase the road capacity on arterials, evacuations during a fire storm are difficult, dangerous, and potentially disastrous.

Bob Kanne, Freeway Complex (1:12:08)

Even with more stringent building codes and relatively new houses, hundreds of homes were lost or damaged. According to Kris Concepcion of OCFA, "embers were getting into the attics of homes."[27] It seems there is still work to be done to harden homes from both flame fronts and ember storms. Most importantly, fleeing residents need to be able to evacuate safely.

[25] Fire Department Network News. "Orange County Fire Authority Declares Full Containment Today of Triangle Complex Fire."

[26] Orange County Fire Authority. Freeway Complex Fire - After Action Report. p. 28.

[27] The Weather Channel. Weathering Disaster: "Yorba Linda Fires" (Episode).

Freeway Complex Fire Photos (11/08)








RECOMMENDATIONS

The data demonstrate that there are three "hotspots" in the Study Area that show a propensity to burn: Santa Ana Canyon, Carbon Canyon, and Rim Crest. With that in mind HFE developed several suggestions for possible adoption by transportation and fire agencies, State Parks, cities, and homeowners. We recognize that these recommendations require appropriate staffing and reliable funding. HFE is willing to help develop the political will and partner on implementing these recommendations.

General Recommendations

- Enforcement of fire rules and regulations is essential if fires in this region are to be reduced. Develop an effective and funded mechanism for fining violators to improve safety.
- OCFA and citizens of Yorba Linda should organize and work together to increase fire safety as the neighboring Carbon Canyon Fire Safe Council has done.
- Communities around the hills should create volunteer Fire Watch programs that patrol streets on high wind days, like the Santiago Canyon area residents have implemented.
- Individual residents should take personal responsibility to improve the fire safety of their own homes.
- Jurisdictions should require the highest standard and state-of-the-art construction for fire prevention (e.g., installing passive closure attic vents, which close without human intervention).
- When planning for future development at the WUI, developers and lead agencies should involve fire agencies at the earliest planning stages.

Santa Ana Canyon Recommendations

- Harden the edges of the 91 Freeway that abut natural lands using K-rails or similar structures.
- Incorporate and enforce an appropriately frequent maintenance program for the power lines owned or operated by Edison and any other utility providers.
- The steep terrain and the wind tunnel effect of this east-west trending canyon heighten the threat of fire in this location. It seems prudent to add a new fire station at either Green River or Gypsum Canyon to improve response time to Santa Ana Canyon fires especially given that the 91 Freeway is often congested which reduces response time.
- Continue to increase fire patrols or fire agency presence on high wind/high heat/low humidity days on the 91 Freeway and neighboring streets/communities.
- Include Caltrans-type flashing signage on high fire hazard days alerting commuters to be cautious and report suspicious behavior.
- Improve safety by enforcing violations caused by agencies, contractors, and businesses that work along the Santa Ana Canyon. For example, agencies should requiring spotters and water trucks when working in or next to natural lands.

Carbon Canyon Recommendations

- Caltrans should continue to improve consistency on fuel clearance in a more timely fashion along Carbon Canyon Road (Highway 142). Spraying of the plants in the Caltrans right-of-way should occur early in the growing season, when the plants are small making handcrew removal easier and more economical.
- Consider reducing the participation for fire agency mutual aid for cities with a WUI and a history of fires. For example, the fire agencies serving Brea, Yorba Linda, and Chino Hills should be "at the bottom of the list" for sending mutual aid to other areas on high fire hazard days since they may have their own fire to respond to. Requests for mutual aid should first be made to more urbanized communities with no WUIs.
- Continue to increase fire agency presence and patrols during high wind/high heat/low humidity days.

Rim Crest Recommendations

- Include a door-to-door homeowner education program before fire season begins each year.
- Incorporate proactive steps by OCFA and the City of Yorba Linda for retrofitting homes with hardening techniques e.g., boxed eaves, automatic attic vent closures, roofs cleared of leaf debris, no ladder fuels near the house, etc.
- Remove non-native highly flammable vegetation (such as palm trees and pampas grass).
- Give fire risk the highest consideration in approving housing projects on the WUI.
- Continue fire agency presence and patrols during high wind/high heat/low humidity days.
- Require new developments to use native, fire resistance landscape to reduce ignition at the WUI and incorporate defensible space within the development.

CONCLUSION

This study shows that Chino Hills State Park and environs have endured significantly more fires, 101 to be exact, than would have naturally occurred by lightning strikes (2). Instead of a fire burning every 50 years in the natural fire regime, humans have increased the ratio essentially to a fire a year. HFE recognizes that a sample size of two fires is not enough to draw firm conclusions. However, our local examples of natural fires indicate fewer acres burn (367 acres) on average than fires ignited by humans or human error (2,494 acres). Natural fires tend to ignite on ridge tops with a lightning strike. The fire then generally spreads downhill and does so more slowly allowing firefighters more time to attack the blaze. Human-caused fires tend to start at a canyon bottom, where roads usually are, and race uphill.

As communities arose and developments were built, opportunities for fires to ignite at the WUI increased. It is clear from this research that humans have changed the natural fire regime—both intentionally and unintentionally. Some of the causes, like machinery hitting a rock igniting dry brush could be prevented. Risk could be reduced with the incorporation of fire spotters, restrictions on work during certain weather conditions, and the presence of water trucks. Other fires ignited by power lines seem to indicate the region would benefit from an improved maintenance schedule before the fire season begins.

It is clear there are many more fires occurring here than would have occurred naturally and there are many consequences to having a fire a year burn in the region. First, there is an increased risk of loss of life, property, and natural resources, which all translate to a huge economic loss, not to mention personal losses, for a region each time it burns. Second, increased fires mean a shift in the type and location of vegetation that normally could have recovered in a natural fire regime. When burned too frequently the native vegetation does not have enough time, and in some cases stored energy, to regenerate or become mature enough to produce seeds. This stress on the native vegetation allows non-native plants to dominate the landscape. Finally, given the $150+ million investment made by private and public agencies in protecting and restoring the hills, it challenges the sensibilities to think of the State Park merely as fuel load. In the short-term, reducing the fuel load exacerbates the long-term problem of type conversion to highly flammable non-native fuels, which generally dry earlier, ignite easier, and spread fire faster than native plants. It was reported during the *Freeway* Complex Fire (2008) that the non-native 30 foot tall water-loving *Arundo donax* spread the flames up Carbon Canyon Creek toward the community of Sleepy Hollow. Riparian corridors are natural buffers to flames, but not when they are choked by non-native, highly flammable plants.

The responsibility for protection of the community from wildland fires lies first with the developer during the planning phase of the development. Governmental jurisdictions also share in this responsibility because decision makers have the power to approve or deny inappropriate developments at the WUI. Finally, private homeowners have the responsibility to learn the vulnerabilities of their home and take proactive steps to remedy them where possible. Additionally, the city and homeowners' associations must ensure proper maintenance of the defensible space within the community.

To reduce the unnatural frequency of fires to a more natural pace: education, outreach, planning, and a shift in approach is needed. HFE is committed to working with planners, natural resource, transportation, and fire agencies to reduce the fire frequency to a more natural fire regime in the Study Area.

Suggestions for Further Study

Due to capacity and time limitations, HFE was only able to report on the wildland fires (perimeters and points of origin), however HFE believes there are additional areas of study that would benefit fire prevention, resource protection, and planning efforts at the WUI. These include:

- An analysis of the effect of repeated wildfires on wildlife habitat and its effect on wildlife
- A historical analysis documenting the loss of valuable vegetation types and type conversion
- The effects wildfires have on wildlife movement, foraging, reproduction, and survival
- Whether enforcement measures for fire prevention are adequate
- The expansion of the WUI and its impacts on the Park

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About the Authors

Claire and Melanie Schlotterbeck are conservation advocates specializing in the Puente-Chino Hills Wildlife Corridor. This mother-daughter team both work as long time consultants to HFE. Melanie is a technical consultant and works on GIS mapping, land acquisition, research projects, and outreach efforts. More recently, her efforts have resulted in acquisition and restoration projects that benefit the State Park. She earned her bachelor's degree in Environmental Geography and her Master of Science in Environmental Science from Cal State Fullerton. Claire Schlotterbeck is the Executive Director of HFE and has been involved in preservation of the Puente-Chino Hills for over three decades. She played a key role in the formation of the 14,100-acre Chino Hills State Park. Claire earned her bachelor's degree in Political Science from UCLA and a Master of Science from Purdue University.

HFE also gratefully recognizes the contributions of:

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APPENDIX A

Fire Perimeter Data

Fire Name	Fire Date	Acreage Burned	Cause	Point of Origin
Fuel Break (Historical)	—	132	—	—
Irvine Ranch	1914	14,830	Unknown	Unknown
Fresno Canyon*	1928	1,007	Unknown	Unknown
Gypsum*	1929	1,085	Unknown	Unknown
Carbon Canyon*	1930	733	Unknown	Unknown
Santa Ana Canyon	Nov. 8, 1943	9,375	Unknown	Unknown
Gaines	Sep. 22, 1944	270	Unknown	Unknown
Shell	July 2, 1947	118	Unknown	Unknown
Green River	Nov. 4, 1948	41,285	Unknown	Unknown
Nohl	June 21, 1951	176	Unknown	Unknown
Santiago	Oct. 15 ,1958	110	Unknown	Unknown
La Vida	Nov. 29, 1959	611	Unknown	Unknown
91 Freeway*	1962	139	Unknown	Unknown
Paseo Grande	Oct. 29, 1967	39,872	Unknown	Known
Firestone	Oct. 30, 1967	236	Unknown	Known
Tonner Canyon	June 13, 1971	9	Unknown	Unknown
Serranos	Sep. 9, 1973	304	Unknown	Known
Mine	July 28, 1977	4,956	Unknown	Unknown
Soquel	Oct. 23, 1978	5,428	Unknown	Known
Soquel Canyon*	Oct. 25, 1978	251	Unknown	Unknown
Los Sarranos [Serranos]	June 19, 1979	172	Unknown	Known
Paseo	Sep. 15, 1979	3,644	Smoldering Sleeper Fire	Known
Corona	1980	116	Unknown	Unknown
Green River	July 13, 1980	379	Unknown	Known
Owl	Oct. 28, 1980	18,332	Unknown	Known
Carbon Canyon	Nov. 16, 1980	14,613	Unknown	Known
Euclid	Oct. 30, 1981	714	Unknown	Known
Fresno Canyon*	Oct. 1982	211	Unknown	Unknown
Gypsum	Oct. 9, 1982	19,986	Power lines	Known

* indicates the fire name was assigned by Hills For Everyone.

Fire Perimeter Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Point of Origin
Santa Ana Canyon*	Fall 1983	443	Unknown	Unknown
Fresno*	July 12, 1983	642	Unknown	Unknown
91 Freeway*	July 13, 1983	1,618	Unknown	Unknown
Bane Canyon*	Sep. 14, 1983	581	Unknown	Unknown
Wardlow Wash*	July 8, 1984	114	Unknown	Unknown
Coal Canyon	July 9, 1984	450	Fireworks (Bottle Rocket)	Known
Coal Canyon	July 2, 1985	540	Plane Crash into Power lines	Known
Shell	Aug. 11, 1985	1,635	Unknown	Known
Green River	Oct. 6, 1985	Less than 1	Unattended Children	Known
Fresno Canyon*	Aug. 2, 1986	95	Unknown	Unknown
Bane Canyon*	June 24, 1988	820	Unknown	Unknown
South Ridge	May 24, 1989	5	Mower hit rock, ignited brush	Known
Aliso Canyon	June 29, 1989	44	Unknown	Unknown
Carbon Canyon	June 27, 1990	6,664	Arson	Known
Yorba	July 12, 1990	7,884	Model Rocket	Known
91 Freeway	July 5, 1991	50	Machinery	Known
San Juan Hill	June 10, 1992	249	Plane Crash	Known
Stagecoach	Oct. 26, 1993	581	Unknown	Unknown
91 Freeway*	1994	41	Unknown	Unknown
Carbon Canyon [Wagon]	June 25, 1994	757	Unknown	Known
91 Freeway*	Aug. 5, 1994	28	Unknown	Known
Highway 91	Aug. 26, 1995	177	Unknown	Unknown
Carbon Canyon	Aug. 31, 1998	733	Lightning	Known
Green	Feb. 9, 2002	2,234	Downed Power lines	Known
Evening	Apr. 21, 2002	893	Fireworks	Known
Blue Gum	Nov. 20, 2002	497	Arson	Known
Coal Canyon	July 12, 2003	2	Arson	Known
Green River	July 24, 2004	16	Car Crash	Known
Carbon Canyon	Sep. 25, 2004	18	Car Fire	Known

* indicates the fire name was assigned by Hills For Everyone.

Fire Perimeter Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Point of Origin
Yorba Linda	July 5, 2005	1,079	Fireworks	Known
Carbon Canyon	Aug. 4, 2005	1	Arson	Unknown
Sierra Peak	Feb. 6, 2006	10,506	Backfire	Known
Brush Canyon	July 11, 2006	1	Unknown	Unknown
Blue Gum	Aug. 2, 2006	3	Illegal Campfire	Unknown
241 Incident	Aug. 22, 2006	Less than 1	Unknown	Unknown
Windy Ridge [241 Incident]	Mar. 11, 2007	1,618	Burning Car (Arson)	Known
Rose	Apr. 12, 2007	8	Machinery	Known
Freeway Complex	Nov. 15, 2008	30,306	Auto Exhaust & Power lines	Known
241 Incident	Sep. 25, 2009	Less than 1	Unknown	Unknown
91 Freeway Incident	June 16, 2010	47	Unknown	Known
Carbon Canyon	July 11, 2011	518	Arson	Known
Rose Drive*	Nov. 2, 2011	5	Power lines	Known

* indicates the fire name was assigned by Hills For Everyone.

APPENDIX B

Fire Causes and Points of Origin Data

Fire Name	Fire Date	Acreage Burned	Cause	Perimeter
Sonome Canyon	Unknown	Unknown	Plane Crash	Unknown
Paseo Grande	Oct. 29, 1967	39,872	Unknown	Known
Firestone	Oct. 30, 1967	236	Unknown	Known
Serranos	Sep. 9, 1973	304	Unknown	Known
Soquel	Oct. 23, 1978	5,428	Unknown	Known
Los Sarranos [Serranos]	June 19, 1979	172	Unknown	Known
Paseo	Sep. 15, 1979	3,644	Smoldering Sleeper Fire	Known
Green River	July 13, 1980	379	Unknown	Known
Owl	Oct. 28, 1980	18,332	Unknown	Known
Carbon Canyon	Nov. 16, 1980	14,613	Unknown	Known
Euclid	Oct. 31, 1981	714	Unknown	Unknown
Gypsum Canyon	Oct. 9, 1982	19,986	Electric Lines	Known
Coal Canyon	July 9, 1984	450	Fireworks (Bottle Rocket)	Known
Coal Canyon	July 2, 1985	540	Plane Crash into Power lines	Known
Shell	Aug. 11, 1985	1,635	Unknown	Known
Green River	Oct. 6, 1985	Unknown	Unattended Children	Known
Coal Canyon	Apr. 21, 1987	25	Vehicle Fire	Unknown
Gypsum Canyon	May 12, 1987	20	Incendiary Device	Unknown
Coal Canyon	July 7, 1987	5	Unknown	Unknown
Coal Canyon	July 28, 1987	10	Unknown	Unknown
Rim Crest	Mar. 13, 1988	10	Kids with Matches	Unknown
Coal Canyon	May 13, 1988	3	Unknown	Unknown
La Vida	Dec. 4, 1988	Unknown	Unknown	Unknown
South Ridge	May 24, 1989	5	Mower hit rock, ignites brush	Known
Carbon Canyon	July 5, 1989	Unknown	Unknown	Unknown
Featherly Regional Park	July 14, 1989	Unknown	Unknown	Unknown

Fire Causes and Points of Origin Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Perimeter
Chino Hills State Park	Oct. 10, 1989	400	Unknown	Unknown
Carbon Canyon	June 27, 1990	6,664	Arson	Known
Yorba	July 12, 1990	7,884	Model Rocket	Known
Carbon Canyon	July 22, 1990	1	Unknown	Unknown
Carbon Canyon	July 27, 1990	2	Downed Power line	Unknown
91 Freeway	July 5, 1991	245	Machinery	Known
Coal Canyon	May 10, 1992	3	Unknown	Unknown
San Juan Hill	June 10, 1992	249	Plane Crash	Known
Chino Hills State Park	Sep. 8, 1992	500	Power lines	Unknown
Carbon Canyon	Nov. 15, 1993	40	Plane Crash	Unknown
Carbon Canyon [Wagon]	June 25, 1994	757	Unknown	Known
91 Freeway	Aug. 5, 1994	28	Unknown	Known
71 Freeway	Dec. 19, 1994	4	Unknown	Unknown
Carbon Canyon	June 24, 1998	20	Road Flare (Arson)	Unknown
Carbon Canyon	Aug. 31, 1998	733	Lightning	Known
Chino Hills State Park	Jan. 19, 1999	Unknown	Plane Crash	Unknown
Woodview	Sep. 12, 2000	200	Unknown	Unknown
Chino Hills Parkway	Sep. 18, 2000	2	Unknown	Unknown
Green	Feb. 9, 2002	2,234	Downed Power lines	Known
Evening	Apr. 21, 2002	893	Fireworks	Known
71 Freeway	Aug. 3, 2002	10	Car Exhaust Pipe	Unknown
Blue Gum	Nov. 20, 2002	497	Arson	Known
Coal Canyon	July 12, 2003	2	Arson	Known
71 Freeway	Aug. 19, 2003	3	Unknown	Unknown
Coal Canyon	May 30, 2004	2	Unknown	Unknown
Green River	July 24, 2004	16	Car Crash	Known
Carbon Canyon	Sep. 25, 2004	18	Car Fire	Known

Fire Causes and Points of Origin Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Perimeter
Yorba Linda	July 5, 2005	1,079	Illegal Fireworks	Known
Sierra Peak	Feb. 6, 2006	10,506	Back Fire	Known
Brush Canyon	July 23, 2006	1	Lightning	Unknown
Feldspar	Sep. 26, 2006	Unknown	Car Crash	Unknown
Red Star	Jan. 7, 2007	175	Unknown	Unknown
Windy Ridge [241 Incident]	Mar. 11, 2007	1,618	Burning Car (Arson)	Known
Rose	Apr. 12, 2007	3	Machinery	Known
Coal Canyon	May 7, 2007	140	Caltrans Machinery	Unknown
Western Hills	May 16, 2008	15	Downed Power lines	Unknown
Freeway Complex	Nov. 15, 2008	30,306	Auto Exhaust Power lines	Known
Windy Ridge	Nov. 25, 2009	80	Unknown	Unknown
Coal Canyon	Mar. 16, 2010	Unknown	Car Accident	Unknown
91 Freeway Incident	June 16, 2010	47	Unknown	Known
Quarter Horse	Sep. 4, 2010	10	Fireworks	Unknown
Carbon Canyon	July 11, 2011	518	Arson	Known
Rose Drive	Nov. 2, 2011	5	Power lines	Known

APPENDIX C

All Fires Combined (Perimeters and Points of Origin) Data

Fire Name	Fire Date	Acreage Burned	Cause	Data Type
Fuel Break (Historical)	—	132	—	Perimeter
Sonome Canyon	Unknown	Unknown	Plane Crash	Point of Origin
Irvine Ranch	1914	14,830	Unknown	Perimeter
Fresno Canyon*	1928	1,007	Unknown	Perimeter
Gypsum*	1929	1,085	Unknown	Perimeter
Carbon Canyon*	1930	733	Unknown	Perimeter
Santa Ana Canyon	Nov. 8, 1943	9,375	Unknown	Perimeter
Gaines	Sep. 22, 1944	270	Unknown	Perimeter
Shell	July 2, 1947	118	Unknown	Perimeter
Green River	Nov. 4, 1948	41,285	Unknown	Both
Nohl	June 21, 1951	176	Unknown	Perimeter
Santiago	Oct. 15, 1958	110	Unknown	Perimeter
La Vida	Nov. 29, 1959	611	Unknown	Perimeter
91 Freeway*	1962	139	Unknown	Perimeter
Paseo Grande	Oct. 29, 1967	39,872	Unknown	Both
Firestone	Oct. 30, 1967	236	Unknown	Both
Tonner Canyon	June 13, 1971	9	Unknown	Perimeter
Serranos	Sep. 9, 1973	304	Unknown	Both
Mine	July 28, 1977	4,956	Unknown	Perimeter
Soquel	Oct. 23, 1978	5,428	Unknown	Both
Soquel Canyon*	Oct. 25, 1978	251	Unknown	Perimeter
Los Serranos [Serranos]	June 19, 1979	172	Unknown	Both
Paseo	Sept. 15, 1979	3,644	Smoldering Sleeper Fire	Both

* indicates the fire name was assigned by Hills For Everyone.

All Fires Combined (Perimeters and Points of Origin) Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Data Type
Corona	1980	116	Unknown	Perimeter
Green River	July 13, 1980	379	Unknown	Both
Owl	Oct. 28, 1980	18,332	Unknown	Both
Carbon Canyon	Nov. 16, 1980	14,613	Unknown	Both
Euclid	Oct. 30, 1981	714	Unknown	Both
Fresno Canyon*	Oct. 1982	211	Unknown	Perimeter
Gypsum	Oct. 9, 1982	19,986	Powerlines	Both
Santa Ana Canyon*	Fall 1983	443	Unknown	Perimeter
Fresno*	July 12, 1983	642	Unknown	Perimeter
91 Freeway*	July 13, 1983	1,618	Unknown	Perimeter
Bane Canyon*	Sep. 14, 1983	581	Unknown	Perimeter
Wardlow Wash*	July 8, 1984	114	Unknown	Perimeter
Coal Canyon	July 9, 1984	450	Fireworks (Bottle Rocket)	Both
Coal Canyon	July 2, 1985	540	Plane Crash into Powerlines	Both
Shell	Aug. 11, 1985	1,635	Unknown	Both
Green River	Oct. 6, 1985	Less than 1	Unattended Children	Both
Fresno Canyon*	Aug. 2, 1986	95	Unknown	Perimeter
Coal Canyon	Apr. 21, 1987	25	Vehicle Fire	Point of Origin
Gypsum Canyon	May 12, 1987	20	Incendiary Device	Point of Origin
Coal Canyon	July 7, 1987	5	Unknown	Point of Origin
Coal Canyon	July 28, 1987	10	Unknown	Point of Origin
Rim Crest	Mar. 13, 1988	10	Kids with Matches	Point of Origin
Coal Canyon	May 13, 1988	3	Unknown	Point of Origin
Bane Canyon*	June 24, 1988	820	Unknown	Perimeter
La Vida	Dec. 4, 1988	Unknown	Unknown	Point of Origin
South Ridge	May 24, 1989	5	Mower hit rock, ignited brush	Both
Aliso Canyon	June 29, 1989	44	Unknown	Perimeter
Carbon Canyon	July 5, 1989	Unknown	Unknown	Point of Origin
Featherly Regional Park	July 14, 1989	Unknown	Unknown	Point of Origin

* indicates the fire name was assigned by Hills For Everyone.

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All Fires Combined (Perimeters and Points of Origin) Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Data Type
Chino Hills State Park	Oct. 10, 1989	400	Unknown	Point of Origin
Carbon Canyon	June 27, 1990	6,664	Arson	Both
Yorba	July 12, 1990	7,884	Model Rocket	Both
Carbon Canyon	July 22, 1990	1	Unknown	Point of Origin
Carbon Canyon	July 27, 1990	2	Downed Power lines	Point of Origin
91 Freeway	July 5, 1991	50	Machinery	Both
Coal Canyon	May 10, 1992	3	Unknown	Point of Origin
San Juan Hill	June 10, 1992	249	Plane Crash	Both
Chino Hills State Park	Sep. 8, 1992	500	Powerlines	Point of Origin
Stagecoach	Oct. 26, 1993	581	Unknown	Perimeter
Carbon Canyon	Nov. 15, 1993	40	Plane Crash	Point of Origin
91 Freeway*	1994	41	Unknown	Perimeter
Carbon Canyon [Wagon]	June 25, 1994	757	Unknown	Both
91 Freeway*	Aug. 5, 1994	28	Unknown	Both
71 Freeway	Dec. 19, 1994	4	Unknown	Point of Origin
Highway 91	Aug. 26, 1995	177	Unknown	Perimeter
Carbon Canyon	June 24, 1998	20	Road Flare (Arson)	Point of Origin
Carbon Canyon	Aug. 31, 1998	733	Lightning	Both
Chino Hills State Park	Jan. 19, 1999	Unknown	Plane Crash	Point of Origin
Woodview	Sep. 12, 2000	200	Unknown	Point of Origin
Chino Hills Parkway	Sep. 18, 2000	2	Unknown	Point of Origin
Green	Feb. 9, 2002	2,234	Downed Power lines	Both
Evening	Apr. 21, 2002	893	Fireworks	Both
71 Freeway	Aug. 3, 2002	10	Car Exhaust Pipe	Point of Origin
Blue Gum	Nov. 20, 2002	497	Arson	Both
Coal Canyon	July 12, 2003	2	Arson	Both
71 Freeway	Aug. 19, 2003	3	Unknown	Point of Origin

* indicates the fire name was assigned by Hills For Everyone.

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All Fires Combined (Perimeters and Points of Origin) Data Continued...

Fire Name	Fire Date	Acreage Burned	Cause	Data Type
Coal Canyon	May 30, 2004	2	Unknown	Point of Origin
Green River	July 24, 2004	16	Car Crash	Both
Carbon Canyon	Sep. 25, 2004	18	Car Fire	Both
Yorba Linda	July 5, 2005	1,079	Fireworks	Both
Carbon Canyon	Aug. 4, 2005	1	Arson	Perimeter
Sierra Peak	Feb. 6, 2006	10,506	Backfire	Both
Brush Canyon	July 11, 2006	1	Unknown	Perimeter
Brush Canyon	July 23, 2006	1	Lightning	Point of Origin
Blue Gum	Aug. 2, 2006	3	Illegal Campfire	Perimeter
241 Incident	Aug. 22, 2006	Less than 1	Unknown	Perimeter
Feldspar	Sep. 26, 2006	Unknown	Car Crash	Point of Origin
Red Star	Jan. 7, 2007	175	Unknown	Point of Origin
Windy Ridge [241 Incident]	Mar. 11, 2007	1,618	Burning Car (Arson)	Both
Rose	Apr. 12, 2007	8	Machinery	Both
Coal Canyon	May 7, 2007	140	Caltrans Machinery	Point of Origin
Western Hills	May 16, 2008	15	Downed Power lines	Point of Origin
Freeway Complex	Nov. 15, 2008	30,306	Auto Exhaust & Powerlines	Both
241 Incident	Sep. 25, 2009	Less than 1	Unknown	Perimeter
Windy Ridge	Nov. 25, 2009	80	Unknown	Point of Origin
Coal Canyon	Mar. 16, 2010	Unknown	Car Accident	Point of Origin
91 Freeway Incident	June 16, 2010	47	Unknown	Both
Quarter Horse	Sep. 4, 2010	10	Fireworks	Point of Origin
Carbon Canyon	July 11, 2011	518	Arson	Both
Rose Drive*	Nov. 2, 2011	5	Powerlines	Both

* indicates the fire name was assigned by Hills For Everyone.

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EXHIBIT H

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PLOS ONE

Land Use Planning and Wildfire: Development Policies Influence Future Probability of Housing Loss

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Abstract

Increasing numbers of homes are being destroyed by wildfire in the wildland-urban interface. With projections of climate change and housing growth potentially exacerbating the threat of wildfire to homes and property, effective fire-risk reduction alternatives are needed as part of a comprehensive fire management plan. Land use planning represents a shift in traditional thinking from trying to eliminate wildfires, or even increasing resilience to them, toward avoiding exposure to them through the informed placement of new residential structures. For land use planning to be effective, it needs to be based on solid understanding of where and how to locate and arrange new homes. We simulated three scenarios of future residential development and projected landscape-level wildfire risk to residential structures in a rapidly urbanizing, fire-prone region in southern California. We based all future development on an econometric subdivision model, but we varied the emphasis of subdivision decision-making based on three broad and common growth types: infill, expansion, and leapfrog. Simulation results showed that decision-making based on these growth types, when applied locally for subdivision of individual parcels, produced substantial landscape-level differences in pattern, location, and extent of development. These differences in development, in turn, affected the area and proportion of structures at risk from burning in wildfires. Scenarios with lower housing density and larger numbers of small, isolated clusters of development, i.e., resulting from leapfrog development, were generally predicted to have the highest predicted fire risk to the largest proportion of structures in the study area, and infill development was predicted to have the lowest risk. These results suggest that land use planning should be considered an important component to fire risk management and that consistently applied policies based on residential pattern may provide substantial benefits for future risk reduction.

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Introduction

The recognition that homes are vulnerable to wildfire in the wildland-urban interface (WUI) has been established for decades [e.g., 1,2]; but with a recent surge in structures burning, this issue is now receiving widespread attention in policy, the media, and the scientific literature. Single fire events, like those in Greece, Australia, southern California, and Colorado have resulted in scores of lost lives, thousands of structures burned, and billions of dollars in expenditures [3–6]. With the potential for increasingly severe fire conditions under climate change [7] and projections of continued housing development [8], it is becoming clear that more effective fire-risk reduction solutions are needed. "Fire risk" here refers to the probability of a structure burning in a wildfire within a given time period.

Traditional fire-risk reduction focuses heavily on fire suppression and manipulation of wildland vegetation to reduce hazardous fuels [9]. Enormous resources are invested in vegetation management [10], but as increasing numbers of homes burn down despite this massive investment, the "business-as-usual" approach to fire management is undergoing reevaluation. One issue is that fuel treatments may not be located in the most strategic positions, i.e., in the wildland-urban interface [11]. Yet, even if treatments surrounded all communities, scattered development patterns are difficult for firefighters to reach [12–14], and fuel treatments do little to protect homes without fireFighter access [15–16]. Fuel treatments may also be ineffective against embers or flaming materials that blow ahead of the fire front [17].

One alternative to traditional fire management that is receiving widespread attention is to prepare communities through the use of fire-safe building materials or creating defensible space around structures [17–18]. These actions represent an important shift in emphasis from trying to prevent wildfires in fire-prone areas to better anticipating fires that are ultimately inevitable. Nevertheless, the cost of building and retrofitting homes to be fire-safe can be prohibitive, and these actions do not guarantee immunity from fire [19].

Land use planning is an alternative that represents a further shift in thinking, beyond the preparation of communities to withstand an inevitable fire, to preventing new residential structures from being exposed to fire in the first place. The reason homes are vulnerable to fires at the wildland-urban interface is a function of its very definition: "where homes meet or intermingle with wildland vegetation" [20]. In other words, the location and pattern of homes influence their fire risk, and past land-use decision-making has allowed homes to be constructed in highly flammable areas [21]. Land use planning for fire safety is beginning to receive some attention in the literature [22–23], and there is growing recognition of the potential benefits of directing development outside of the most hazardous locations [8,19,24].

Despite recent attention in the literature, land use planning for wildfire has yet to gain traction in practice, particularly in the United States. However, fire history has been used to help define land zoning for fire planning in Italy [22], and bushfire hazard maps are integrated into planning policy in Victoria, Australia [25]. Although some inertia inevitably arises from complications with existing policy and plans, a primary impediment to the design and implementation of fire-smart land use planning is lack of guidance about specific locations, patterns of development, or appropriate methodology to direct the placement of new development. Without a solid knowledge base to draw from, planners will be misinformed about which planning decisions may result in the greatest overall reduction of residential landscape risk. Even worse, poor science could result in placement of homes in areas that actually have high fire hazard.

Research on how planning decisions contributed to structures burning in the past provides some guidance about what actions may work in the future. Analysis of hundreds of homes that burned in southern California the last decade showed that housing arrangement and location strongly influence fire risk, particularly through housing density and spacing, location along the perimeter of development, slope, and fire history [26]. Although high-density structure-to-structure loss can occur [27–28], structures in areas with low- to intermediate- housing density were most likely to burn, potentially due to intermingling with wildland vegetation or difficulty of firefighter access. Fire frequency also tends to be highest at low to intermediate housing density, at least in regions where humans are the primary cause of ignitions [29–30].

These results suggest, for example, that placing new residential development within the boundaries of existing high-density developments or in areas of low relief may reduce fire risk. However, it is difficult to know whether broad-scale planning policies would actually result in the intended housing arrangement and pattern at the landscape scale, and whether those patterns would result in lower fire risk. Our objective here was to simulate three scenarios of future residential development, and to project wildfire risk, in a rapidly urbanizing and fire-prone region where we have studied past structure loss [25]. We based all future development on an econometric subdivision model, but we varied the emphasis of subdivision decision-making based on three broad and common growth types.

Although cities vary in extent, fragmentation, and residential density [31–32], urban form typically adheres to a set of common patterns [33–34], and we based our development scenarios on the three primary means by which residential development typically occurs: infill, expansion, or leapfrog [34]. Infill is characterized by development of vacant land surrounded by existing development, typically in built-up areas where public facilities already exist. [35–36], and should result in higher structure density rather than increased urban extent. Expansion growth occurs along the edge of existing development, extends the size of the urban patch to which it is adjacent, and may have variable influence on structure density. Leapfrog growth occurs when development occurs beyond existing urban areas such that the new structure is surrounded by undeveloped land. This type of growth would expand the urban extent and initially result in lower structure density; but these areas may eventually become centers of growth from which infill or expansion can occur. We asked:

1) Do residential development policies reflecting broad growth types affect the resulting pattern and footprint of development across the landscape?
2) Do differences in extent, location, and pattern of residential development translate into differences in wildfire risk, based on the current configuration of structures?
3) Which development process, infill, expansion, or leapfrog, results in the lowest projected fire risk across the landscape?

Methods

Study Area

The study area included all land within the South Coast Ecoregion of San Diego County, California, US, encompassing an area of 8312 km^2. The region is topographically diverse with high levels of biodiversity, and urban development has been the primary cause of natural habitat loss and species extinction [37]. Owing to the Mediterranean climate, with mild, wet winters and long summer droughts, the native shrublands dominating the landscape are extremely fire-prone. San Diego County was the site of major wildfire losses in 2003 and 2007 [38], although large wildfire events have occurred in the county since record-keeping began, and are expected to continue, as fire frequency has steadily increased in recent decades [29,39]. The county is home to more than three million residents, and approximately one million more people are expected by 2030 [40]. Although most residential development has been concentrated along the coast, expansion of housing is expected in the eastern, unincorporated part of the county.

Econometric Subdivision Model

A host of alternative modeling approaches exist to simulate future land use scenarios [41], including a cellular automaton model that we previously applied to the study area [42]. We chose to use an econometric modelling approach for this study because we wanted to capture fine-scale, structure-level patterns and processes that are correlated with housing loss to wildfire [26]; and econometric models may perform better at the scale of individual parcels [43].

Although we based the three development scenarios on generalized planning policies, we also wanted to ensure that the residential projections were realistic and adhered to current planning regulations. The objective of the econometric modeling was to estimate the likelihood that residential parcels will subdivide in the future. Therefore, we used a probit model to estimate the transition probability of each parcel based on a range of potential explanatory variables typically associated with parcel subdivision and housing development [44–45].

To develop the model of subdivision probability, we acquired GIS data of the county's parcel boundaries in years 2005 and 2009 from the San Diego Association of Governments (SANDAG). The dependent variable was equal to 1 if a parcel subdivided between 2005 and 2009, and zero otherwise. Using these data layers we first determined which parcels were legally able to subdivide given current land use regulations. Minimum lot size restrictions are typically considered the most import restriction for determining future land use. We deemed a parcel eligible for subdivision if the current lot size was greater than twice the minimum legal size given the land class. To determine which parcels subdivided between 2005 and 2009, we queried parcel IDs where the total dataset of existing housing includes locations of 687,869 structures, of which 4% were located within the perimeter of one of 40 fires that burned since 2001. During these fires, 4315 structures were completely destroyed, and another 935 were damaged.

For future development scenarios, we wanted to allocate an equal number of new structures to the landscape. This was to ensure that any predicted difference in fire risk was a function of the arrangement and location of structures, not the total number of structures. Nevertheless, differences in the total number of structures were simulated with each of the 5-year time steps. We determined the number of housing units to add during the simulations based on projections made by San Diego County [46]. Using factors such as development proposals, general plan densities, and information from jurisdictions, the county estimated that between 331,378 units and 486,336 units could be supported within the developable residential land by 2030. Because the eastern, desert portion of the county was not included in our study area, we used a conservative approach and simulated the addition of 331,378 new dwelling units. We divided this number by four to define the number of new dwelling units to add at each time step, assuming a linear growth rate.

One output of the econometric model was the prediction of the maximum number of new dwelling units that could be added to each parcel. However, dwelling units may consist of apartments as well as single family homes. The mix of single and multifamily units in the region has remained relatively constant over time, and the overall trend has been a mix of roughly 1/3 multifamily and 2/3 single family units. Because the fire risk model is based on points representing structure locations across the landscape, regardless of the number of dwelling units per structure, we needed to generate a conversion factor from dwelling units to structures. We therefore defined a minimum lot size of 0.25 acre on which no more than a single structure could be built, regardless of the number of dwelling units in it (i.e., a single family home or apartment complex). Then, once a parcel was selected for development by the model (see details below), we divided its total area by the maximum number of dwelling units to be added, according to the econometric model. If the result was larger than 0.25, we subdivided parcels according to the result. If not, we quantified how many 0.25 acre parcels fit into the original parcel, and generated the new parcel boundaries accordingly.

Using the initial map of parcels (year 2010), we classified each parcel that was defined as eligible for development (in the previous stage) as suitable for one of the three planning scenarios described above, according to the number of developed parcels in its immediate neighborhood (i.e., those parcels that share a boundary with the focal parcel). We defined 'developed parcels' as ones that had more than one house per 20 acres (8.09 ha). Therefore, according to these density thresholds, we allowed some parcels with nonzero housing density to be considered as 'undeveloped' because these large, rural parcels might contain a single or a handful of houses but they exist within a large open area. In other words, the overall land cover of these parcels was effectively undeveloped, and we therefore assumed that development in adjacent parcels would be akin to development in open areas.

We defined infill parcels as those that were completely surrounded by developed parcels. Expansion parcels had at least one neighboring parcel that was undeveloped; and leapfrog parcels were those with no developed parcels in their immediate surroundings. We reclassified the type of each available parcel in the same manner after each time step, to account for changing dynamics in the development map of the county.

We conducted three simulations, one for each development scenario (infill, expansion, and leapfrog). In each simulation, all parcels were eligible to subdivide, regardless of their class. Therefore, to build a simulation for a specific scenario, we increased the development probability of parcels of the selected scenario by 20%, to favor their development compared to the other types of parcels, without prohibiting development in the other parcel types. This approach was necessary because the projected number of dwelling units was much larger than it would be possible to fit in infill and leapfrog class parcels solely. For example, as the spatial coverage of developed parcel expands, there is less contiguous area that is undevelopable and suitable for leapfrog development. Therefore, the scenarios are not exclusive, but rather a mixture of the three development types. Yet, in each scenario, there is one main type of development, and smaller amounts of development events of the other two types.

Due to the immense computational demand of the simulations, we adopted a deterministic, rather than a stochastic approach to decide on which parcels were subdivided. After enhancing the transition probability according to the corresponding scenario, we ranked and then sorted all parcels according to their probability of subdivision. We then sequentially selected parcels, while simultaneously tallying the number of dwelling units in them, until the development target in that time step (one fourth of the total number of dwelling units to be added: 82,795) was reached. Once the development target was reached, we moved to the next time step. After each time step, the remaining parcels that were still eligible for development were re-classified to development types according to the new spatial configuration of the landscape.

Once a parcel was selected for subdivision, and the number of new parcels to develop in it was calculated (as detailed above), an equal-area spatial splitting model was employed to split the parent parcel to the predefined number of equal-area child parcels. We developed a simple splitting model which is based on iterative splitting of larger parcels into two smaller parcels using a straight line splitting boundary. Once the parcel was fully split into the needed number of sub-parcels, we allocated a new structure inside each new parcel by generating a point at its centroid (center of gravity). The point datasets of all structure locations per time step per scenario were passed over to the fire risk model, which is described below.

Fire Risk Modeling and Analysis

To project the distribution of fire risk under alternative scenarios, we used MaxEnt [47–48], a map-based modeling software used primarily for species distribution modeling [48], but we have used it successfully for ignition modeling [50] and for projecting current fire risk in the study area [26]. For this study, we slightly modified the model from Syphard et al. [26]. The dependent variable was the location of structures destroyed by fire between 2001 and 2010. Although inclusion of damaged structures in the data set does not significantly affect results [26], we only included completely destroyed structures to avoid the introduction of any uncertainty.

The MaxEnt software uses a machine-learning algorithm that iteratively evaluates contrasts among values of predictor values at locations where structures burned versus values distributed across the entire study area. The model assumes that the best approximation of an unknown distribution (i.e., structure destruction) is the one with maximum entropy. The output is an exponential function that assigns a probability to every cell of a map. Thus, the resulting continuous maps of fire risk represented the probability of a structure being destroyed by fire. In these output maps, areas of predicted high fire risk that did not have structures on them represented environmental conditions similar to those in which structures have actually burned.

area was reduced by at least the minimum lot size between the two time periods. Finally, we were able to generate a suite of variables that determine the likelihood of a parcel developing in the future (Table S1).

We overlaid the parcel boundaries over a range of GIS layers representing our explanatory variables. These data are available to download at (http://www.sandag.org/index.asp?subclassid = 100&fuseaction = home.subclasshome). Our explanatory variables included: parcel size, parcel size squared, six dummy variables which capture non-linear effects of parcel size, distance to the coast, distance to the coast squared; distance to city center and its square, current zoning, slope, land use, roads, if the parcel is in a protected area, if the parcel is in a development area, if the parcel is in the redevelopment area (Table 1).

Spatial Model of Future Development under Planning Alternatives

The outcome of the land use change econometric model is the subdivision probability for each parcel for a five-year time step. Based on these probabilities, we developed a GIS spatial simulation model of future land use under three distinct planning scenarios: infill (development in open or low density parcels within already developed areas), expansion (development on the fringe of developed areas), and leapfrog (development in open areas). The model runs in four 5-year time steps from 2010 to 2030, and generates the spatial locations of new housing units in the county.

Although development decisions could feasibly depend on fire risk, we did not model that here. There is no evidence that fire has influenced past regional planning decisions, so it was not used as an explanatory variable in the econometric model. Although we could have evaluated the potential for future development decisions to be based in part on fire risk, this would have required simulation of feedbacks between fires and probability of development. Because our objective in this study was to isolate the effects of the three distinct growth types, we modeled fire risk only as a function of development pattern and not vice versa.

We constructed a complete spatial database of existing residential structures in the study area [26]. These structures and their corresponding parcel boundaries served as the initial conditions for all three scenarios of the spatial simulation model. The current and projected future GIS layers of structures were also subsequently used in the fire risk model (see below). The

Table 1. Variables and results from the probit regression model of parcel subdivision in San Diego County.

Subdivided (1 = yes,0 = no)	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Acres of lot	0.0026342	0.00075	3.51	0	0.001164	0.004105
Acres of lot ^{2}	−3.02E-06	1.29E-06	−2.34	0.019	−5.55E-06	−4.93E-07
Distance to ocean	−7.42E-06	1.33E-06	−5.59	0	−0.00001	−4.82E-06
Distance to ocean ^{2}	2.33E-11	8.28E-12	2.82	0.005	7.11E-12	3.96E-11
Distance to major road	2.17E-07	2.74E-06	0.08	0.937	−5.16E-06	5.59E-06
Distance to major road ^{2}	−1.94E-11	1.70E-11	−1.14	0.252	−5.27E-11	1.38E-11
Distance to nearest city center	−0.0000115	1.70E-06	−6.76	0	−1.3E-05	−8.16E-06
Distance to nearest city center ^{2}	2.89E-11	9.70E-12	2.98	0.003	9.91E-12	4.79E-11
Slope between 0–5%	0.6211289	0.211761	2.93	0.003	0.206585	1.035773
Slope between 5–10%	0.3911427	0.210684	1.86	0.063	−0.02179	0.804076
Slope between 10–25%	0.0716669	0.212725	0.34	0.736	−0.34527	0.4886
Rural Residential	−0.3563149	0.071512	−4.98	0	−0.49648	−0.21615
Single Family	0.1361149	0.068678	1.98	0.047	0.001509	0.270721
Multi-Family	−0.2505093	0.151486	−1.65	0.098	−0.54742	0.046397
Road	0.015329	0.086094	0.18	0.859	−0.15341	0.184069
Open Space	−0.7440933	0.099145	−7.51	0	−0.93841	−0.54977
Orchard/Vineyard	−0.5813305	0.097867	−5.94	0	−0.77315	−0.38951
Agriculture	−0.9785208	0.132734	−7.37	0	−1.23867	−0.71837
Vacant Land	−0.5227501	0.074586	−7	0	−0.668844	−0.37656
Zoned protected	0.2537169	0.076881	3.3	0.001	0.103086	0.404453
Area marked for redevelopment	−0.2680261	0.14069	−1.91	0.057	−0.54377	0.007722
Area marked for development	0.5780101	0.064103	9.02	0	0.452371	0.703649
Parcel between 10–20 acres	−0.3379532	0.065899	−5.13	0	−0.46711	−0.20879
Parcel between 5–10 acres	−0.6119036	0.067012	−9.13	0	−0.74325	−0.48056
Parcel between 2–5 acres	−1.16297	0.07062	−16.47	0	−1.30138	−1.02456
Parcel between 1–2 acres	−1.563956	0.090286	−17.32	0	−1.74091	−1.387
Parcel between.5–1 acres	−1.999939	0.099893	−20.02	0	−2.19573	−1.80415
Parcel between.25–.5 acres	−2.178273	0.117101	−18.6	0	−2.40779	−1.94876
Constant	−1.397931	0.227467	−6.15	0	−1.84376	−0.9521

Sample size 113 001, LR Chi^2 1535.23, prob>chi 0, pseudo R^2 0.22. Further description of the variables is provided in Table S1.
doi:10.1371/journal.pone.0071708.t001

We based the explanatory variables on those that were significantly related to burned structures in Syphard et al. [26], including maps depicting housing arrangement and pattern, housing location, and biophysical factors. Housing pattern variables reflected individual structure locations as well as the arrangement of structures within housing clusters. We calculated housing clusters, defined as groups of structures located within a maximum of 100 m from each other, by creating 100 m buffers around all structures and dissolving the overlapping boundaries [51].

Because burned structures were significantly related to small housing clusters [26], we calculated the area of every cluster as an attribute, and then created raster grids based on that attribute. Low-to intermediate housing density and distance to the edge of the cluster were also significant explanatory variables relative to housing pattern and location [26], so we also created raster grids for those. GIS buffer measures at 1-km have been found to explain approximately 90% of the variation in rural residential density [52], so we developed density grids using simple density interpolation based on a 1-km search radius, with area determined through square map units. To create grids representing distance to the edge of clusters, we first collapsed the cluster polygons into vector polyline files, and then created grids of interpolated Euclidean Distance to the edge within each cluster.

Because the MaxEnt model randomly selects background samples in the map to compare with locations of destroyed structures, we used a mask to restrict sampling to the developed environment within cluster boundaries; the distance to the edge of the cluster would represent a different relationship inside a cluster boundary versus outside in the wildland. We also modified the grids to ensure that any random sample located within the 100m buffer zone would receive a value of 100m; thus, all points within the buffer were considered "the edge of the development".

After creating the grids representing housing pattern and arrangement of the current configuration of structures, we applied the same algorithms to the maps of simulated future structure locations. We thus generated grids representing future housing pattern and arrangement under alternative development scenarios. The other explanatory variables, including fire history, slope, fuel type, southwest aspect, and distance to coast [26] remained constant through time for current and future scenarios. Although historic fire frequency and fuel type typically change through time, we did not simulate their dynamics here because we wanted to isolate the effect of planning decisions on housing pattern and arrangement while holding everything else constant.

We conditioned the MaxEnt model on present distributions of housing using ten thousand random background points and destroyed structures located no closer than 500-m to minimize any effect of spatial autocorrelation. We used 80% (260 records) of these data for model training, and 20% [66 records) for testing. We repeated the process using cross-validation with five replicates and used the average of these five models for analyses. For smoother functions of the explanatory variables, we used hinge features, linear, and quadratic with an increase in regularization of beta set at 2.5, based on Elith et al. [48]. The smoother response curves minimize over fitting of the model. We conducted jackknife tests of explanatory variable importance.

We first developed the model using mapped explanatory variables derived from the current configuration of structures. To project fire risk under the different time steps of the alternative development scenarios, projected the model conditioned upon current conditions onto maps representing future conditions by substituting the grids representing future housing pattern and arrangement. This is similar to how potential future distributions of species are projected under climate change scenarios [49].

To quantify differences among current and future alternative scenarios, we calculated metrics representing housing density, pattern, and footprint to determine the extent to which the planning policies produced differences in housing pattern and location. We compared the modeled structure fire risk of the scenarios by overlaying all maps of structure locations with their respective mapped output grids from the MaxEnt models and calculating probability of burning for every structure point. We also calculated total area of risk by selecting three threshold criteria [53]. These criteria, at 0.05, 0.25, and 0.5 represented three different degrees of risk, and we calculated the proportion of structures that were located in risk areas for every time step in all scenarios.

Results

The probit econometric model, run on 113 001 observations, showed that larger parcels were most likely to subdivide, although the relationship between parcel size and subdivision probability was non-linear (Table 1). Parcels closer to existing roads, the ocean, those with lower slopes, and those designated as fit for development were all most likely to develop. Parcels designated in redevelopment areas were less likely to develop. Overall, the model had a pseudo r −squared of 0.22.

The land use simulation model, based on a combination of the econometric subdivision model and three different growth policies, resulted in substantial differences in the extent and pattern of housing of the three scenarios. The total area of housing development, or the housing footprint, was largest for simulations where leapfrog growth dominated, followed by expansion-type development, and then infill (Figure 1a). The differences in the housing footprint became larger among the scenarios over time, but the largest difference was between infill and the other two development types. As the housing footprint expanded in the three scenarios, the corresponding housing density declined, so that leapfrog growth resulted in the lowest housing density per 1-km, followed by expansion and then infill (Figure 2b). Despite the near inverse of this relationship, there was generally a larger separation among scenarios with regard to housing density. With larger housing footprints and lower housing density, the number of separate housing clusters increased while their size decreased (Figure 2c).

In the first two time steps of the model (2015 and 2020), the simulated development pattern closely followed the desired pattern in the scenario, although some of the growth in the infill scenario ended up becoming expansion or leapfrog (Table 2). In the last two time steps (2025 and 2030), there were not enough infill parcels left, and thus, the majority of growth in these simulations became expansion, followed by infill, and then leapfrog. In the last time step, there were not enough isolated parcels in the leapfrog scenario and thus, the majority of development became expansion. Thus in general, as more development occurred in the simulations by the year 2030, the majority took the form of expansion.

The area under the curve (AUC) of receiver operating characteristic (ROC) plots, indicating the ability of the MaxEnt model to discriminate between burned and unburned structures, averaged across five cross-validated replicate runs was 0.91. The AUC represents the probability that, for a randomly selected set of observations, the model prediction was higher for a burned structure than for an unburned structure [49].The two most important variables in the model according to the internal jackknife tests in MaxEnt [47] were related to housing pattern:

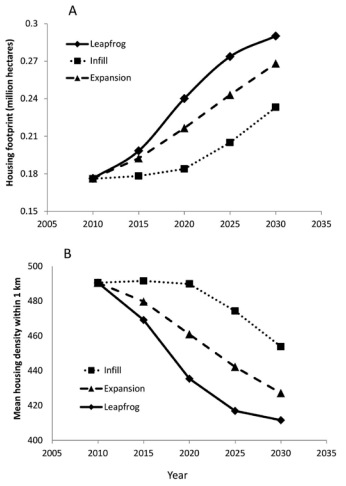

Figure 1. Trends of development extent and pattern for three planning policy simulations from 2010–2030, including A) total housing footprint representing the area of land within all housing clusters, and B) mean housing density averaged across all housing clusters.
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low to intermediate housing density and small cluster size and housing density (Figure 3). The distance to the edge of housing cluster was a less important contribution.

Maps showing the probability of a structure being destroyed in a wildfire, displayed as a gradient from low to high risk, show broad agreement relative to the general areas of the landscape that are riskiest, with correlation coefficients ranging from 0.85–0.91 (Figure 4). Nevertheless, subtle differences are apparent in the three development-scenario maps by year 2030, with the highest-risk areas in the expansion scenario located farther east than infill, and the highest-risk areas in leapfrog occupying a wider extent than either of the other two scenarios.

Differences among current housing and the three development scenarios are clearly illustrated through the mean landscape risk, or total probability of all structures burning (Figure 5). All three development scenarios were predicted to experience an increase in mean landscape risk over the duration of the simulations, except for infill at year 2015. The highest landscape risk to structures was predicted for the leapfrog scenario, followed by expansion, and then infill. The increase in risk over time is more gradual for the infill scenario than the other two scenarios.

The ranking of scenarios varied according to the proportion of structures located within different levels of risk defined through binary thresholding (Figure 6). When the continuous risk maps were thresholded at the lowest number of 0.05, a large proportion

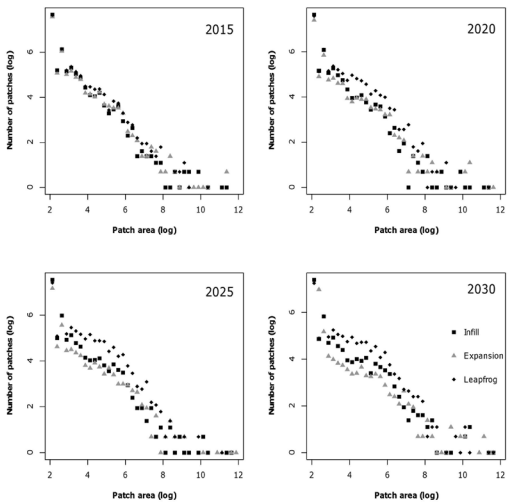

Figure 2. Trends in number of patches and patch area for three planning policy simulations from 2010–2030. Numbers were log-transformed for better visual representation of the scenarios.
doi:10.1371/journal.pone.0071708.g002

of structures in all scenarios fell within areas defined as risky according to this criterion. At this threshold, the proportion of structures in high-risk areas increased linearly for the expansion and leapfrog development scenarios while the proportion of infill homes increased more gradually. When risk was defined more conservatively at 0.25, temporal trends for the leapfrog and infill scenarios were similar to the 0.05 threshold. However, the proportion of structures at risk in the expansion scenario initially increased to 2020, but this proportion leveled off and declined by 2030. When the threshold was highest at 0.50, a very low proportion of structures in any scenario were located in areas at risk. But in these high-risk areas, the expansion scenario switched places with infill to have the lowest proportion of structures at risk in all time steps. Leapfrog had the largest proportion of homes at risk. This proportion of homes located in areas at risk with a threshold at 0.5 declined over time for all three scenarios.

Discussion

Our simulations of residential development showed that planning policies based on different growth types, applied locally for subdivision of individual parcels, will likely produce substantial and cumulative landscape-level differences in pattern, location, and extent of development. These differences in development pattern, in turn, will likely affect the area and proportion of

Table 2. Pattern of simulated development under infill, expansion, and leapfrog growth policies.

		Actual development		
Development scenario	**year**	*Infill*	*Expansion*	*Leapfrog*
Infill	2015	9450	18	6
	2020	11787	153	29
	2025	236	624	144
	2030	325	890	179
Expansion	2015	0	772	0
	2020	0	1243	2
	2025	0	1871	1
	2030	0	2662	0
Leapfrog	2015	0	10	408
	2020	0	5	1132
	2025	1	83	3563
	2030	34	917	0

The numbers in the table denote the numbers of patches of a given development type.
doi:10.1371/journal.pone.0071708.t002

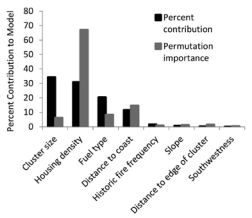

Figure 3. The importance of explanatory variables averaged across five cross-validated replications in the MaxEnt fire risk model. Percent contribution is determined as a function of the information gain from each environmental variable throughout the MaxEnt model iterations. Permutation importance reflects the drop in model accuracy that results from random permutations of each environmental variable, normalized to percentages.
doi:10.1371/journal.pone.0071708.g003

structures at risk from burning in wildfires. In particular, the scenarios with lower housing density and larger numbers of small, isolated clusters of development, i.e., leapfrog followed by expansion and infill, were generally predicted to have the highest predicted fire risk to the largest proportion of structures in the study area. Nevertheless, rankings of scenarios were affected by the definition of risk.

Theoretically, it makes sense that leapfrog development produced fragmented development with larger numbers of small patches, lower housing density, and a larger housing footprint; and that infill resulted in the opposite, with expansion in the middle. By definition, leapfrog development requires open space around all sides of the newly developed parcel, whereas infill requires development on all sides, and expansion requires development on one side and open space on another. Implementing these planning policies on real landscapes, however, can be complex if there are more houses to build than there are parcels that meet the definitions of the three planning rules, and thus not all development conforms strictly to the policy [54]. In our simulations, parcels meeting the definition of each growth type had a higher probability of subdividing; yet, as we were simulating a real landscape, many newly developed parcels did not meet the scenario criteria. That the three scenarios nevertheless produced substantial differences in landscape-level development patterns shows that decision-making at the individual level can lead to meaningful broad-scale effects.

The objective of the econometric model was to provide a baseline probability to predict which parcels were most likely to subdivide; thus, the econometric model itself provides no explanation of how a given policy affects likelihood of subdivision, although it does indicate the correlation between the policy and the outcome. In our setting, which areas are protected, marked for redevelopment, or marked for development may be endogenous to the land owner decision to subdivide. In the case of these variables especially, our results should not be interpreted as causal predictors. Likewise, we use data only from 2005–2009 to predict changes to 2030. If major changes in the land market take place over this time horizon our model will not be able to take this into account.

Although some differences in predicted fire risk among the three scenarios likely stemmed from location of new structures relative to variables such as distance to coast, fuel type, or slope, the most important variables in the fire risk model were housing density and cluster size, with most structure loss historically occurring in areas with low housing density and in small, isolated housing clusters. Thus, leapfrog development was generally the riskiest scenario and infill the least risky. The most surprising result was the variation in predicted risk for the expansion scenario over time and at different thresholds. While leapfrog and infill showed similar trajectories across thresholds, expansion went from being the highest-risk scenario at the low threshold to being the lowest-risk scenario at the highest threshold. Because the threshold is merely a way to group structures into a binary classification, this means that, while the average risk calculated across all homes shows expansion to rank in the middle of infill and leapfrog throughout the simulation (Figure 5), the other two scenarios have a relatively larger proportion of homes that are modeled to be at a very high risk (i.e., 0.25 or 0.5), particularly by the end of the simulations. Because the total number of structures with a risk greater than 0.25 or 0.5 is relatively low in all scenarios, this difference in distribution of homes at the highest risk is not reflected in the mean. Another reason for the shift in rank of expansion over time is that, as more development occupied the landscape, there were fewer parcels remaining to accomplish infill or leapfrog type growth in the other scenarios. Thus, by the end of the simulations in year 2030, the majority of growth in all scenarios was expansion, and there was some convergence between scenarios. Finally, the change in risk of expansion growth over time may reflect that, despite the relatively low importance of distance to edge of cluster as an explanatory variable, expansion growth is characterized as having an initially fragmented landscape pattern that eventually merges into large patches with low edge.

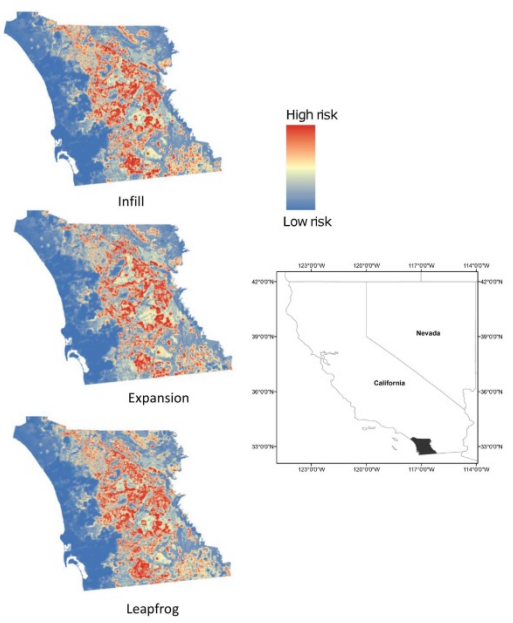

Figure 4. Maps of the study area showing projected wildfire risk at year 2030 for simulations of residential development under policies emphasizing infill, expansion, or leapfrog growth.
doi:10.1371/journal.pone.0071708.g004

Although leapfrog development clearly ranked highest in terms of fire risk, the interpretation of which planning policy is best may depend on fire management objectives and resources, as well as other considerations such as biodiversity or ecological impacts.

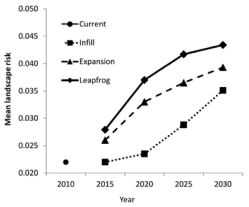

Figure 5. Projected landscape fire risk, reflecting the probability of burning in a wildfire averaged across all residential structures on the current landscape and in three development scenarios of infill, expansion, and leapfrog for year 2030.
doi:10.1371/journal.pone.0071708.g005

The spatial pattern of development affects multiple ecological functions and services [55], with potentially varying conservation implications; both leapfrog and expansion development consumed more land than infill, which would likely lead to more ecological degradation [56]; nevertheless, higher-density clustered development may be dominated by more invasive species [57]. Trade-offs between fire protection and conservation are common, but techniques are available for identifying mutually beneficial solutions [58].

Different perceptions of the fire risk results could also potentially translate into different planning priorities for management. For example, if the priority is to plan for the lowest overall risk to structures, then the mean landscape risk clearly delineates the rankings of options, with infill being the winner. However, if the objective is to reduce the number of structures at the highest risk threshold, i.e., $>=0.5$, then expansion is the best option, at least by 2030. An important consideration for fire management is the total area that needs to be protected, as well as the length of wildland-urban interface [8,13]. Therefore, despite the lower number of structures at the highest risk thresholds, expansion creates more edge than infill and may translate into greater challenges for firefighter protection.

Although we did not create separate scenarios for high or low growth, the results at different time steps can be substituted to envision the potential outcome of developing more or fewer houses. In the short term, the total fire risk is projected to increase proportionately as more land is developed. However, given the inverse relationship between housing density and fire risk, it is possible that this trend could reverse if housing growth eventually resulted in expansive high-density development.

Land use planning is one of a range of options available for reducing fire risk, and the best outcome will likely be achieved through a combination of strategies that include homeowner actions, improvements in fire-safe building codes, and advanced fire suppression tactics. Although we isolated the effect of land use planning policy in the three development scenarios, the fire risk model nevertheless showed that the pattern and location of structures in this study area were the most important out of a suite of factors influencing structure loss. We used a correlative approach that did not incorporate mechanisms or feedbacks, but our models clearly illustrated differences in the cumulative effects of individual planning decisions. The relationship between spatial pattern of development and fire risk is likely related to the intermixing of development and wildland vegetation [29,59]; thus, these results likely apply to a wide range of fire-prone ecosystems with large proportions of human-caused ignitions. Nevertheless, because fire risk is highly variable over space and time, and due to a range of human and biophysical variables [60], we recommend planners develop their own models for the best understanding of where the most fire-prone areas are in their region [19].

With projections of substantial global change in climate and human development, we recommend that land use planning should be considered as an important component to fire risk management, potentially to become as successful as the prevention of building on flood plains [61]. History has shown us that preventing fires is impossible in areas where large wildfires are a natural ecological process [4,9]. As Roger Kennedy put it, "the

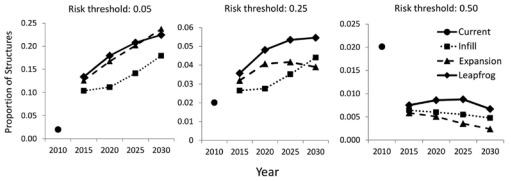

Figure 6. Proportion of residential structures that are located in areas of high fire risk defined using thresholds from the fire risk model of 0.05, 0.25, and 0.5 for current structures and for structures simulated under infill, expansion, and leapfrog growth policies.
doi:10.1371/journal.pone.0071708.g006

problem isn't fires; the problem is people in the wrong places [62]."

Supporting Information

Table S1 Definitions and summary statistics for variables used in the probit model.
(DOCX)

Acknowledgments

We thank V.C. Radeloff for insightful discussions, and we are grateful for the helpful suggestions from Susan Jones, Rob Klinger, Ben Bondurant, and the anonymous reviewers. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Author Contributions

Conceived and designed the experiments: ADS JEK ABM VB. Performed the experiments: ADS ABM VB. Analyzed the data: ADS ABM VB. Wrote the paper: ADS JEK ABM VB.

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EXHIBIT I

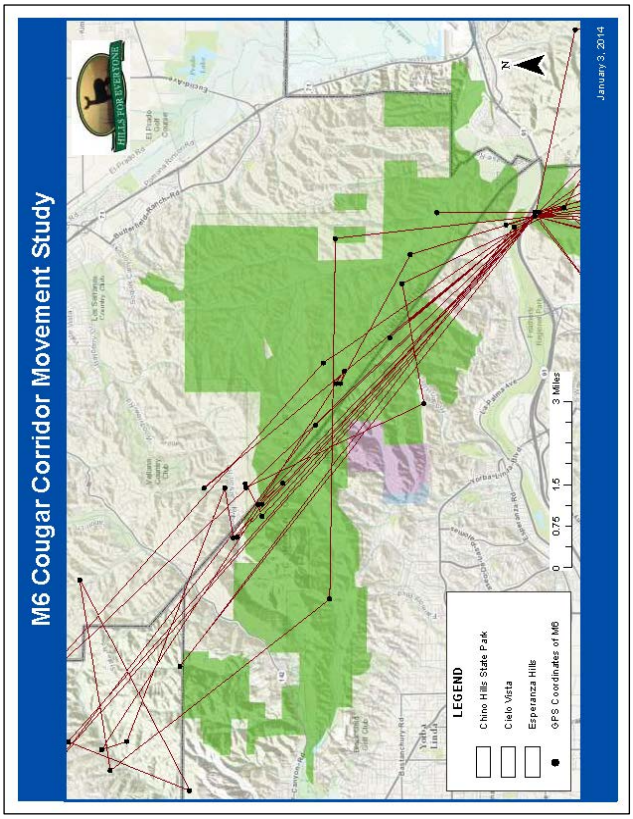

EXHIBIT J

THE COUGAR IN

THE SANTA ANA MOUNTAIN RANGE,

CALIFORNIA

Paul Beier and **Reginald H. Barrett**
Department of Forestry and Resource Management,
University of California, Berkeley CA

Final Report

ORANGE COUNTY COOPERATIVE MOUNTAIN LION STUDY

June 1 1993

CONTENTS

INTRODUCTION

This report summarizes cougar (mountain lion, Felis concolor) research in Orange County from April 1 1988 through February 1 1993. This research was pursued under interagency agreements FG7510 and FG0217 between the California Department of Fish and Game and the University of California at Berkeley, and Agreements D87-232 and FG0233 between the County of Orange and the California Department of Fish and Game. The following headings encompass the 18 objectives explicitly set forth in the contracts. The language following each heading is taken directly from the objectives contained in the contracts. The 10 chapters in this report follow these same headings.

1. Home ranges and habitat use. Document home range sizes for male and female cougars. Document habitat use in the Santa Ana and Santa Margarita mountain ranges.

2. Population density and structure. Determine the density of cougars, and the sex and age class structure of the cougar population.

3. Distribution and travel corridors. Document cougar use of existing County Parks, including habitat use within these Parks, and travel corridors between Parks. Investigate reports of cougar sightings in the San Joaquin Hills and Laguna Greenbelt areas. Evaluate and document the actual and potential movement corridors necessary to insure the integrity of the cougar population.

4. Population dynamics. Document reproductive activity, litter sizes, and recruitment into the population.

5. Utility of track surveys. Evaluate the validity of track survey information.

6. Activity patterns. Document daily and seasonal activity patterns for male and female cougars. Document movements of individual cougars.

7. Prey relationships. Document cougar prey relationships based on field surveys including deer herd composition surveys and examination of cougar-killed prey carcasses.

8. Impact of urban growth. Determine the actual and potential impacts of expanding urban development on cougar habitat. Provide information applicable to proposed highway projects.

9. Cougar-human encounters. Document factors which may help explain the recent increase in cougar-human encounters. Document the reaction of collared cougars to humans and to artificial food sources including garbage. Determine if such reactions vary with changes in cougar density, age of cougar, or the reproductive status of the cougar. Test the feasibility of conditioning cougars to avoid humans by removing artificial food sources and other practical methods. Monitor trends in cougar use of areas on the fringes of development.

10. Public education. Prepare a slide presentation for use in park Visitor Centers, to include: study results, natural history and social behavior of cougars, information on conservation of cougars, and warnings of the potential dangers inherent in having cougars as part of the wilderness.

This report follows this 10-point outline. We are also providing to the County and the Department data files of cougar locations for use in planning and management activities.

Acknowledgments

We gratefully acknowledge the financial support of the California Department of Fish and Game, and of the County of Orange, California. The Department of Fish and Game also supplied capture specialists, vehicles, telemetry equipment, training in animal handling, and air services. Terry Mansfield. Eric Loft, and Bill Clark of the Department were especially important in insuring continued support for this project. We also thank CDFG employees in Region 5: Rich Anthes, Esther Burkett, Jim Davis, John Fallon, Greg Gerstenberg, Cheryl Heffley, Larry Henson, Lisa Kramer, Art Lawrence, Marty Matorini, John Massey, Larry Sitton, Ralph Sugg, Jeff Veal, Ken Walton, Jan Yost, and Al Zamudio. The County of Orange assisted with access to public and private lands and supported the project in many other ways, most notably in allowing Donna Krucki flexibility in her work schedule at Caspers Wilderness Park so that she could assist us in field work. We especially thank County employees Stan Bengtson, Bruce Buchman, Donna Krucki, Al Macias, Gary Madeiros, Tim Miller, Tim Neely, Cathy Nowak, and Chuck Thornberg.

Paul Beier, Allan Brody, Jeff Brent, David Choate, Pete de Simone, Karen Drewe, Donna Krucki, W. Douglas Padley, Tracy Tennant, and Duggins Wroe carried out most of the field work. Dug Wroe's capture skills and Dave Choate's careful field work were critical to our success. Jeff Hornacek, Jack Williams, and Bob Chipman generously loaned their airplanes and services as pilots.

Special thanks go to Doug Padley and Joel Weintraub. Padley monitored radio-tagged cougars for the County of Orange in 1986-87 and for US Marine Corps Base Camp Pendleton in 1987-1989; his data are included in this report. He also worked as a volunteer on this study, and shared data from his 1990-1991 work on mule deer. Joel Weintraub of California State University at Fullerton performed the determination of prey remains in cougar scats.

For gracious access to land holdings, we thank Boy Scouts of America, California State Parks, Ford Aerospace, Hon Development Company, Irvine Company, Metropolitan Water District, National Audubon Society, Orange County, Rancho Mission Viejo, Rancho Santa Margarita, Riverside County, San Diego County, San Diego State University, The Nature Conservancy, TRW Corporation, US Forest Service, US Marine Corps Base Camp Pendleton, and US Naval Weapons Station Fallbrook. Camp Pendleton was especially helpful in arranging access, loaning equipment, sharing data, and in many other ways. Rancho Mission Viejo generously provided several kinds of support, including living space for volunteer field workers.

We offer heartfelt thanks to many others who helped in ways too numerous to mention, among them Jon Atwood, Greg Ballmer, Cameron Barrows, Celia Beier, Michelle Beier, Gary Bell, Pete Bloom, David Bontrager, Dave Boyer, Dave Bramlet, Phil Brylski, Slader Buck, Ray Chandos, Charlotte Clarke, Steve Coontz, Pete de Simone, Sandy de Simone, Paul Edelman, Mike Evans, Merrillee Fellows, Scott Ferguson, Em Fermin, Phil Feyerabend, Dave Fjelline, Robert Frazer, Amy Greyson, Maribeth Gustafson, Loren Hays, Jean Jenks, David Kossack, Sharon Lockhart, Steve Loe, Karlin Marsh, Sherrie Meddick, Lori Merkle, Claudia Meuller, Sara Miller, Pat Mock, Donna O'Neill, Richard O'Neill, Richard Orisio, Marie Patterson, Spence Porter, Fred Roberts, Gordon Ruser, Larry Salata, Joel Shows, Connie Spenger, Maryann van Drielen, Lee Waian, Ken Weaver, Susan Wroe, and Cliff Wylie. We apologize to these people for so brief a mention and to the many others whose names we failed to list.

BACKGROUND, STUDY AREA, METHODS

Background

The cougar (Felis concolor) is also known by the names mountain lion, puma, and panther. Cougars have the broadest distribution of any terrestrial mammal native to the New World, ranging from southern Yukon to southern South America (Lindzey 1987:657). Once native to all of the contiguous United States, cougars now occupy less than half of this historic range, mainly west of the 100th Meridian (Anderson 1983). The main cause of this range contraction was persecution of cougars, which began with European colonization and ended as each state ended its bounty system during 1958-1970. Cougars were present as recently as 1950-1976 in several states where the species is now extinct, including Arkansas, Louisiana, Oklahoma, Tennessee, and West Virginia (Currier 1978, Anderson 1983:80-83). Since the end of the bounty system, cougars have increased in most western states (Smith 1989). However, there are local declines in some areas due to habitat loss and fragmentation. These same processes may prevent cougars from recolonizing the eastern United States. There is no statistically sound and precise estimate of total numbers of cougars for any entire state. The cougar's elusive habits and low density make any such estimate prohibitively expensive. The California population was estimated at 4100-5700 animals in 1984 (Mansfield 1986), a number far larger than for any other U.S. state or Canadian province (Smith 1989).

Hornocker (1969, 1970) carried out the first intensive study on the ecology of cougars, following individually marked animals over time and observing population processes in a well-defined study area. Virtually all our knowledge of cougar ecology has been obtained since 1970. The best summaries of the scientific literature on cougars are provided by Anderson (1983) and Lindzey (1987); Anderson et al. (1992) reference most of the more recent literature. Excluding a half-dozen studies of trends in cougar numbers and depredation incidents, only 3 intensive studies of cougar ecology were carried out in California prior to the present study. Sitton and Wallen (1976) radio-tagged 14 cougars and ear-tagged 2 cubs in a 2-year study in southern Monterey County. Hopkins (1981, 1989) radio-tagged and studied cougars in the Mount Hamilton area (Santa Clara County and adjacent areas) during 1978-1988. Neal et al. (1986) reported on home range use and density in the North Kings River area (west central Sierra Nevada) during 1983-1985.

Until 1986, cougar studies in southern California were limited to track surveys. In that year the National Audubon Society began plans for a radio-telemetry study centered on Starr Ranch Sanctuary. In November 1986, CDFG radio-tagged 2 adult female cougars near Caspers Park and took the lead in planning a larger study. CDFG and County of Orange agreed to jointly fund the study, and in February 1988, the University of California signed a contract to carry out the project; field work began in April 1988. Meanwhile, Camp Pendleton had begun a study using radio-tagged cougars in summer 1987. The two studies were closely coordinated. In late 1989 the Camp Pendleton study terminated and we took over monitoring of those animals. This report treats data from both study sites as a single data set.

The results of the present study appear in several documents in addition to this report:

- Much of the Camp Pendleton data were summarized in Padley's (1990) Master's thesis.
- Padley (in press) reports on social interactions among female cougars in a paper submitted to Journal of Mammalogy.
- Beier (1993) simulated the population dynamics of this cougar population and demonstrated the critical importance of

preserving corridors for wildlife movement. This paper appears as Appendix 1 in this report.

- Beier (1991, 1992) presented the historical record of cougar attacks on humans in the United States and Canada. These papers are included as Appendix 2 and Appendix 3.
- Beier and Loe (1992), in a paper partially related to this study, suggested how to evaluate impacts to wildlife movements. This paper is included as Appendix 3.
- Beier (1993b) described a version of the software used in these simulations, modified for use as a teaching tool.
- Beier reports on "Dispersal movements of cougars in fragmented habitat" in a paper to be submitted for publication this summer.

Additional papers, presently being prepared for publication, will present other results to the scientific community.

Study Area

The Santa Ana Mountain Range was our study area. It included about 2070 square km (800 mi^2) of contiguous wildlands used by cougars; these wildlands include the Santa Margarita Mountains, the Santa Rosa Plateau, the Chino Hills, and the nearby San Joaquin Hills (Figure 1). The study area thus straddled 5 counties and abutted 17 incorporated cities. About 61% of cougar habitat in the study area is in some sort of protected status (Table 1). The largest of these parcels (Trabuco Ranger District, Camp Pendleton, Starr Ranch, and Caspers Park) form a large central habitat area. Many of the smaller protected parcels are at risk of being fragmented from the central habitat area (Table 1), and the central habitat area itself is at risk of being isolated from the adjacent population in the Palomar Range (Figure 1).

The 1988 contract defined the original study area as "Rancho Mission Viejo, Rancho Santa Margarita, Coto de Caza, Starr Ranch Sanctuary, Ronald Caspers Wilderness Park, O'Neill Regional Park, and Wagon Wheel Canyon Regional Park." This area is only about 260 km^2 (100 mi^2, or about 12% of the area used by the cougar population), and we soon realized that meaningful biological results demanded expanding to the entire range. In spring 1989 the study area expanded to include Irvine Company holdings east of I-5 and the Cleveland National Forest. From September 1987 through August 1989, US Marine Corps Base Camp Pendleton funded a companion study of cougars on Camp Pendleton and Fallbrook Naval Weapons Station (Padley 1990). From the beginning, the sister studies co-operated closely, and after September 1989 we formally included these lands in our study. In early 1990 we expanded into the San Joaquin Hills, Chino Hills, and the Santa Rosa Plateau. This final study area included all large wildlands west of Interstate 15 north of State Route 76 and south of State Route 60. These man-made boundaries delimit a biologically meaningful study area because these urban features circumscribe the real confines of a single cougar population. Our study thus encompassed an entire cougar population for its final 2½ years.

The area included a diversity of vegetation communities including:

- **chaparral**, dominated by chamise (Adenostema fasciculatum), ceanothus (Ceanothus spp.), scrub oak (Quercus dumosa), and mountain mahogany (Cercocarpus betuloides). Sumac (Rhus and Malosma spp) and toyon (Heteromeles arbuitifolia) were also common at lower elevations, as was manzanita (Arctostaphylos spp.) at higher elevations.
- **oak woodlands**, dominated by coast live oak (Q. agrifolia) and engelmann oak (Q. engelmannii).

Table 1. Area (hectares) of protected lands contained in cougar habitat in the Santa Ana Mountain Range.

Ownership and Parcel Name	Areas forming a large contiguous block	Areas surrounded by unprotected land
Federal:		
Cleveland National Forest	53,604[a]	
Cleveland National Forest (6 parcels)		626
Camp Pendleton	49,292[b]	
Fallbrook Naval Weapons Station	3,099	
Bureau of Land Management (7 parcels)		550
Bureau of Land Management (1 parcel)	364	
State:		
Chino Hills State Park		5,059
San Diego State University Field Station		1,805[c]
Department of Fish & Game Coal Canyon Preserve	385	
Orange County Parks:		
Caspers	3,085	
Limestone Canyon		2,169[d]
O'Neill		805
Whiting Ranch		632
Irvine		193
Wagon Wheel		178
Santiago Oaks		142
Private Reserves:		
Santa Rosa Plateau Preserve		2,803[e]
National Audubon Society Starr Ranch	1,578	
Rancho Mission Viejo Conservancy		486
Total	111,407	15,448

[a] excludes private inholdings.
[b] includes land leased to San Onofre Beach State Park; excludes 1700 ha in urban uses and airfield; includes some bombing ranges that may not be suitable habitat.
[c] includes 510 ha of BLM land administered by the field station.
[d] expected to be transferred to County from private ownership.
[e] administered by The Nature Conservancy (TNC); includes lands owned by TNC, State of California, and Riverside County.

- **riparian areas**, dominated by coast live oak, sycamore (Platanus racemosa), willow (Salix spp.), mule fat (Baccharis pilularis), and alder (Alnus rhombifolia)
- **coastal sage scrub**, dominated by buckwheat (Eriogonum fasciculatum), true sages (Salvia spp.), and (near the coast) California sagebrush (Artemisia californica),
- **conifer forests**, including bigcone doug-fir (Pseudotsuga macrocarpa), coulter pine (Pinus coulteri), and Tecate cypress (Cupressus forbesii), were found mainly at higher elevations, especially on north-facing slopes.
- **grasslands**, a mixture of native perennials (Stipa spp) and exotic annuals.
- **orchards**, predominantly of oranges or avocados

The topography was rugged, with elevations ranging from sea level to about 1690 m. Very few drainages had perennial surface flow throughout their length, but seeps and other water sources were well-distributed throughout the area. Most water sources remained reliable throughout the drought years that characterized the first half of the study.

Methods

We relied heavily on data obtained from radio-tagged cougars. A total of 32 cougars were captured and radio-tagged during this study. Animals were tagged and died at different times, so that the number monitored at any point in time varied from 4 to 16 (Table 2). To avoid burdening young animals with the stress of pursuit and the weight of a radio-tag, we did not pursue or capture animals under about 10 months of age.

Cougars were captured by using hounds or snares, and immobilized with ketamine hydrochloride and xylazine hydrochloride in a concentrated 5:1 mixture (Jessup and Clark 1986). Immobilized cougars were examined and assigned an age based on tooth wear, pelage, and body mass (Ashman et al. 1983). Some animals were ear-tattooed with a distinctive letter or number code. External body measurements were taken and body mass was measured on a spring scale for most animals. Antibacterial dressing was applied to any wounds, and ophthalmic salve was applied to prevent drug-induced corneal dehydration. Each cougar was assigned a letter-number code, with the letter indicating sex (M, F), and the number indicating the order in which the animal was captured (starting with 1 for the first animal of each sex). Blood was drawn from most cougars and sent to CDFG's Wildlife Investigations Lab (WIL) (Rancho Cordova CA) and/or to National Cancer Institute (NCI) (Frederick MD). WIL tested the blood for pathogens and other characteristics. NCI received tissue from 11 animals (Males 6, 10, 12, 13; Females 2, 5, 15-19) for use in their study of cougar population genetics across the Americas. Johimbine was administered to most cougars to speed recovery from the drugs, and each animal was observed until it was able to walk.

Each captured cougar was fitted with a radio-transmitter collar, weighing about 650g (model 500, Telonics, Inc., Mesa, AZ). Mortality sensors in each collar caused the pulse rate to increase after 6 hours of inactivity. Animals were recaptured to replace the transmitter about 30 months after transmitter deployment.

We regularly determined locations of radio-tagged cougars. Locations were determined from the air about once every 10 days. Ground locations were obtained more frequently, usually every 1-4 days, using standard triangulation techniques (Mech 1983), usually with a single observer.

On over 180 occasions during this study, a focal animal was located by triangulation every 15 minutes for periods of up to 24 hours. Seventy four (74) of the early sessions were for full diel (24-hour) periods, usually noon to noon. Because cougars were rarely active during daylight, 108 of the later session were nocturnal, starting 1 hour before sunset and continuing until 1 hour after sunrise. In selecting the focal animal for a session, we gave strong preference to dispersing juveniles exploring new terrain, to cats at the wildland-urban interface, and to cougars that might yield information on unknown travel routes.

Other field methods included spotlight surveys to determine deer herd composition, track surveys for cougar presence, search of historical records for cougar attacks, building a population simulation model, post-mortem examinations to determine cause of death, and collection and analysis of scats to determine prey. These methods are discussed in the relevant sections of this report.

Table 2. Dates of birth, capture, and death for 32 cougars radio-tagged in the Santa Ana and Santa Margarita Mountain Ranges during 1986-1992. ID# begins with "F" for females or "M" for males. Animals designated "alive" were living as of Feb 1 1993.

ID #	Birth Year	Date of capture	Date of death	Notes:
F1	1981	Oct 31 1986	Jul 1 1989	no litters 1986-89, killed by cougar
F2	1982	Nov 5 1986	Mar 12 1991	litter Jul 1989 (sons M3 & M4), broke femur in vehicle accident Dec 1989, had unusual kinked tail; died of intestinal disease
F3	1983	Sep 16 1987	Dec 28 1989	litters in Nov 1987 (3 cubs, all died by Feb 1989) and Jul 1989 (3 cubs); died of intestinal disease
F4	1979	Jan 8 1988	Jul 20 1990	litter Jul 1989 (2 cubs died within 3 mos); died of "old age"
F5	1984	May 17 1989	alive	no litters 1989-1992; very thin, blue eyes, stump tail
F6	1984	May 20 1989	May 23 1992	litter Aug 1990 (sons M11 & M12), killed by cougar
F7	1986	May 27 1989	--	lost radio contact Aug 15 1992
F8	1986	May 29 1989	Aug 14 1989	killed in vehicle accident on S.R. 91
F9	1983	Oct 17 1987	Mar 1 1992	radio failed Jul 1988, killed on I-15 south of Temecula
F10	1982	Feb 11 1987	Oct 1991?	disappeared Oct 1991 (death suspected); litters Jul 1989 (son M7) and Jun 1991 (2-3 cubs)
F11	1985	Aug 14 1988	Jan 25 1993	litter Jul 1989 (daughter F14), shot (goat depredation)
F12	1983	Aug 15 1988	Dec 21 1990	litter May 1989 (sons M8 & M10), killed on I-5
F13	1981	Mar 25 1990	Oct 10 1990	may have had a yearling cub at capture; killed on S.R. 74
F14	1989	Dec 21 1990	--	collar slipped off
F15	1987	Feb 21 1991	Jun 13 1992	bred several times with M9, but no litters 1991-92; broke hip in vehicle accident Jun 4 1992, died several days later
F16	1989	Jul 28 1991	Sep 19 1991	died 5 weeks after vehicle accident
F17	1989	Jul 28 1991	Jan 7 1992	died of unknown causes (no acute trauma)
F18	1986	Jul 28 1991	alive	litter Dec 1989 (daughters F16 & F17)
F19	1987	Aug 8 1991	alive	no litters during 1991-92
M1	1980	Jan 13 1988	Feb 6 1988	breeding male (several consorts); shot (sheep depredation)
M2	1987	Oct 10 1989	Mar 4 1992	breeding male (many consorts); shot (goat depredation)
M3	1989	Jun 5 1990	Feb 16 1991	entered residential area as a disperser (Feb 8 1991), died of disease
M4	1989	Jun 5 1990	Nov 10 1990	died in vehicle accident or killed by cougar (fed upon by F2 & M3)
M5	1989	Aug 3 1990	Sep 22 1991	captured as disperser in a residential area, broke hip and knee in vehicle accident Apr 23 1991, injuries were major factor in death
M6	1989	Aug 27 1990	alive	captured as disperser; crossed S.R. 91 at Coal Canyon 22 times
M7	1989	Oct 23 1990	alive	successfully dispersed; no breeding documented
M8	1989	Oct 29 1990	May 3 1991	dispersed from Pendleton to Chino Hills, killed on S.R. 60
M9	1986	Feb 17 1991	alive	breeding male (many consorts)
M10	1989	Feb 25 1991	Sep 15 1992	dispersed from Pendleton to S.R. 91, broke femur May 7 1991 in vehicle accident, killed on impact in second accident
M11	1990	May 4 1991	Feb 29 1992	light injury in vehicle accident Feb 4 1992, shot in City of Oceanside
M12	1990	Aug 15 1991	Apr 1 1992	dispersed via Pechanga Corridor into Palomar Range; died of unknown causes
M13	1988	Oct 25 1991	alive	captured as disperser; no breeding documented

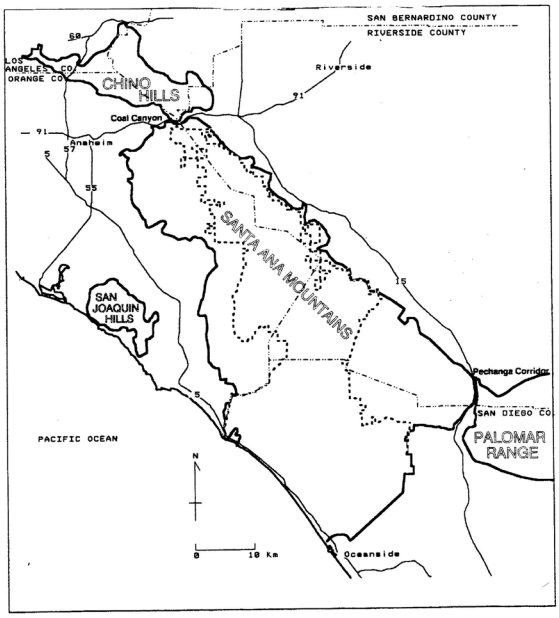

Figure 1: The heavy solid lines enclose 3 areas: 800 mi^2 (2070 km^2) of cougar habitat in the Santa Ana Mountain Range (including the Santa Margarita Mountains and the Chino Hills); 29 mi^2 (75 km^2) of suitable habitat in the San Joaquin Hills (subpopulation recently extinct); and (east of Interstate Highway 15) a portion of the habitat of the adjacent population in the Palomar Range. The heavy dashed line encloses 430 mi^2 of protected areas forming a large contiguous block of habitat (Cleveland National Forest, Camp Pendleton, Fallbrook Naval Weapons Station, Caspers Park, Starr Ranch Sanctuary).

CHAPTER 1. HOME RANGES AND HABITAT USE

Home ranges

The minimum convex polygon (MCP) method was used to calculate seasonal and cumulative home range size for each adult cougar. Home range sizes were calculated separately for the wet season (November-April) and the dry season (May-October). Home ranges were not calculated for: (1) animals monitored for fewer than 160 days out of each season's 182 days, (2) animals with less than 45 locations in a season (unless the home range size was larger than average), or (3) mothers with young (0-8-weeks-old) cubs during that season. In addition, F5 was excluded in several seasons because she exhibited 2 distinct home range areas separated by a large intervening area with little use (see below). Occasionally an animal would make an excursion far outside its normal home range, and these outlying points were excluded from MCP home ranges.

Home ranges of adult females averaged about 113 km^2 (6-month season) and 218 km^2 (cumulative) (Table 3). Male home ranges were about 4 times the size of female ranges, averaging about 485 km^2 (6-month season) and 767 km^2 (cumulative). Home range size did not differ between wet and dry seasons ($P > 0.50$ for females or males). The smallest female seasonal home range was 56 km^2 (F1 in the wet season of 1986-87), and the largest was 195 km^2 (F19 in the 1992 dry season). Seasonal ranges of males varied from a low of 356 km^2 (M2, 1990 dry season) to a high of 635 km^2 (M9, 1991 dry season).

Table 3. Seasonal and cumulative home range areas (km^2) for adult cougars in the Santa Ana Mountain Range, as computed by the minimum convex polygon method. Wet Season = November-April; dry season = May-October; n = number of seasons monitored. We excluded F5's locations for 1989-90, when she wandered widely. See Table 1 for duration of cumulative ranges. Number of locations includes no more than 1 location per day. Areas were computed only when there were at least 45 locations spanning 100 days within a season.

Cougar	Wet Season mean area	n	Dry Season mean area	n	Cumulative area	no. of locations
F1	108	3	123	2	252	433
F2	77	4	76	3	268	718
F3	65	2	91	1	112	590
F4	77	2	124	2	208	537
F5	76	2	94	2	127	151
F6	164	2	154	2	272	267
F9	108	1		0	144	213
F10	121	2	135	3	297	380
F11	115	4	87	4	191	357
F12	96	2	97	1	162	304
F15	151	1		0	349	131
F19	145	1	195	1	230	130
Female Mean	**109**		**118**		**218**	
M2	494	3	367	2	705	290
M9	552	1	527	2	829	129
Male Mean	**523**	**4**	**447**	**4**	**767**	**210**

Our sample included only 2 adult males (M2 and M9) with known histories of consorting with females. Most other radio-tagged males died before establishing a stable adult home range. Three of the young males (M6, M7, and M13) exhibited stable home ranges during the last months of the study, and these home ranges will probably form the nucleus of their eventual adult home ranges if they continue to survive. However, their home ranges remained markedly smaller than those of M2 and M9 through the end of the study. The home ranges and movements of these and other dispersing juveniles are discussed in detail in Chapter 6.

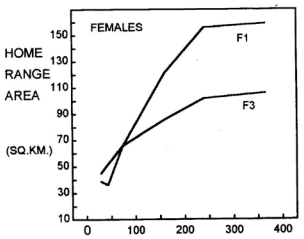

Figure 2. Area used by 2 adult female cougars as a function of length of the observation period.

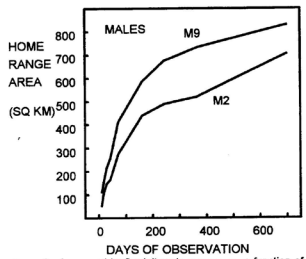

Figure 3. Area used by 2 adult male cougars as a function of length of the observation period.

One adult female, F5, exhibited an unusually large home range during 1989 dry season and the 1990 wet season. During these months she alternated between 2 widely separated home range areas (Figure 4). F5 was unusual in several other respects that may or may not have any bearing on her home range pattern: (1) During 2.5 years of monitoring we could not confirm that she consorted with a male or had any cubs, (2) F5 was markedly thinner than other adult females (although not emaciated), and (3) F5 was the only adult in our study with blue (rather than yellow) eyes. The latter 2 traits were evident both during the initial capture and during recapture to replace her radio-collar 26 months later.

The size of each adult cougar's home range increased with the length of the observation period, but it eventually reached an asymptote (plateau) at about 200-250 days for females, at which point there was only about a 10% increase in area for an additional 200-400 days of observation (Figure 2). For males, home range size continued to increase with increasingly long observation periods (Figure 3). This means that it took about 7 months for an adult cougar to use most of its home range, and that only a fraction of its range was used in any given week or month. An adult female cougar typically used less than a third of her home range in any given month (Figure 2).

This finding has implications for using tracks or other sign to detect cougar presence. For example, such sign is often used to determine whether the site of a proposed project is being used by cougars. No sign for a 200-day sampling period would be strong evidence that the site is not a normal part of any cougar's home range. However, shorter efforts could well fail to detect the presence of a resident cougar.

Overlap among home ranges

Home ranges of adult females overlapped extensively when viewed on an annual basis (Figures 4 & 5). This pattern of wide overlap among adult females has been reported in 14 of 16 studies addressing this issue (references in Anderson 1992:Table 35).

Home ranges of adult males overlapped each other minimally (Map 4). However, home ranges of transient males were overlapped almost entirely by the ranges of adult males. Of 14 previous studies addressing the issue of overlap among males, 8 reported little or no overlap and 6 studies reported considerable overlap among adjacent males (summary in Anderson 1992:Table 35). Because many studies did not distinguish subadult males from territorial adults, some reports of male-male overlap could reflect tolerance of subadult males by adults. Alternatively, the studies reporting non-overlap were based on only 2-4 males (versus 4-7 males in studies noting overlap); they may have failed to detect overlap simply due to under-sampling.

Adult female cougars regularly encountered each other, and on many occasions pairs of adults remained close together (0-300m apart) for 1-3 days. Such pairings were observed on about 20 occasions, and included 8 different females. Observations of such associations among adults have been reported very rarely in previous studies; W. D. Padley (J. Mammalogy, In Review) summarizes most of the data on female-female interactions collected in this study effort.

Habitat use

Radio-tagged cougars in the Santa Ana Mountain Range used all available habitats, although some types were apparently preferred and others avoided. In a future report, we will overlay cougar locations on vegetation maps and give a more formal analysis of habitat use and preference. We have obtained digitized habitat data for Riverside County (west of I-15) and for Camp Pendleton, but Orange County and San Diego County did not have vegetation data ready for release in time for us to analyze the data and include them in this report. We anticipate receiving the San Diego data in June 1993 and the Orange County data in Fall 1993.

In the interim, we offer the following qualitative assessments based on our field experience with respect to 5 factors that influence habitat suitability, namely: vegetation, topography, fire, human use, and habitat size and connectivity. We caution that future conclusions from quantitative analyses of vegetation data may differ from these tentative conclusions.

Vegetation. Cougars clearly used all native vegetation types, but used large grasslands (e.g. Horno Canyon near San Juan Capistrano, large areas in the Chino Hills and Santa Rosa Plateau) much less than would be expected on the basis of relative availability of that habitat type. Horno Canyon, for instance, was used by only 2 cougars, both subadult males, and only on a few occasions. Smaller grassland areas (e.g., much of the Cañada Gobernadora and Cañada Chiquita flood plains) were more readily used than large grasslands. When cougars crossed grasslands during overnight monitoring sessions, they usually moved quickly across them to the nearest woody vegetation. The cougar's reliance on stealth and ambush probably accounts for this tendency to avoid open areas. Row-crop agricultural areas were strongly avoided, and orchards were moderately avoided, by cougars.

There have been 3 previous quantitative assessments of cougar preference for various vegetation types (Laing and Lindzey

1991, Logan and Irwin 1985, and Belden et al. 1988). These studies also reported avoidance of agricultural areas, habitats lacking woody vegetation, and habitats that provided little horizontal (hiding) cover.

Topography. Cougars used all types of terrain, including the steepest slopes and rock outcrops, and all aspects. During all night monitoring we documented that cougars hunted, traveled, and rested in a variety of topographic situations. We suspect there might also be some avoidance of flat areas, as reported by Logan and Irwin (1985) and Laing and Lindzey (1991), but this would be difficult to document in our study because almost all flat areas had been cleared for housing, row crops, or livestock pastures.

During long distance movements, cougars seemed to prefer the scour zones in the bottoms of larger canyons. Dirt roads often paralleled these zones, and typically a cougar alternated between walking in the road and in the wash. Ridgetops were also favored travel routes, especially when a dirt road or hiking trail created an easy path through chaparral or other brushy vegetation. Although the preference for canyon bottoms and ridgetops for travel was pronounced, it was far from absolute; on many occasions cougars traveled midslope along a contour line, along the fall line of a steep slope, or diagonal to the fall line. Even when traveling predominantly along a ridge or wash, cougars made frequent detours into other topographic situations.

Fire. Radio-tagged cougars experienced several large fires during the study. The animals always successfully avoided the flames. When a fire occurred within a cougar's home range, the cat usually re-entered the burned area (or at least the unburned patches within that area) within 2 weeks after the fire. For example, on October 18-20 1989, a 9000-acre fire burned portions of Camp Pendleton, Rancho Mission Viejo, and Cleveland National Forest. The burned area includes large portions of Talega, San Mateo, and La Paz Canyons, which are very important parts of F3's and F4's home ranges. In the first week following the fire, both cats avoided the burn area, but started re-using it within 2 weeks and made extensive use of the burn within 6 weeks. A similar patterns of short-term avoidance of burn areas was exhibited by F11 on Camp Pendleton on 2 occasions.

Human use. Radio-tagged cougars traveled through some rural areas with low housing density, e.g., Williams Canyon, Santiago Canyon just west of Modjeska, the cluster of dwellings on Starr Ranch. Cougars categorically avoided denser areas such as the communities of Modjeska, Silverado, and Trabuco Canyon, although they would skirt these areas within 100 meters of the peripheral homes.

It is difficult to specify the housing density at which cougars will cease to use an area. Cougars clearly tolerate 1 dwelling per 40 acres, if the area is adjacent to unpopulated areas. Our best estimate is that the transition from habitat to nonhabitat occurs at about 1 dwelling per 20 acres. Under ideal conditions (no tall fences, no free-roaming dogs, low-speed roads, minimal loss of native vegetation, no goats or sheep to provoke depredation incidents, tolerant landowners) we suspect that cougars might tolerate housing densities as high as 1 dwelling unit per 10 acres.

Habitat Size and Connectivity. Because cougars have large home ranges and do not reach high population density, habitat must be either contiguous with or connected to at least several hundred square miles of suitable habitat. Because the undeveloped portion of the Santa Ana Mountain Range is only about 2070 km^2 (800 mi^2), connectivity is critically important, and loss of connectivity is the main factor threatening to cause many wildlands to cease being cougar habitat. For example, the

San Joaquin Hills, which was ideal habitat with respect to the first 4 criteria, has not been cougar habitat since it was isolated from larger areas of habitat. It is simply too small to support a cougar population in isolation. This subject is discussed at greater length in Chapters 3 and 4, and in Beier (1993).

In summary, cougars in the Santa Ana Mountain Range were habitat generalists. Although some habitat types were used more than others, cougars were neither obligate users of any particular vegetation type, nor did they show a categorical aversion to any native vegetation type that included woody cover. In general, all land in the Santa Ana Mountain Range (including the Santa Margarita Mountain Range, the Santa Rosa Plateau, and the Chino Hills) was cougar habitat if it met all 5 of the following criteria:

1. The vegetation was predominantly native.
2. There was some woody vegetation.
3. The area had ample prey, especially mule deer.
4. There was a low density of buildings and human dwellings.
5. The area was contiguous or connected to the main block of cougar habitat (see Figure 1).

CHAPTER 2. POPULATION DENSITY AND STRUCTURE

Thirty-two cougars were radio-tagged during this study (Table 2). The number of radio-tagged animals increased in the first 3 years as our effort and the size of the study area increased, and then decreased in the final 1.5 years as we discontinued capture efforts. These changes do not reflect changes in cougar numbers. In all likelihood, the number of adult cougars has not changed markedly during the 5 years of the study. Although the long-term prognosis is for cougar numbers to decrease as habitat is lost and fragmented, we could not detect significant change in this 5 year period.

The sample of radio-tagged cougars was largest in August-September 1991; at that time the population consisted of a minimum of 7 adult females, 3 adult males (counting M6 as an adult who had not yet established a full-size territory), 3 subadult males, 2 female cubs, and 2 male cubs, for a total of 10 adult and 7 juvenile cougars.

Because a relatively large fraction of the population was radio-tagged in September 1991, we estimated cougar numbers in the Santa Ana Mountains for that month. In these estimates, cougars are classed as cub (from birth until dispersing out of its mother's home range at 18-24 months of age), subadult (from age of dispersal until a stable home range is established), or adult (over 24 months of age and exhibiting a stable home range). "Juvenile" refers collectively to cubs and subadults. We estimate that there are about 2070 km^2 (800 mi^2) of suitable cougar habitat (Figure 1).

The true population size in September 1991 was larger than the sample of radio-tagged animals. We made no attempt to capture or radio-collar cubs younger than 10 months of age, and we know that at least 2 such cubs (offspring of F10) were alive at that time. M13 (a subadult collared October 1991) and another young male shot on a depredation permit in January 1992 (see below) were also present in September 1991 (unless they immigrated from the Palomar Range). Tracks indicate that at least 3 other uncollared cougars (females or subadults) were present in easily-surveyed areas in late 1991. Furthermore, much of the Cleveland National Forest is not conducive to capture efforts or track surveys, so probably several more uncollared animals were not detected. Finally, the regular appearance of dispersing subadult males that were not the offspring of radio-tagged females indicates that there were additional adult females.

Nonetheless, 3 lines of evidence suggest that a large fraction of the population (at least those over about 20 months of age) in the Santa Ana Mountain Range was radio-tagged in Fall 1991:

(1) **Depredation incidents**. During 1991, Orange County Animal Control, CDFG wardens, or citizens relayed to our study team about 12 reports of domestic goats or sheep being killed by cougars. Eight cases were promptly investigated (in other cases, the report was received too long after the fact to be useful). In 7 of these 8 cases, a radio-tagged cougar was almost certainly the offending animal, based on its proximity to the fresh carcass. Although 1 cougar (M12) was the offender in 4 of the cases, the other cases involved 1 uncollared and 3 different radio-tagged cougars.

Although 7/8 of these livestock depredations involved radio-tagged cougars, it would be inappropriate to conclude that 7/8 of the entire population was radio-tagged. The depredations all occurred in the western foothills of the range (Santiago Canyon, Williams Canyon, Live Oak Canyon, La Paz Canyon, and San Onofre Canyon). The study team was most active in these foothills throughout the study, and may in fact have

collared about 80% of the cougars using these foothills. However, in other parts of the range, a smaller proportion of the cougars was radio-tagged.

(2) **Highway accidents**. Highway Patrol officers, Camp Pendleton wardens, police, local Animal Control agencies, and citizens regularly relayed to us reports of cougars being hit by automobiles. During August 1990 through January 1992, we received 9 such reports (we exclude an incredible and unverifiable report from Dana Point). Seven of these 9 accidents involved radio-tagged cougars (see last Quarterly Report). The other 2 accidents involved an animal killed on I-15 near Temecula (October 1990) and a probably valid report of a non-fatal accident on Basilone Road (Camp Pendleton, August 1990).

Again, the collisions occurred in well-roaded areas which were also the areas where we were most able to detect and radio-tag cougars, so we caution that we probably had not radio-tagged 78% (7/9) of the population. Nonetheless every cougar faced some risk of a vehicle collision (each radio-tagged cougar crossed paved roads on several to many occasions) and clearly these data show that a large fraction of the population was radio-tagged.

(3) **Inadvertent recaptures** in Roblar and lower De Luz Creeks. After F10 and her cubs disappeared in late October 1991, we put 5 snares in her home range and checked them for 33 days. Although we did not catch F10, 3 other radio-tagged animals (M9, F15, and F18) tripped these snares during that time. The snare sites were in peripheral and rarely-used portions of the home ranges of F18 and F15. Most significantly, no uncollared cougar visited any of the 5 snare sites during this time. Although a 30-day effort does not rule out use of these canyons by uncollared animals (Chapter 1: home range size), clearly there were far more radio-tagged than uncollared cougars in the vicinity of Roblar and lower De Luz Canyons.

This evidence strongly indicates that in September 1991 we had captured at least half, but certainly not all, of the adult population. To estimate the total number of adult cougars, we examined maps of cougar home ranges for adults of each sex during 1991 and 1989.

Home ranges of adult females did not vary over the years either in size or in amount of overlap (Chapter 1). Home range overlap is well illustrated in the Camp Pendleton area in 1991 (Figure 5) and in several areas in 1989 (Figure 4). If we extrapolate this amount of overlap throughout the range, we estimate that we had collared about half of the adult females. Thus, there may have been about 14 adult females in the entire Santa Ana Mountain Range in September 1991.

The range may well be capable of supporting more than 14 adult females. There was a failure in reproduction in much of the southern half of the range during 1988 and it is possible that the number of adults in 1991 may not yet have rebounded to normal levels. This would be supported by the fact that 2 adult females used the Caspers Park area as the core of their home ranges in 1989 (Figure 4), whereas no adult female did so during 1991-92 (Figure 5, and road-tracking data: any adult female would have been detected in almost daily track searches by our crew or by trained Park rangers). Because Caspers Park is excellent cougar habitat, it will doubtless be occupied again. As recruits fill in vacancies created by recent adult mortality, it seems reasonable to expect that the mountain range can probably support 3-4 additional adult females.

A similar map of adult male home ranges as of October 1991 (Figure 6) includes 2 young males (M6 and M7) who exhibited stable

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home ranges for several months. Although the 1991 home ranges of M6 and M7 were significantly smaller than those of M2 and M9, they were far larger and more stable than the ranges of dispersing males, and probably were early adult territories. Based on the minimal overlap among these ranges and the lack of suitable habitat not occupied by these males, probably no more than 1 adult territorial male was not radio-tagged in September 1991. Male territory sizes are probably somewhat plastic, and a larger number of males could probably coexist by using smaller territories and tolerating more overlap. However, it seems that a reasonable estimate for the maximum number of adult territorial males is 7 or 8.

In summary, we estimate that the Santa Ana Mountain Range contained 10-14 adult females in September 1991, and that it may be able to support an average of 10-19 adult females in the long run. We also estimate that the Range contained 4-5 adult (or near-adult) males in September 1991, and that it may be able to support as many as 7-8 adult males in the long run. Juvenile mortality is very high and variable, as is reproduction, so we offer only a very rough estimate of 10-20 juvenile cougars in the Range.

Schoenfelder and Kimple (1979) used road transects to estimate cougar numbers in the Santa Ana Mountain Range in 1977 and 1978. They defined any medium or large size track traveling alone as "adult" (this would include both subadults and adults as defined herein). They estimated 12-18 adult-size cougars within the 400 square miles of the Santa Ana Mountain Range they surveyed. Assuming that about 25% of these animals were subadults, and extrapolating to the current total of 2070 km^2 (800 mi^2) of habitat, their estimate would be 18-27 adults. Our estimate of 14-19 adults (in September 1991) and 14-27 adults (potential long term carrying capacity) is similar to theirs. Given the poor accuracy and precision of track surveys (Van Dyke et al. 1986, Van Sickle and Lindzey 1992, Kendall et al. 1992), this agreement is probably due largely to chance.

Sex Ratio. The ratio of adult females to males in September 1991 was 1.75:1 for radio-tagged animals (counting M6 and M7 as adults; the ratio would be 2.3:1 if M7 is classed as subadult). Using estimated population size for Fall 1991, the adult sex ratio was between 2.5:1 (10/4) and 2.8:1 (14/5). In the long-term the expected sex ratio would be about 2:1 (15/7.5). Most other studies have also reported a sex ratio of approximately 2:1 (Seidensticker et al. 1973, Currier et al. 1977, Ashman et al. 1983, Murphy 1983, Hemker et al. 1984, Logan et al. 1986, Neal et al. 1987, Hopkins 1989). A few studies have reported other adult sex ratios, but all vary between 1:1 and 3:1 (Hornocker 1970, Seidensticker et al. 1973, Currier et al. 1977, Shaw 1977, Hopkins 1981, Quigley et al. 1989).

Carrying capacity. Dividing the long-term number of adults by the total 2070 km^2 of habitat, we estimate carrying capacity as 0.7 adult females and 0.35 adult males per 100 km^2 (or about 2 adult females and 1 adult male per 100 mi^2 of habitat). Previous studies have provided widely varying estimates of density many of which are roughly the same as our estimates (Hornocker 1970, Seidensticker et al. 1973, Sitton and Wallen 1976, Currier et al. 1977, Shaw 1977, Hemker et al. 1984, Logan et al. 1986, Neal et al. 1987, Hopkins 1989). It is difficult to determine how well previously reported densities correspond to our estimate because some studies lump non-breeding subadults with adults and because some study sites were chosen because of atypically high cougar densities.

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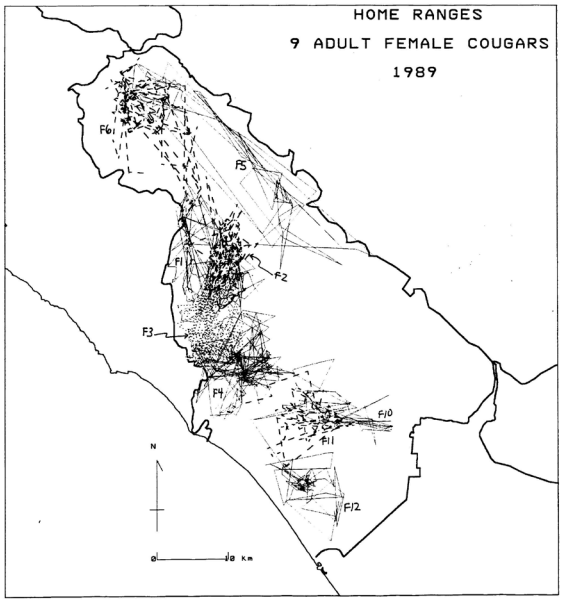

Figure 4. Home ranges of the 9 adult female cougars radio-tagged in July 1989. For each home range all locations for 1989 are connected in chronological order. The heavy solid line encloses 800 mi^2 of cougar habitat in the Santa Ana Mountain Range.

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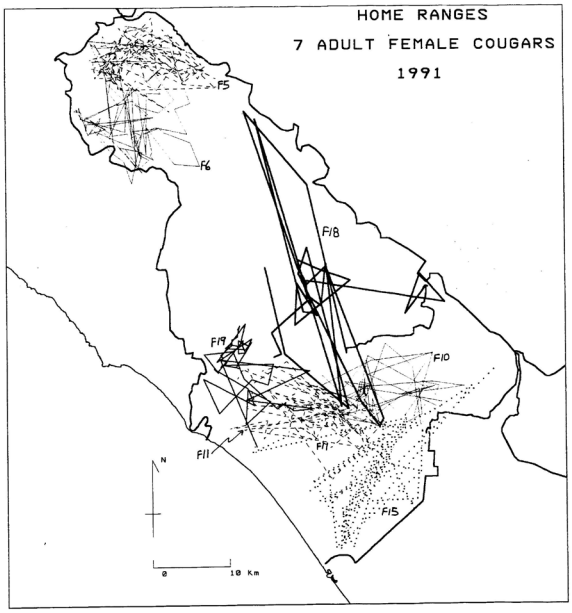

Figure 5. Home ranges of the 7 adult female cougars radio-tagged in September 1991. For each home range all locations for 1991 are connected in chronological order. The heavy solid line encloses 800 mi^2 of cougar habitat in the Santa Ana Mountain Range.

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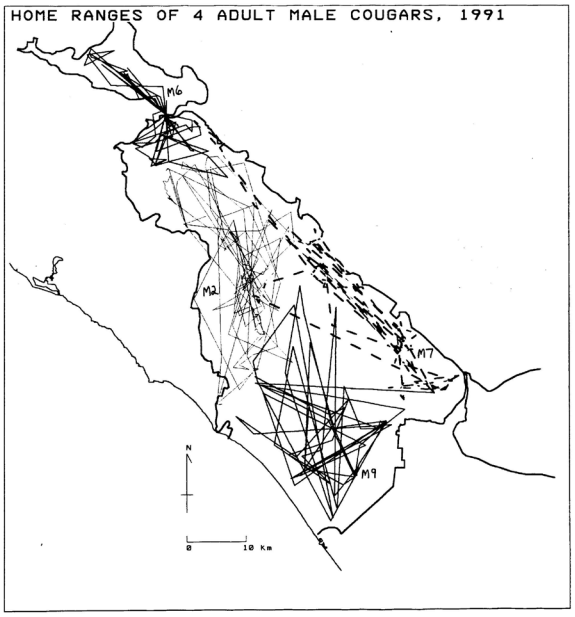

Figure 6: Home ranges of the 2 adult male cougars (M2 and M9) radio-tagged in December 1991 and 2 near-adults (M6 and M7). M6 and M7 continued to expand on these home ranges throughout 1992. For each home range all locations for 1991 are connected in chronological order, except for M6 (whose range excludes dispersal movements and includes only Oct 91-Jan 92 locations). The heavy solid line encloses 800 mi^2 of cougar habitat in the Santa Ana Mountain Range.

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CHAPTER 3. DISTRIBUTION AND TRAVEL CORRIDORS

Cougar Habitat in the Santa Ana Mountain Range

Using the 5 criteria listed at the end of Chapter 1, there was about 2070 km^2 (800 mi^2) of cougar habitat in the Santa Ana Mountain Range during 1988-1992. We obtain the same estimate by computing the area within a polygon enclosing all cougar locations. The largest uncertainty in this estimate concerns over 50 km^2 of land in and around the Santa Rosa Plateau that had a mix of orchards, low-density housing, and semi-open pasture. These areas were included in our estimate on the basis of documented cougar use (usually brief visits). However, much of this area was clearly marginal habitat, and will become unusable if human use intensifies.

Cougar Use of County Parks East of I-5

All major regional parks east of I-5 were cougar habitat. Caspers Wilderness Park, Limestone Canyon Regional Park, Whiting Ranch Regional Park, Wagon Wheel Regional Park, Weir Canyon Regional Park (proposed), Irvine Regional Park (including the Villa Park impoundment) and O'Neill Regional Park (including the Arroyo Trabuco) were all used regularly by radio-tagged adult cougars. Each of these 7 parks was an important part of the home range of at least 1 radio-tagged adult cougar.

In addition, Peters Canyon Reservoir Regional Park and Santiago Oaks Regional Park were both used by subadult radio-tagged cougars, although we never documented use by any adult cougar. Only one cougar (M5) used Peters Canyon Reservoir. He first encountered and used the reservoir during his dispersal explorations, but most of his use of the area was after he broke his hip and knee in a vehicle accident. Both M5 and M10 used Santiago Oaks Regional Park (both after their vehicle accidents). Although both parks offered excellent habitat in terms of good native vegetation, ample woody cover, and ample prey, each was marginal with respect to housing density and connectivity (see Chapter 1: habitat use). Both parks were immediately adjacent to and nearly surrounded by high density housing tracts, and both had only a narrow connection to the central block of habitat. Indeed the only non-urban terrain adjacent to Peters Canyon Reservoir was an open grassy area nearly 400 m wide, with only 2 thin stringers of shrubs leading toward larger suitable habitat.

Peters Canyon Reservoir will become unusable by cats if the Eastern Tollroad or East Orange Project is built. Even without these projects, it will remain marginal and rarely-used habitat.

In contrast, good riparian vegetation connects Santiago Oaks Regional Park to Irvine and Weir Canyon Parks. Santiago Oaks Regional Park will probably continue to receive occasional use by cougars, especially by dispersing juveniles and injured animals. However, if the proposed Eastern Tollroad (and the tract homes that follow it) isolates Irvine and Weir Canyon Regional Parks from the central habitat area to the east, it will remove cougars from all 3 of these Regional Parks.

We never documented any cougar use of Carbon Canyon Regional Park in the Chino Hills. Nonetheless it did meet all 5 criteria for cougar habitat, and we believe that it was occasionally used by cougars during 1988-1992. It certainly will be potential cougar habitat as long as cougars remain in the Chino Hills.

All regional parks, except Caspers Wilderness Park, will become unusable by cougars if urbanization isolates them from the central habitat block. Loss of the Limestone Canyon-Whiting Ranch Parks complex would be a severe blow to the cougar population, and such isolation is certain to occur without careful management of urban growth along Santiago Canyon Road. The proposed Eastern Tollroad and the housing tracts that will follow it will (unless carefully planned) similarly prevent cougars from using Irvine Regional Park and the proposed Weir Canyon Regional Park. Ongoing and future urbanization, especially that associated with the proposed Foothill Tollroad, threaten to isolate O'Neill and Wagon Wheel Regional Parks. These issues are discussed at greater length under "corridors" below.

Cougar Use of the San Joaquin Hills

West of Interstate 5 there is only 1 area - the San Joaquin Hills - that meets 4 of the 5 criteria for cougar habitat. The San Joaquin Hills offer ample native vegetation, woody cover, and prey (including mule deer). About 75 km^2 (29 mi^2) of the area had low (essentially zero) housing density in 1990-91. The area included 5 relatively pristine canyons: Muddy Canyon, Moro Canyon, Emerald Canyon, Bommer Canyon, Shady Canyon, and Wood Canyon. Good habitat also existed in portions of Laguna Canyon and about half of Los Trancos Canyon. The only missing habitat element lacking was connectivity, with about 5 km (3 mi) of urban sprawl isolating these hills from the main block of cougar habitat. Although this area became isolated only about a decade ago and probably supported a few cougars for several years afterward, our population model (Chapter 4) demonstrates that an area of this size cannot sustain a breeding population of cougars.

Nonetheless, there were persistent reports of cougars being sighted in the San Joaquin Hills. On several occasions (October 8 1989, 2 dates in winter 1990, and September 21, September 30, and October 3 1992) we were able to initiate track surveys within hours of such reports. On each occasion we searched the site of the report and adjacent washes, ridges, trails, and dirt roads for tracks. Although tracks of many species were evident, no cougar tracks were seen.

On the chance that 1-2 cougars might still be hanging on in the San Joaquin Hills, we undertook intensive track surveys in the San Joaquin Hills from May 21 through May 26 1990 (6 consecutive days). Dusty road conditions were optimal for tracking on all survey routes. On each survey, we covered a Basic Survey Route consisting of 2 tributaries of Laguna Canyon and the full lengths of Moro, Shady, Emerald, and Wood Canyons. Portions of Bommer, Los Trancos, and Muddy Canyons were covered on some of the survey dates. A detailed route map was included in this study's Quarterly Report dated August 1 1990. To design the Basic Survey Route we first identified the roads that traversed the best cougar habitat, selecting those that crossed the area from one developed edge to the other. In addition to the Basic Survey Route, on each day we also covered some road segments on secondary canyons or ridges. On average, each secondary segment was covered twice during the survey period.

Our rationale in repeatedly checking the same long roads daily for a week was based on the habits of radio-tagged cougars. Although a cougar may remain in one place for 3-4 days while feeding on a deer, over the course of a week there are several nights during which the cat hunts, traveling several km per night. The only exception is a mother with newborn cubs who may remain within 2 km of the den for the first few weeks postpartum. In all other circumstances, we would expect a

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cougar to cross dirt roads on several occasions during a week-long period.

The track survey was usually carried out by a 2-person team. One person drove the vehicle at 5-8 mph while the second sat on the hood and searched the ground for tracks. On 2 survey dates, the route was covered by a single observer. On these days the observer attempted to compensate by driving very slowly and frequently stopping to investigate on foot.

No cougar tracks were detected on any of the surveys. We did find tracks of prey species, including deer, cottontail rabbits, coyotes, raccoon, fox, opossum, and bobcat. Emerald Canyon had markedly more deer tracks than the other canyons surveyed.

Because our coverage of the area was so thorough and the tracking conditions so good, we conclude that cougars no longer live in the San Joaquin Hills.

Wildlife corridors

A wildlife corridor is a piece of habitat, usually longer than wide, with vegetation and topography that facilitate the movements of wild plants and animals from 1 large patch of suitable habitat to another (Harris and Gallagher 1989). Forman and Godron (1986:364-426), Adams and Dove (1989), and Harris and Gallagher (1989) provide comprehensive reviews of the literature on corridors.

Over most of the cougar's range in North America, cougars have access to a vast interconnected landscape and there is no pressing need for corridors. In the Santa Ana Mountain Range, however, urbanization has nearly isolated the cougar population from the only adjacent population (in the Palomar Range) and urban growth will fragment most or all of the population into non-viable sub-units unless linkages are maintained among habitat patches. Without careful planning, the 5059-ha (12,500-acre) Chino Hills State Park and all but one of Orange County's Regional Parks will soon become isolated and unusable as cougar habitat. Even cougars in the central block of habitat, including Caspers Wilderness Park, are at great risk if the Santa Ana Mountain Range becomes isolated from the Palomar Range (Chapter 4, Beier 1993). Our dispersal data (Chapter 6, Beier 1993, manuscript in preparation) clearly demonstrates that dispersing cougars will find and use suitable corridors if available.

Factors influencing corridor suitability for cougars

Although this section deals solely with factors influencing corridor suitability for cougars, any corridor design should consider the needs of more than a single species. Beier and Loe (1992; included as Appendix 4 in this report) and Harrison (1992) should be consulted for an overview of such issues. In evaluating a potential corridor, it is important to keep in mind that a corridor facilitates travel for the entire distance between 2 significant habitat areas, not simply for the length of a highway underpass or other constriction. In rapidly urbanizing southern California, no corridor will be effective unless it encompasses the entire corridor length and explicitly connects to 2 or more larger habitat areas.

Applied to wildlife corridors, the term "design" is not used in its traditional sense of drawing a plan on a blank slate. Instead corridor design involves preservation of an existing travel route, minimizing impacts to an existing route, or leaving a route in an area that formerly allowed unobstructed movement. We cannot usually design corridors that force animals to travel in locations that are convenient for development plans. Therefore, if a project may impact a corridor, the project

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proponent should be required to monitor animal use of the corridor area both pre- and post-project (Beier and Loe 1992).

For cougars, the major factors influencing success of a movement corridor are:

- **location**: a cougar cannot use the corridor unless its normal travel pattern causes it to encounter the corridor entrance. Conversely, a corridor along a natural travel route is likely to be used even if habitat conditions within the corridor are suboptimal. Foster and Humphrey (1992:17) noted: "Most importantly, [corridors] must be located where animals naturally [travel]. Thus prior knowledge of traditional travel landscape-determined travel routes of the target animals is essential. [Corridors and] underpasses installed away from such crossing points are ineffective." Thus cougars are much more likely to cross State Route 91 via the suboptimal crossing at Coal Canyon than via the superior undercrossing 1.6 km east, simply because Coal Canyon is a well-used cougar travel route. In our intensive monitoring sessions, we have identified the routes by which cougars traveled among various parks and protected areas. In planning future urban growth, these routes provide ideal corridor sites. In the absence of data from radio-tagged animals, canyons with scour zones, or ridgelines free of artificial light, are likely locations for cougar travel routes.
- **cover**: Some native woody vegetation should be present to provide visual cover. Cougars will move up to 400 m across open terrain within a wildland matrix, but would not move across this length of open terrain with dense housing on either side.
- **lighting**: cougars travel mostly at night and avoid brightly-lit areas. Lights are especially detrimental in a bridged undercrossing. In several monitoring sessions, radio-tagged dispersers exploring new terrain apparently oriented toward dark areas and away from city lights. Thus lighting would probably also be effective in deterring an animal from entering a "cul-de-sac corridor" that looks inviting at its entrance but which leads to urban areas instead of good habitat (e.g., Temecula Creek).
- **roads:** Roads can render a corridor useless or cause animal injury and mortality. Where heavily-used roads cross a corridor, a bridged undercrossing is preferable to a culvert, and fencing can guide animals away from a high-speed road and toward the underpass. In Florida, an 8' x 24' precast segmental box culvert with 2.5% grades was a cost effective design with high probability of use by large wildlife, including cougars (Florida Department of Transportation 1992). Foster and Humphrey (1992:25) recommend that animals should have an unobstructed view of the habitat or horizon on the opposite side of a crossing structure, and that medians be open rather than covered. However, if the median is narrow, an opening may admit more noise and debris than light, and should probably be covered (Reed et al. 1975). The Florida study found that a 10-12-ft high chain-link fence topped with 3 strands of barbed wire was effective in inducing cougars to stay off highway right-of-way and use underpasses. We believe that a chain-link fence 8 feet high topped with 1-2 outrigger strands of barbed wire would also be effective and cheaper. A cougar could, but probably would not, climb or jump such a fence. Humphrey (1992) provides an excellent annotated bibliography on the limited literature relating to wildlife undercrossings and highway fencing. We believe that overpasses would also be readily used by cougars if the roadbed is recessed into the terrain, if the overcrossing is free of artificial light, and if there is appropriate visual screening so that the animal does not expose itself to view. On rural roads, vehicle speeds can be kept low through appropriate design elements (e.g., curves, grades, narrow road width, speed limits). Rural access roads should be 1.5 lanes wide with pullouts to encourage slow driving; wildlife undercrossings would not be necessary on such roads.
- **disturbances**: Unrestrained domestic dogs can harass cougars (and other wildlife) and render a potential corridor unusable. Dogs may be less of a problem adjacent to tract homes (where pets are usually restrained at night) than adjacent to a rural community, where dogs often roam free. Daytime use of a corridor by equestrians and hikers is fully compatible with use for cougar movement. Rural housing impacts can be minimized by having housing pads set back from stream courses or ridgetops, and by requiring large (10-40 acre) minimum parcel sizes.
- **frequency of use**: A corridor between the Santa Ana Mountains and the Palomar Range need be used only by a handful of immigrants per decade, with each animal making a single passage. In contrast, because the Chino Hills is smaller than an adult male home range, it requires a linkage that will allow a male to repeatedly use the corridor to breed with the resident females. The Regional Parks, being smaller than an adult female home range, require high-quality, preferably multiple linkages, to allow resident females to use them as part of their home range.
- **width**: It is impossible to specify a general minimum width, because the width needed depends on all of the above factors, and also on the length of the corridor. Width can also vary along a corridor. For instance, a width of 10 feet may be acceptable for a road undercrossing but not for the entire length of a corridor. As a rule of thumb, if other conditions (woody cover, no lighting, freedom from dogs, canyon bottom location, etc.) are met, we suggest that a corridor designed for use by cougars should be at least 100 m (300 ft) wide if the total distance to be spanned is 800 m (½ mi) or less. To the extent that other elements are deficient, and as the corridor length increases, corridor width should also be increased.

As mentioned above, knowledge of the traditional movement patterns of the target animal is the most important factor in corridor design. By intensive monitoring of individual focal animals, we learned the actual routes by which cougars traveled from the protected core area (Table 1, Figure 1) to most regional parks and smaller protected parcels. We describe these routes in the remaining sections of this chapter. Although most these routes now traverse pristine open space, they will become corridors (at best) as continued urban growth removes the adjacent habitat.

The most critical link: the Pechanga Corridor from the Palomar Range to the Santa Ana Mountain Range

Due to past urban growth, the cougar population in the Santa Ana Mountain Range is isolated from all other cougar populations except that in the Palomar Range to the southeast (Figure 1). Aerial photographs suggest that the amount of habitat and the size of the cougar population are much larger in the Palomar Range. A corridor to allow immigration from the Palomar Range is necessary to insure survival of our cougar population (Chapter 4, Beier 1993). Any viable corridor must link the Palomar District of Cleveland National Forest and the adjacent Pechanga Indian Reservation (the westernmost protected area in the Palomar Range) to San Diego State University's Margarita Field Station (the easternmost protected area in our mountain range) (Figure 7). If successful, The Nature Conservancy's Santa Margarita River Project will allow movement westward from the

SDSU parcel to Camp Pendleton and the Trabuco Ranger District.

We have named this linkage the "Pechanga Corridor" because Pechanga Creek is the main watercourse leading between the 2 areas. The 2 main threats to this linkage are I-15 and urban growth in and south of the City of Temecula. Although I-15 is the biggest hurdle today, within a few short years urbanization, if not controlled, will present an even more impenetrable barrier. This report's focus on I-15 should not obscure the fact that an effective corridor must be much longer than a highway underpass. In the following discussion, bear in mind that only west-bound immigration will reduce extinction risk. Because the cougar population in the Palomar Range is much larger, it does not need immigrants from the Santa Ana Mountain Range.

During our study several cougars attempted to cross I-15 to move between the 2 mountain ranges (Figure 8). Between October 1 1990 and December 31 1992, 3 cougars were killed on I-15 just north of the Border Patrol Station and a fourth cougar was killed on I-15 just north of Flynn Nursery at the north edge of the village of Rainbow. The dispersing M12 crossed I-15 about 500 m south of the Santa Margarita River. The dispersing M5 was initially captured and radio-tagged after being treed by domestic dogs in the city of Temecula; his tracks indicated that he had come from the confluence of Pechanga and Temecula Creeks, about 700 m upstream from the Santa Margarita Bridge. He probably had reached this confluence from the Santa Margarita River. From the west, M7 approached I-15 at the Santa Margarita River on several occasions, and may have made short forays east of I-15. During our study no cougars were road-killed elsewhere along I-15, nor did we have evidence that any cougars approached I-15 outside of this same area.

These patterns clearly show that the natural travel route for cougars leads them to cross I-15 at the crest just north of the Border Patrol Station. This is certainly **the** crossing point for any cougar traveling in the critically important westward direction, because urban sprawl strongly discourages west-bound cougars from approaching I-15 north or south of this area.

Beier (1993) was pessimistic about the present utility of this corridor. But the number of attempted crossings since that paper went to press suggests that dispersing cougars occasionally have crossed from east to west across I-15, and in sufficient numbers to benefit the cougar population. During 1990-92, night-time traffic on I-15 was light and the five road-kills may have been matched by a similar number of successful (but less detectable) crossings. As few as 1 or 2 successful west-bound dispersals during that 2-year period would significantly benefit the cougar population in the Santa Ana Mountain Range (Beier 1993). Nonetheless, we have not documented a single successful west-bound crossing of I-15.

Unfortunately, as traffic volumes increase in concert with urban growth, cougars will soon be unable to make at-grade crossings of I-15. Of equal concern, there is no safe underpass within 1 km of the ridgetop crossing area. Cougar habitat abuts I-15 only for about 6 km starting at and south of the Santa Margarita River bridge. There were 3 bridges and about 10 culverts on I-15 between Temecula and Mission Road (Fallbrook). None of the culverts offered a suitable undercrossing. All culverts were corrugated metal pipes 3 or 3½ feet in diameter (except 1 that was 6 feet in diameter), at least 150 feet in length, and steeply sloped with no light visible from the other end.

Of the 3 bridges, only the bridge over the Santa Margarita River is currently a feasible undercrossing for regular use by cougars. The bridge at Rainbow Creek is unusable because a trailer park lies squarely under and alongside this bridge, and to the east the creek meanders through an open area with large container-stock nurseries. The bridge for a 2-lane paved road 650 m south of Rainbow Creek does not lie along a natural travel corridor for cougars, especially for a west-bound animal, due to the village of Rainbow with its housing and large nurseries. The Santa Margarita Bridge is an excellent undercrossing structure, and the River itself would readily lead a west-bound cougar into the central habitat block. However, urban sprawl in Temecula makes it difficult for a cougar to encounter the underpass from the west. Pechanga Creek (the best watercourse leading west toward the bridge) has been highly devegetated, lined with concrete on parts of its north bank, subject to light pollution from adjacent housing tracts on the north bank, and has a large golf course resort on the south side.

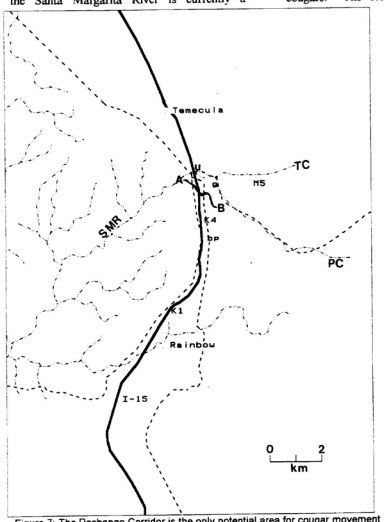

Figure 7: The Pechanga Corridor is the only potential area for cougar movement between the Santa Ana Mountain Range (west of I-15) and the adjacent population in the Palomar Range (east of I-15). Thick dashed line = wildland/urban edge. Note that Temecula Creek, **TC**, is a cul-de-sac corridor (it dead-ends in unsuitable habitat). During August 1990-December 1992, 3 cougars were road-killed at point **K4** (just north of the Border Patrol station, **bp**), 1 cougar was killed at **K1**, 1 cougar (M5) was treed by domestic dogs near the Temecula cul-de-sac at **M5**, and M12 crossed eastward along line **A-B**, passing near the golf course, **g**. The 3 options for allowing safe west-bound animal movement are restoration of Pechanga Creek (**PC**), using fencing to divert animals to the suitable underpass at **u**, or an overpass at **K4**. **SMR** = Santa Margarita River.

Without preventive action, this corridor will be lost. There are 3 options for

insuring the future integrity of this linkage, and a 4th option requiring continued human intervention:

1. Restore Pechanga Creek. Pechanga Creek leads directly to the only suitable undercrossing. Restoring the creek would be costly but would protect a corridor of regional significance. If this option were taken, restoration measures should include:

- Physically prevent vehicles from driving in the creek bottom
- Enhance native vegetation in Pechanga Creek. Revegetate a strip of land (at least 35m wide) along the Creek-Golf Course edge.
- Direct lighting from creekside homes away from the creek. Prevent free-roaming dogs in the creek. Unleashed dogs keep out not only cougars but also deer and other species whose presence would make the creek attractive to cougars. In 1990 we found no deer tracks, pellets, or other deer sign in the Creek, probably due to high use of the Creek by dogs.
- Discourage cougars from moving upstream along Temecula Creek from its confluence with Pechanga Creek. In 1990-92, Temecula Creek had a denser riparian forest and greater water flow, and probably would appear more inviting to a dispersing animal than Pechanga Creek. However, 800 m above the confluence it "dead-ends" in tract homes. Cougars can probably be deterred from entering the cul-de-sac by installing bright lights and removing a small amount of riparian vegetation near the Wolf Valley bridge.
- Prevent further urbanization along and south of Pechanga Creek.
- Fence I-15 south of the Margarita Bridge to prevent animals from being killed there.

2. Divert animals from the ridge route toward the River undercrossing. The natural travel route for west-bound cougars follows the ridge to an at-grade freeway crossing just north of the Border Patrol station. As traffic volumes increase, animal mortality will increase and eventually this route will become infeasible. To prevent road-kills and preserve a crossing, several measures would be needed:

- Fence I-15 from the village of Rainbow to the Santa Margarita River; the fence should be at least 8 ft high with a barbed-wire outrigger. Hopefully at least some west-bound animals encountering this fence would make the "right" decision to turn north rather than south.
- Keep the area along the fence as wild as possible. A west-bound cougar deflected by the fence would have to follow the fence north for 1500m, including 700m of golf course, before reaching the Santa Margarita River. The golf course along most of this area is relatively wild, and was traversed by M12 in January 1992. However, it would help to redesign the open area around the driving range area; its large fences intersect the animal travel route.
- Prevent urbanization along the wooded ridge that leads from the east to the current crossing area.

3. Build an overpass at the natural crossing area. A freeway overcrossing at the natural travel area just north of the border patrol station would maintain the linkage. Because I-15 is dug into bedrock for about 1.5 km north and south of this crossing area, it would be nearly impossible to retro-fit an underpass here. The overpass would in effect create a tunnel for vehicular traffic on I-15. If wide (say 100 ft), covered with natural substrate and vegetation, and with sidewalls to block vehicle light and noise, such an overcrossing would probably facilitate cougar movements at least as well as any other option.

Dirt roads (closed to motor vehicles at night) leading to either end of the overpass would further enhance the corridor, because cougars and other animals often to use such roads to travel through woody vegetation. Such roads would also allow the overcrossing to be used by hikers and equestrians. This option should also include freeway fencing and preventing urbanization along the ridge east of the crossing point. This option is novel but may be appropriate given this region's accelerating urbanization.

4. Import animals into the Santa Ana Mountain Range. When a cougar enters a residential area without posing a threat to human property or safety, the current policy of California Department of Fish and Game (CDFG) is that the animal is captured and moved to the nearest appropriate habitat. Such incidents occur regularly in southern California. Several administrators have suggested to us that this policy could be modified to favor translocating such non-problem animals into the Santa Ana Mountain Range. Although clearly more artificial and less aesthetically pleasing than maintaining natural connectivity and letting cougars immigrate on their own, such an approach may be feasible. However, it would clearly be an unprecedented experiment, and would require a commitment (by CDFG) and funding (most appropriately from the planning agencies and developers that cause loss of existing linkages) in perpetuity. If such an option is pursued, it should include:

- importing only animals of dispersal age (12-28 months of age).
- importing only animals from a similar habitat type in southern California.
- monitoring the results. This would be a large experiment. Transplanted animals would suffer high mortality, and could disrupt the social structure or resident cougars; such impacts would depend on the existing demographics of the population. If the translocation option is chosen, many resident cougars and all transplanted animals should be radio-tagged and monitored. The monitoring effort should continue for at least 20 years, with annual support similar to that expended in our study.

Chino Hills State Park to Trabuco Ranger District

A wildlife corridor for cougars between the Santa Ana Mountain Range and the Chino Hills will allow cougars to use an area (the Chino Hills) that cannot support a population of cougars if it were to become isolated (Beier 1993). Quite simply, if there is no corridor, then there will be no cougars in the Chino Hills. To be effective, such a corridor must not simply be a freeway underpass, but must reach from Trabuco Ranger District and the adjacent Tecate Cypress Reserve in upper Coal Canyon (the northernmost protected parcels in the Santa Ana Mountain Range) to Chino Hills State Park (the southernmost protected parcel in the Chino Hills).

We approached our evaluation of potential movement corridors from the perspective of a cougar attempting to travel north from the Santa Ana Mountain Range into the Chino Hills (Figure 8). State Route 91 (Riverside Freeway) and associated urban growth form a narrow band separating the Chino Hills on the north from the Santa Ana Mountain Range to the south. Cougars can approach the south side of Highway 91 along the entire 5.5 km from Gypsum Canyon to the Green River Road exit. Unlike I-15 near Temecula, the Riverside Freeway's 8 lanes are too busy at night to allow safe at-grade crossings by wildlife. There were 11 culverts and 3 vehicle underpasses in this 5.5-km section. Seven of the culverts were < 3 ft in width and height and were located such that it would be nearly impossible for a cougar to find the entrance. Two others (a 4-ft diameter cylinder and a 5-ft wide box) were similarly

inaccessible. On May 7 1991 M10 was struck by a vehicle on the Riverside Freeway within 50 feet of the 5x5-foot box culvert, which was inconspicuous from as close as 20 feet away. Only 2 culverts (B Canyon and Coal Canyon) were large (10 ft wide and 8-12 ft high) and located at canyon mouths where cougars could reasonably be expected to encounter the entrance; these are considered in greater detail below.

Of the 3 underpasses, the Mindermann or Green River underpass (a 1-lane paved access road for the old Minderman Ranch) did not lie along a canyon or ridge and would not be encountered by a traveling cougar. The Gypsum Canyon Road underpass was at an excellent location with respect to topography and cougar travel patterns, but the 500-m long underpass was occupied by the Gypsum Canyon Road interchange, where heavy traffic precluded cougar use. In August 1989 (even before the interchange was opened to Bridge traffic), F8 was road-killed at this interchange. Only 1 vehicle underpass (Coal Canyon) was located along a natural travel route and was undisturbed enough to allow cougar passage. Because this underpass lies immediately adjacent to the Coal Canyon culvert, the 2 are considered together below.

The 2 potential culverts and 1 vehicle underpass thus yield only 2 potential crossings of SR-91:

1. Coal Canyon. The Coal Canyon Road vehicle underpass and the twin box culverts alongside it offer by far the best route to cross SR-91. The main factor is that it lies at the mouth of Coal Canyon, a major wildlife travel route. We have abundant evidence that Coal Canyon is a major travel route. Coal Canyon was used by 6 radio-tagged cougars (F5, F6, F17, M6, M8, and M10), three of which either crossed or attempted to cross the freeway there. The dispersing juvenile M10 moved from Camp Pendleton, entered upper Coal Canyon for the first time on May 8 1991, moved rapidly down the Coal Canyon to the freeway on May 9, and was struck on the freeway May 10. In April 1991, M8 entered the Chino Hills, almost certainly via this corridor, and was later road-killed at the north end of the Chino Hills. Most dramatically, M6 traveled this corridor at least 22 times during June 1 1991 - December 31 1992 (Figure 8). Finally, 1-2 uncollared cougars (probably 1 juvenile female based on track size) used the culvert to cross the freeway in 1991.

On 18 of his 22 crossings, M6 used the box culvert under SR-91. On the other 4 crossings we found no tracks in the excellent substrate in the B Canyon or Coal Canyon culverts, so we conclude he used the (paved) vehicle underpass. M6's preference for a culvert is not typical of cougars confronted with roads. Other radio-tagged cougars preferred to cross 2-lane paved roads at grade rather than use a culvert directly in front of them, and all cougars used bridged undercrossings without hesitation. Certainly with enhancement of woody vegetation in the underpass, the vehicle underpass would be the preferred route for all animals.

2. B Canyon. The B Canyon culvert lies about 400 m east of the clubhouse for the Green River Golf Courses. Its canyon is well-wooded and has a spring in its headlands. A cougar in B Canyon could follow it to the culvert, which is physically ideal for animal movement. The problem then becomes getting into B Canyon, which now receives little cougar use. Even M6's, whose home range straddles SR-91 (Figure 8, Figure 23), has never used the B Canyon crossing and has never been located in B Canyon. Only 2 radio-tagged cougars (M10, F5) were documented using B Canyon; both of them entered via the lowermost main tributary of Coal Canyon (Cut-Across Canyon in Figure 8). Thus B Canyon, already rarely used, would receive extremely little use if the main access via Cut-Across Canyon is removed

by urban growth. Dispersing cougars are so proficient at finding travel routes that a rare disperser probably would use B Canyon to enter the Chino Hills even if Coal Canyon is destroyed. However, the Chino Hills is such a small area of habitat that it needs more than 1 immigrant every few years; it needs regular visitation by an adult male (Beier 1993). In short, the Chino Hills need visitation such as was demonstrated by M6's use of Coal Canyon Corridor in 1991 and 1992 (Figure 8, Figure 23). B Canyon does not allow this level of use today, and it is inconceivable that it would do so if access to B Canyon from Cut-Across Canyon were lost.

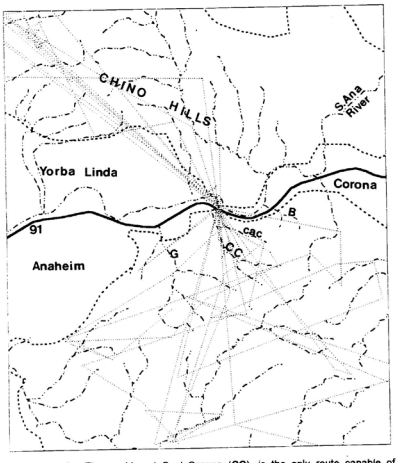

Figure 8. The corridor at Coal Canyon (**CC**), is the only route capable of allowing the frequent movements needed to maintain cougars in the Chino Hills. B Canyon (**B**) provides a suitable undercrossing but is not a major travel route. Cougars access B Canyon via Cut-Across Canyon (**cac**). A proposed housing tract would block both Coal and Cut-Across Canyons. G = Gypsum Canyon. Dotted lines indicate M6's travels during May-Dec 1991, including 12 of his 22 passages through the Coal Canyon Corridor.

On March 3 1992, the Anaheim City Council voted to allow construction of up to 1500 homes in Coal Canyon. The Council did so despite the conclusion in the City's EIR that the project would "result in the loss of potential for a cougar population to occur in the Chino Hills." By guaranteeing the loss of cougars from the Chino Hills, the project would also reduce the amount of habitat available to the cougar population in the Santa Ana Mountain Range by about 8%, adding to the risk of extinction for the larger population (Figure 11).

No construction has begun on the Coal Canyon project, in part because the City stipulated that no building permit can be issued nor any homes sold in Coal Canyon until additional lanes are added to SR-91. Thus there is still an opportunity to plan urban growth in a way that preserves the Coal Canyon Corridor. The following steps are

necessary for corridor preservation:

- minimize urban growth in Coal Canyon (including the parcel in Yorba Linda just north of SR-91) and along the Green River Golf Course.
- Increase the amount of woody vegetation near the underpass. Ideally take the creek out of the culvert and into the underpass, removing the pavement and adding vegetation to the underpass.
- fence SR-91 to funnel animals toward the underpass and culvert and keep them off the freeway.
- keep night-time vehicle traffic at the Coal Canyon Road interchange at its present level, (i.e., virtually no vehicle use at night). Remove the existing lighting in the underpass.
- If possible, increase shrub and tree cover at the edges of the golf courses, and on the large grassy field just northeast of Scully Hill.

Because many of these steps could be implemented when new lanes are added to the Riverside Freeway, Paul Beier conveyed these recommendations to CalTrans on February 6 1992; Beier stressed that the growth-inducing impacts of the freeway were the most critical issue to address and quoted the City of Anaheim's conditions of approval to the effect that 9,500 homes could not be built or sold in Gypsum and Coal Canyons until CalTrans widened SR-91. CEQA requires an EIR for any project with growth-inducing impacts, and an appropriate mitigation for this induced growth would be for CalTrans to work with the Cities of Anaheim and Yorba Linda to develop a cross-jurisdictional plan to preserve the wildlife movement corridor. In late February 1992 CalTrans issued a statement that no EIR was needed for the project.

The third entity with planning authority over the Coal Canyon Corridor is the City of Yorba Linda. During 1992, Yorba Linda approved language in its General Plan stating that the Yorba Linda will protect the corridor if the City of Anaheim will co-operate in the effort.

O'Neill-Arroyo Trabuco-Wagon Wheel Regional Parks to the Protected Core Area

At least 10 radio-tagged cougars (F1, F2, F13, M2, M3, M4, M8, M10, M12, M13) used the Arroyo Trabuco and Wagon Wheel Parks during this study. Animals moved to these Parks from the central habitat block by using both northern and eastern routes (Figure 9). The 2 northern routes are based on overnight monitoring sessions on F1 and M12, and the 2 eastern routes are based on overnight monitoring on M8, M1, F2, and M2, and a long series of tracks by an uncollared cougar. Although the Arroyo Trabuco appears a logical corridor on a map, cougars avoided the Arroyo Trabuco for about 2 km of its length, starting at the developed portions of O'Neill Park and continuing well north of Live Oak Canyon Road.

These routes will remain viable only if protected along their entire length between these smaller parks on one end and either National Forest Land (to the north) or Caspers Park (to the east) on the other ends. Maps describing these routes were given to the County of Orange and the Transportation Corridor Agencies (TCA) in 1991. Both the County and the TCA responded with good-faith efforts to minimize impacts to these routes.

Excellent regulations for protecting wildlife movement along the northern routes were included in the recent Foothill-Trabuco Specific Plan. If these regulations are strictly enforced. these northern routes should remain usable by cougars and other wildlife.

Significant planning has also been made to protect the eastern corridors, although problems remain. To mitigate impacts to wildlife movement, the County of Orange modified the southern edge of the proposed Las Flores Planned Community and added plans for a bridge to Antonio Parkway just south of Oso Parkway. These measures will effectively mitigate the impact of these 2 projects on wildlife movement. To mitigate impacts further east, the TCA added several bridges, and shifted part of the alignment of the Foothill Tollroad. As of late 1991, however, the TCA had not resolved the problem of how to build the interchange with Crown Valley Parkway without blocking one of the routes. Most importantly, the underpasses provided by TCA do not in themselves protect the entire length of these travel routes. In the long term, Tollroad-induced urban growth will cut off these corridors unless effective restrictions are put on future land use.

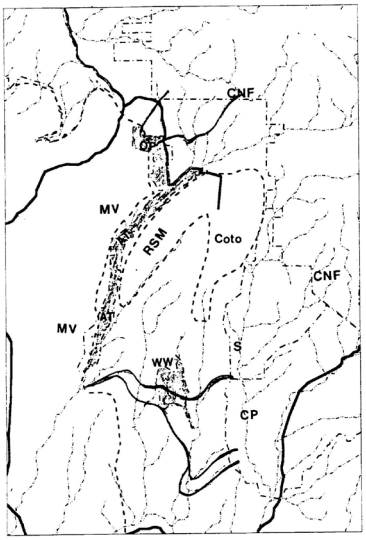

Figure 9. Linkages between O'Neill Park (**OP**), Arroyo Trabuco (**AT**), Wagon Wheel Park (**WW**) and the central habitat block (Cleveland National Forest - **CNF**, Caspers Park - **CP**, and Starr Ranch - **S**). Dashed lines indicate approximate edge of habitat, thick lines indicate paved roads, thin lines indicate approximate cougar travel routes. **MV** = City of Mission Viejo; **RSM** = Rancho Santa Margarita; **Coto** = Coto de Caza. Note that the Arroyo Trabuco is a narrow corridor of habitat lined with tract homes.

Weir Canyon-Santiago Oaks-Irvine Regional Parks to Trabuco Ranger District

Eight radio-tagged cougars (M5, M6, M10, M11, M12, F6, F5, F8) used the proposed Weir Canyon Regional Park. Most of these animals also used at least the Villa Park impoundment within Irvine Park, but we believe that only 2 (M5, M10) used Santiago Oaks Park. During 1988-1992,

there were no significant barriers to animal movements in the 6 km (4 mi) between these contiguous 3 parks and the Trabuco Ranger District (the nearest parcel in the protected core area).

However, the combined impact of the proposed 8000-home Mountain Park project, the proposed 13,000-home East Orange project, the proposed Eastern Tollroad, and future (Tollroad-induced) urban growth threatens to sever the connection between these 3 parks and National Forest land. In the draft EIR released in late 1991, the TCA committed itself to only 1 wildlife undercrossing, to be provided by a bridge over Santiago Creek. Unfortunately, this bridge does not correspond with the travel routes of radio-tagged cougars and it is unlikely that it would be used by them. It will become impossible for cougars to use the Santiago Creek undercrossing after the 13,000-home East Orange project is built upstream. TCA listed (but did not promise bridges at) 5 additional potential crossing points, 4 of which would be useless as wildlife crossings due to topography, approved housing projects, or planned interchanges. TCA's potential bridge at "WC4" is at an excellent crossing area, but is located in an area that is already being considered for the new county landfill and for tract homes. In January 1992, we suggested including measures to protect the approaches to WC4 or building a bridge to accommodate a different cougar travel route in the uppermost part of Blind Canyon. Our new route was used by several radio-tagged cougars, is in a steeper (less developable) area, and would require less habitat to be preserved between Weir and Fremont Canyons than the routes leading to TCA's potential bridge sites. As of spring 1992, TCA had elected not to incorporate these suggestions.

Limestone-Whiting Regional Parks to Trabuco Ranger District

Nine radio-tagged cougars (F6, F17, M2, M5, M6, M8, M10, M11, M12) used these contiguous wilderness parks. The parks offered excellent cougar habitat and at 6920 combined acres, they approached the size of Caspers Park (7620 acres). Unlike Caspers Park, however, these parks did not abut the Cleveland National Forest, but were surrounded by private property. If urban growth on the private land is not controlled, these parks will become isolated from the National Forest. Because 6920 acres is smaller than a single cougar home range, this area will be lost to cougars unless high quality connections are maintained to the main block of wildlands to the east. A marginal corridor that allows only occasional cougar use would greatly reduce or eliminate the ability of this land to help maintain a cougar population in the Santa Ana Mountain Range.

Based on data from radio-tagged cougars, topography, and the location of existing roads and housing, there are presently 2, and possibly 3, such linkages that can be maintained in the long term. These linkages are described in detail and shown in 3 maps in our Quarterly Report of October 1 1992. The northern corridor ("South Silverado") and the southern corridor ("Equestrian") have each been used by radio-tagged cougars on several occasions. The large size and importance of these wildlands warrants maintaining both of these corridors. Reliance on a single corridor may prove disastrous if we miscalculate what is needed to protect it, or if a single defiant landowner ignored protective regulations. Furthermore, even if a single corridor is adequate for cougars, many other species need corridors and some of these species may not be served by the limited number of habitat types, soil conditions, etc., that can be contained in a single corridor.

We have no data to indicate that the "Pancho Canyon Corridor" was used by cougars, and in July 1992 we noted active grading in the mouth of Pancho Canyon continuing north nearly to the mouth of Williams Canyon. We mention it mainly to consider all feasible options. With appropriate screening from the new project, the topography and habitat suggest that this could be a functional corridor. Although it is also relatively long, the eastern portion (Harding Canyon) may already be protected if strict zoning prohibits building there to protect water quality in Modjeska Reservoir.

A critically important step in protecting each of these corridors is to construct a wildlife undercrossing under Santiago Canyon Road where each corridor's major drainage crosses the road, along with fencing to keep animals off the road and to funnel them toward the undercrossing. Santiago Canyon Road is a busy, high-speed road, and use will increase greatly if the proposed 13,000-home East Orange Project and the proposed Eastern Tollroad are built. The County is already planning to rebuild the Road to accommodate projected traffic, and the road rebuilding can be used as an opportunity to construct bridges beneath which cougars and other animals can walk.

Our data for radio-tagged cougars along the South Silverado Corridor indicate that they crossed Santiago Canyon Road at grade just a few feet north of a 5-ft box culvert there. Fencing could be used to guide animals to the existing culvert. However, a better solution (when the road is rebuilt) would be to build a bridge to allow a larger undercrossing.

At the Santiago Equestrian Center, a larger undercrossing could be built during the rebuilding of Santiago Canyon Road by moving the road about 200m north for about 300m on either side of the stables. This would get the Road out of Aliso Creek and allow the road to bridge the 2 tributaries of upper Aliso Creek which meet just below the Stables. As configured in 1991, the equestrian center apparently was not a barrier to cougars. If the corridor is to be maintained, there should be no increase in night-time human use or lighting at the stables, and no additional clearing of vegetation near the stables. It is especially important to avoid any significant loss of habitat on the ridge immediately west of the stables; animals must cross this ridge to reach the Parks. Constructing one or more unlit trails (for hikers or equestrians) over this ridge would not degrade its utility as a wildlife corridor, and may make it more acceptable for some species, including cougars

In addition to the 3 corridors mentioned above, we have documented that cougars cross Santiago Canyon Road at 2 other locations further west. Because both of these areas lie in or adjacent to the approved East Orange Project, they will remain functional only if the project is not built. One well-used crossing point was the first small canyon east of the hillcrest fire station. The sparse vegetation made this a surprising location for cougar movement, but both M5 and M10 were struck crossing Santiago Canyon Road at this canyon, and 2 uncollared cougars were killed there in 1989. The second area was about 200m southeast of the junction of Hicks Haul Road and Santiago Canyon Road.

Rancho Mission Viejo Conservancy to Camp Pendleton

The Rancho Mission Viejo Conservancy was used by 13 radio-tagged cougars (M2, M6, M8, M9, M10, M11, M12, M13, F3, F4, F13, F17, and F19) and is excellent cougar habitat. F3 chose a canyon in this parcel for her parturition site in 1989. The alignment for the Foothill Tollroad lies near the eastern edge of the Conservancy, and threatens to isolate it from Camp Pendleton (the nearest

large protected parcel). Cougars now access the Conservancy across an unobstructed landscape. With the tollway and tollway-induced urban growth there will be at most 2 routes, namely Gabino-Blind Canyon and upper Christianitos Creek. The TCA has promised bridges at both sites. TCA's late 1991 map of the alignment omitted the *upper* Christianitos bridge, because TCA thought our suggestion was for a bridge where the Tollroad crosses *lower* Christianitos Creek. However, TCA responded to this misunderstanding by verbally promising the upper bridge. Assuming that the bridges are built, long term protection of these corridors requires protecting an unbroken route to Camp Pendleton.

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CHAPTER 4. POPULATION DYNAMICS

Reproductive activity and litter sizes

Prior to expansion of the study area (May 1989), 3 full-time biologists and several volunteers intensively monitored 7 radio-tagged females in the vicinity of Caspers Wilderness Park, Rancho Mission Viejo, and Camp Pendleton, locating most cougars daily and looking carefully for sign of cubs or adult males. The evidence overwhelmingly indicates that there was no reproductive activity in this area for over 12 months due to lack of a breeding male in this portion of the mountain range (our Quarterly Reports; Padley 1990). Despite intense searches, there was no evidence (e.g., tracks, scrapes) of a breeding male. Only 1 female had cubs at heel (F3's litter born November 1987) and none of the 7 females gave birth during 1988. In early 1989, 2 young males (who we believe we later radio-tagged as M2 and M9) established adjacent territories that overlapped these 7 females. We immediately detected the tracks of these males and heard the northern male (presumably M2) copulating with 4 females in April 1989. Exactly 83-104 days (1 gestation period) after we first noted sign of these adult males, 6 of the 7 females bore cubs. Such a reproductive failure, although it was temporary, demonstrates that the population was demographically unstable. Such demographic instability is to be expected in small, isolated populations of cougars (Beier 1993).

Of 9 known parturition dates for radio-tagged cougars, 5 litters were born in July, and 1 litter in each of May, June, August, and November (Table 1). A 10th litter probably occurred in December, based on the estimated ages at capture of F18's cubs. These data show a birth peak in late spring through summer, with no litters being born during the months of January-April. In previous North American studies (summarized by Anderson 1983, 1992), about 60% of births occured during April-August; the others were scattered among all other months. The more pronounced peak noted in this study (about 80% of births during May-August) was largely due to 2 new breeding males entering the study area in early 1989, causing a burst of 5 litters in July that ended a year of reproductive failure in the southern part of the range.

For 9 litters, the mean known litter size was 2.4 cubs per litter. However, in most cases we did not attempt to document litter sizes until several weeks or months after the suspected parturition date. Because some mortality likely occurred during the first weeks after birth, the mean litter size at birth was certainly higher than 2.4. Across the cougar's range, litter sizes average about 2.7 cubs per litter (summarized by Anderson 1983:34).

For 3 cougars, we can estimate the gestation period based on dates of copulation (as evidenced by vocalizations) and parturition. F3 and F4 were bred by the same male in the same canyon during April 4-7 1989, and their neonates (eyes closed, poor mobility) were seen and photographed on July 13 1989. Both F3 and F4 had arrived and stayed at their respective den sites on July 7 or 8. We believe that the parturition date for each cat was during July 7-9, and thus the gestation periods were between 91 days (if they conceived on April 7 and gave birth July 7) and 96 days (conceived April 4, born July 9). F2 was bred during April 21-23 1989; although her neonates were not observed, her greatly constricted movements indicate that she established her den site during July 25-August 3. Assuming that her cubs were born within 24 hours of establishing the site, her gestation period was 93-104 days.

We can also estimate gestation period for F10. Although we did not get close enough to hear copulatory vocalizations, F10 apparently consorted with M9 during April 8-10 1991 (16 days after her son M7 dispersed). She moved to her den site during July 2-10 1991, indicating a gestation period of 83-93 days. Using the midpoints of these ranges as

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our best estimate, we observed 4 gestation periods that averaged 93 days and ranged from 88 to 96 days. To our knowledge, our data are the first to estimate gestation period for wild cougars. The mean gestation period for 42 litters born to captive cougars averaged 92 days and ranged from 84-98 days (Anderson 1983).

We inspected the exact den sites of F3 and F4 within a week of parturition, and revisited these sites a week after the cubs were moved. In addition, we knew the den sites of F12 and F2 to within 100m and investigated these sites after the cubs had been moved. Several traits were common to all 4 sites. Each site was in a small tributary canyon with very dense brush on the canyon sides and in the canyon bottom, lacked a well-developed scour zone in the canyon bottom, had no detectable animal trails, and had very few trees (except for some Rhus or Malosma plants with shrubby growth form). Each canyon was away from regular cougar travel routes, and the vegetation made it very difficult for a person to crawl to the birth site. The micro-sites were in drainage bottoms and in the upper ¼ of the drainage. No site was associated with a cave or rock outcrop.

At the 2 den sites where neonates were observed, there was no physical modification of the soil or vegetation at the site; the cubs were simply in a location that looked much like any other nearby spot in the dense shrubs. Even after 40 days of use, the only sign of use was some compression of the leaf litter. In particular there were no scats, no urine odors, and no noticeable trampling or breaking of live vegetation. Because these sites lacked distinctive topographic features (e.g., a cave) and any "nest" or other modification, we use the term "den site" simply to designate the place where cubs spend their first few weeks. These observations suggest that den sites are selected mainly because they are unlikely to be visited by other predators, and that mother cougars avoid enlarging passageways or leaving scents that might increase the likelihood of such visits. Movement patterns of the adult females suggest that the den site was used for about 6 weeks.

In addition to the 10 known litters, tracks indicated that F4 probably had a yearling at heel when she was initially captured in January 1988. Tracks of this cub were no longer evident after May 1988, indicating either death or dispersal occurred at about that time. Similarly, tracks suggested that a small-footed cat may have accompanied F13 just prior to her initial capture in March 1990. However, the tracks may also have been F13 doubling back on her route, and there was no subsequent evidence of a cub accompanying her.

In all cases of known parturition, the adult female greatly constricted her movements for the next 5-7 weeks. During the first 2 weeks, her daytime locations were almost always at the parturition site. About 7 weeks after birth, cub tracks could often be seen near their mother's tracks. Thus birth of a litter was easy to detect at our level of monitoring. Twelve females were monitored for over 12 months with sufficient intensity to detect successful cub-rearing if it occurred. To our surprise, 4 of these 12 females never gave birth during these years of monitoring, or if they did give birth, their cubs died within days of birth. We followed 3 of these females with sufficient intensity that we are quite certain that they had no litters that survived more than 2 weeks during the time they were monitored. The 4th female (F5) ranged widely and used many remote areas, and was not monitored as intensively. Although F5 may have had litters that we did not detect, it is very unlikely that any such litter survived more than a month. The non-reproducers were:

- **F1**: no successful litter during October 1986-July 1 1989. F1 was bred May 2-4 1989 (copulatory vocalizations heard), but at her death in early July 1989 she was not pregnant nor lactating.
- **F5**: no successful litter during May 1989-January 1993. F5 was located very close

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to M2 on 2 occasions, and with M6 on 2 occasions (we were unable to get close enough to hear copulatory vocalizations). F5 was very thin, which may have contributed to her lack of reproduction. During the first year of monitoring, May 1989-May 1990, she exhibited a home range over twice as large as any other adult female. Perhaps the lack of home range stability during that first year inhibited her from reproducing (Seidensticker et al. 1973), but this would not explain her last 2.5 years of non-productivity. F5 was also unusual in having blue eyes, unlike the normal yellow eye of adults.

- **F15**: no successful litter during February 1991-June 1992. F15 definitely bred (copulatory screams heard all night long) with M9 on July 29-30 1991. She also apparently consorted (we did not get close enough to hear vocalizations) with M9 April 4-8 1991, August 31 1991, January 9 1992, and January 27-February 4 1992. At her death following a vehicle accident in June 1992, F15 was not pregnant or lactating.
- **F19**: no successful litter during August 1991-December 1992. She possibly consorted with M9 in early October 1992, but apparently there was no other breeding activity.

Four other adult females (F7, F8, F9, F13) were not confirmed to have any offspring during the time they were radio-tagged. However, each of these animals was monitored for less than 7 months, and it would be inappropriate to draw any conclusions from the lack of breeding evidence for these cats.

We had expected that virtually all females would bear cubs in any year in which they had no surviving cubs from the previous year, and we were surprised to learn that 4 of 12 adult females failed to reproduce. To our knowledge, no previous research has reported a similar lack of births in adult females followed through time. Robinette et. al. (1961) necropsied 199 female cougars and reported the pregnancy rates and the proportion whose tracks were accompanied by cub tracks. Although our inspection of their data show that nearly 40% of those females apparently were neither pregnant nor accompanied by young, Robinette et al. (1961) did not mention this apparent lack of fecundity. Certainly not all dependent cubs would be detected by a track search near the female, some immature females were probably included in their sample (Robinette et al. 1961:216), and they were unable to detect pregnancy during the first 2.5 weeks after conception (p.216); these factors probably caused them to avoid speculating on infertility rates. Perhaps this result was so unexpected that they were reluctant to mention it. We do not know if this is typical of parturition rates of cougars in other populations, nor if it is typical of our population in the long run.

Beier's (1993) population model presumed that all adult females would either have young at heel or have a new litter each year. This assumption is violated by the presence of females that do not bear young for several years. Therefore the predictions of Beier's model are probably unrealistically optimistic, and true extinction risk is probably somewhat higher than predicted.

Juvenile survivorship

Each cougar was considered a juvenile from birth until establishing a stable home range independent of its mother. Nineteen cubs were monitored for periods ranging from 1 to 22 months each, for a total of 288 juvenile-months of monitoring (Table 4). We calculated survival rates from these data using 1-month time intervals and the product limit (or Kaplan-Meier) procedure with staggered entry (Pollock et al. 1989). The product of 12 monthly rates

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yielded an estimate of annual survival rate, and the average of these running products yielded a single point estimate.

The annual survival rate for juveniles was 0.52. Thus a cub in the Santa Ana Mountain Range had a 52% chance of living for another 12 months. Assuming that on average 30 months (2.5 years) elapsed between birth and adulthood (defined by a stable, independent home range), then about 20% ($0.524^{2.5}$) of cubs born could expect to reach adulthood. There were insufficient data to determine if juvenile survivorship varied for first-year versus second-year animals, or by sex.

The actual juvenile survival rate was certainly somewhat lower than 52%, because we always estimated each litter at the minimum known number. We intruded on new families to count neonates in only 2 cases (both in July 1989, when F3 had 3 cubs and F4 had twins). In other cases we waited several weeks to count cub tracks accompanying females. By this time some cubs probably died, and when cubs were small it was often difficult to detect how many distinct sets of cub tracks were present. Although the most common litter size in cougars is 3 cubs, our analyses included only the number of cubs that we actually verified by handling or on the basis of clearly unique tracks. Thus our computations presumed that F10 had 1 cub (M7) in July 1989 and 2 cubs in June 1991, that F2 had 2 cubs (M3, M4), that F6 had 2 cubs (M11, M12), that F12 had 2 cubs (M8, M10), and that F18 had 2 cubs (F16, F17). A reanalysis presuming that each litter had 3 cubs and that the "added" cubs died by age 12 months yielded an estimate of 0.45. The true juvenile survival rate for our population probably lay between 45% and 52%.

Table 4. Survivorship and causes of death for juvenile cougars in the Santa Ana Mountain Range 1987-1992. In addition, 3 surviving cougars (M7, M6, M13) were used in the survival rate estimates.

Animal ID	Birth Month	Death Month	Cause of death
son of F3[a]	Nov 1987	Aug 1988	vehicle accident
son of F3[a]	Nov 1987	Feb 1989	injured by cougar, died during capture attempt
daughter of F3[a]	Nov 1987	Feb 1989	killed and eaten by cougar
M3	July 1989	Jan 1991	disease
M4	Jul 1989	Nov 1990	killed by cougar? eaten by brother and mother
3 offspring of F3	Jul 1989	Dec 1989	died after being orphaned
2 offspring of F10	Jul 1991	Oct 1991	died after mom disappeared; 1 may have been captured illegally
2 daughters of F4	Jul 1989	Sep 1989	not known, "disappeared"
M8	Jul 1989	May 1991	vehicle accident
M10	Jul 1989	Sep 1992	vehicle accident
M5	early 1989	Sep 1991	vehicle accident
M11	Aug 1990	Feb 1992	unknown, not caused by vehicle, cougar, or acute physical trauma
M12	Aug 1990	Apr 1992	shot
F16	Dec 1989	Sep 1991	vehicle accident
F17	Dec 1989	Jan 1992	unknown, not caused by vehicle, cougar, or acute physical trauma

[a] not included in survival rate computation, due to small sample size in 1987-88; including these animals would have lowered the survival rate estimate.

Our juvenile survival rates were lower than other published estimates, perhaps because high vehicle mortality in our population was only partially compensated by reductions in other types of mortality (e.g., shooting). However, we suspect that our rate of 52%

may be typical of, or only moderately less than, that of other populations. Three of the 4 previously published rates provided unrealistically high estimates of true survival rates. Comparing mean litter sizes near birth and at 12 months (not the same litters followed through time) Ashman et al. (1983), suggested a value of 78%. Similar data in Robinette et al. (1961:213, inferring age from weight) suggested a survival rate of about 73%. However this method considers only litters in which at least 1 cub survived to 12 months of age. Whenever all cubs in a litter died within 12 months, the method would not detect a litter, thus ignoring a large number of cub deaths (Robinette et al 1961:213). Hemker et al. (1986) followed marked animals over time, reporting a survival rate of 72% for cubs between 3 and 10 months of age and 92% for cubs from 10 months to dispersal at 16-19 months, in an area of extremely low cougar density (gross density of 0.5 cougars per 100 km^2). Hemker et al. (1986:330) cautioned that their estimates did not reflect overall juvenile survivorship because they excluded the 2 periods of highest mortality, namely the early neonatal period (age 0-3 months) and the post-dispersal period. Their estimates also may reflect density-dependent enhancement of survival rates at low density. Using methods similar to ours, Anderson et al. (1992) computed the survival rate for yearling cougars as 0.642, an estimate much closer to ours than the previous reports; they did not attempt to monitor or estimate density for juveniles less than 1 year old.

In many cases, we could infer cause of death of juveniles (Table 4). Vehicle accidents and being orphaned were the leading causes of death for juvenile cougars (5 cases each). Cougar-inflicted injuries were implicated in 3 deaths. These cases are discussed in greater detail in later sections of this chapter. In most other cases, the cause of death could not be determined.

Adult survivorship

Adult survivorship was computed from data on 20 adults monitored for periods of time varying from 2 to 58 months, or a total of 497 cougar-months. There were insufficient data to compute survival rates separately for males and females, and our sample was mostly females. We analyzed these data using 1-month time intervals and the product limit procedure with staggered entry (Pollock et al. 1989). The product of 12 monthly rates yielded an estimate of annual survival rate, and the average of these running products yielded a single point estimate.

The annual survival rate for adults was 75%. This means that on average an adult had a 75% chance of being alive in 12 months. F7 and F10 were dropped from the computations in the month we lost their signal. If these animals in fact died at the time of disappearance (which is probably true for F10 at least), then the adult survival rate was 72%. As with juveniles, vehicle accidents were the leading cause of death (Table 5), killing 5 adults (F8, F9, F12, F13, F15). Two adult cougars (F1, F6) were killed by other cougars. Two (F2, F3) died of intestinal illnesses (probably not the same disease). Three adults (M1, M2, F11) were shot on depredation permits after eating goats or sheep. Two cougars (F7, F10) disappeared abruptly; there is some evidence that F10 may have been poached. Each cause of death is considered in greater detail in the following sections.

Our estimated adult survival rate of 75% is higher than the approximately 68% inferred from hunting returns of marked animals by Ashman et al. (1983) and from existing age structure by Robinette et al. 1977:123). Our estimate is nearly identical to the 74% observed in Utah by Lindzey et al. (1988), and somewhat lower than the approximately 80-92% observed in Colorado

Table 5. Causes of death for radio-tagged cougars and their offspring in the Santa Ana Mountains, 1988-1993.

Cause of Death	Juveniles	Adults	Total	Per Cent
Vehicle accidents	5	5	10	32%
Orphaned	5	0	5	16%
Probable intestinal disease	1	2	3	10%
Probable other disease	2	1[a]	3	10%
Intraspecific strife	3[b]	2	5	16%
Illegally killed	0	1(?)[c]	1(?)	3%
Depredation permit	0	3	3	10%
Shot legally by police	1	0	1	3%
Total	17	14	31	100%

[a] "old age" and capture stress contributed to F4's death
[b] includes a severely-injured juvenile that died during capture attempt
[c] Just after F10's disappearance, we received a report of a poaching in that vicinity. In addition, F7 abruptly disappeared 3 months after transmitter deployment.

by Anderson et al. (1992:53). The latter estimates, like ours, were derived using the Kaplan-Meier procedure on data from radio-tagged cougars in non-hunted populations (although several cougars in the Colorado study were killed by hunters off the study area).

Mortality factors

Collisions with motor vehicles caused 32% of the 27 documented cougar deaths in all age classes (Table 5). Vehicle accidents were not a mortality factor in any other study in the western states, but caused 49% of cougar deaths in Florida (Maehr et al. 1991). In most previous studies, hunting and predator-control activities caused most deaths (Shaw 1977, Shaw 1980, Hornocker 1970, Anderson et al. 1992, Murphy 1983), although natural deaths predominated in studies by Sweanor (1990) and Lindzey et al. (1988).

Disease

Three cougars (F3, M3, F2) apparently died of intestinal diseases, although no pathogen or other cause was identified. Disease was a likely factor in 3 other cougar deaths (F4, F17, M12).

Cougar **F3** died on December 27 1989; we retrieved her carcass within 24 hours. Pale mucous membranes and submucosal bleeding in the small bowel suggested that she died due to loss of circulating blood. The patchy distribution of the bleeding suggested that the bleeding was caused by a bacterial infection in the bowel. The bleeding could also have been caused by trauma to the abdomen, but there was no evidence to suggest trauma from collision with a vehicle, ingested poison, a gunshot wound, or being kicked by a large hoofed animal. The cougar had low fat reserves and an empty stomach, but was in fair condition and certainly not emaciated. She weighed 86 pounds at death.

M3 died on February 16 or 17 1991. A previous severe injury to his palate (sometime during June-October 1990) had healed remarkably well and had not prevented him from growing to normal size and weight. He had just started dispersing from his mother's home range on January 27 1991, when on the night of February 8 was treed by a domestic dog in a residential area adjacent to cougar habitat. Animal Control officers injected M3 with 6cc of ketamine via tranquilizer dart. M3 fell out of the small tree, striking his head on a planter box. On release that night in his mother's home range, his physical condition appeared good and his movements appeared normal for an animal recovering from ketamine.

By morning he had walked 200m up canyon but he remained at that site for the next week until he died. He apparently had not eaten during that week. Tracks indicated that he had walked 20m to a small pool of water at least once during February 12-18. The carcass weight was 79 pounds with moderate subcutaneous fat; he had obviously lost some weight during the previous week. We recovered his carcass on February 19, by which time no cause of death could be determined. There was no apparent skull or neck injury at death. We suspect intestinal disease simply because his mother died of intestinal disease after encountering his carcass.

F2 (M3's mother) had been in another part of her home range during the time M3 was dying. After necropsy we left M3's carcass in a trench near some dwellings on Starr Ranch. On the night of February 21-22, F2 arrived at M3's carcass, apparently encountering it by chance, and was seen walking away from his carcass at dawn on February 22. At that time, a strip of muscle had been torn from the carcass, presumably by F2, but left at the site, uneaten. F2 had covered the carcass with grass and leaves in the manner of a cougar covering a fresh prey carcass, but she did not return to feed on it. F2 bedded within 250m of the carcass for the next 3 days, and then moved about 600m further from the site to a confluence of 2 streams. She killed and ate a raccoon at that confluence on March 4. On March 10 we walked in on her after she had been daybedding at this confluence for 2 weeks. We observed that she was weak and losing weight and we conferred with veterinarians at the San Diego Zoo, who agreed to evaluate her. However, she died a few hours before we arrived to capture her on the morning of March 12. She weighed 73 pounds, a loss of 17 pounds since we last handled her on December 13 1990. Amy Shima, DVM (San Diego Zoo) reported that her death was apparently related to dehydration and diarrhea, but no pathogen could be identified.

F4 died on July 20 1990, at 12-14 years of age, which approaches the maximum lifespan for cougars. She had the most severe tick infestation we observed on a cougar during the study. Her upper left canine tooth and both upper carnassial (shearing) teeth were missing, the other canines were short and blunt, and her incisors were worn to the gumline. Her 70-pound weight did not look thin on her light frame and her pelage and body fat reserves were normal. Four days prior to her death she had moved about 3 km west of her previous home range into open grassland habitat where she bedded near a spring in a small arroyo, killing and eating at least 2 coyotes there. We recaptured her to replace her collar at that site on July 18, and the capture operation went smoothly with no sign of abnormal recovery. She fed on a coyote carcass the night after the capture but died 2 days later. In this case a combination of "old age," capture stress, and extreme heat probably all contributed to F4's death.

Two other carcasses (**F17, M12**) clearly had not suffered acute physical trauma (gunshot, vehicle accident, cougar-inflicted injuries, etc.) and it appeared each cougar had crawled into a typical wooded daybed site before death. Neither animal appeared emaciated. It seems likely that disease played the dominant role in these deaths.

M12 died under an oak tree in dense chaparral. His carcass was too decomposed to allow examination of soft tissues or tests for pathogens. The intact skin on the right side of his body showed no sign of trauma; his skull and leg bones had no injuries. The 2nd cheek tooth on the right mandible was missing, and the adult tooth, fully formed, lay below the bone, as if ready to erupt. However, part of the new tooth lay below the 3rd (fully erupted adult) cheek tooth, and the gap between the erupted teeth appeared too small for the new tooth. Thickening of the mandible alongside the

unerupted tooth suggested that the delayed eruption was causing some bone disease. Otherwise all the adult teeth were in good condition and formed a functional shearing apparatus.

F17's carcass was in good condition for an exam, due to cool temperatures at her death. She appeared in excellent condition with no sign of external injury and a thick layer of subcutaneous fat. The only remarkable internal finding was the presence of blood in her lungs and bronchi. The intestinal tract lacked any evidence of recent feeding; there was a small amount of tarry black stool in the colon.

Intraspecific strife

Three cougar deaths were unambiguously due to fights with other cougars; 2 of these 3 carcasses were also cannibalized. In a 4th case, a cougar was fed upon by other cougars, but death may have been due to other causes. A cougar-inflicted injury and capture trauma contributed to a fifth death. In all, about 16% of deaths were related to intraspecific strife. In addition to these cases, F13 had multiple wounds on the right side of her face and on her left shoulder at her initial capture; these injuries had almost certainly been inflicted by another cougar; the injuries had completely healed by her death 6 months later.

This level of intraspecific aggression is not unusual in cougars. Our observation that 16% of mortalities were cougar-related falls about midway between a rate of 3-5% in populations that have high man-caused mortality (hunting and predator control) (Anderson 1983:58, and Anderson et al. 1992:51) and a rate of 31% in a population with very low man-caused mortality (Sweanor 1990:36).

Two uncollared cubs of F3. During intensive monitoring on the night on February 8 1989, F3 traveled a short distance and spent almost the entire night in 1 location before moving to a more secluded location at dawn. We expected to find that she had been feeding on deer, but at the site where she had spent the night we found the very fresh and partially consumed carcass of F3's yearling daughter (not radio-tagged). She was in very good physical condition prior to death (abdominal fat 26mm). There was extensive subcutaneous bleeding and muscle trauma on her forelimbs and face, indicative of a prolonged fight using her forelimbs for defense, and her neck was broken between the skull and top vertebra. We set snares on her carcass and captured a yearling cougar, almost certainly her sibling, the following night. The male cub had severe, infected wounds from cougar bites to his hind quarters, and died during the capture operation. Fat reserves and overall size in relation to age indicated that the male yearling was also in good physical condition before the attack. Steady night-time rainfall obliterated tracks in the vicinity of the kill, and we could not determine the identity of the cougar that killed the female cub and injured the male. Perhaps the 2 cubs injured each other in a fight, but we speculate that an uncollared male was responsible. Five months later, F1 was killed (but not eaten) by a cougar less than 250m from the same location.

F1. F1 was killed by an uncollared cougar on July 3 or 4 1989. Her carcass was lying among some cattails adjacent to a creek near the confluence with the small dry tributary in which the 2 yearling offspring of F3 died in February 1989. Her position indicated that she had crawled there on her own; the only wounds were two conspicuous canine punctures, one entering her skull downward above her right eye (crushing the supraorbital arch) and the other entering upward near the posterior margin of the right mandible. Tooth size, distance, and position indicate that this bite was delivered by another cougar; the attacker did not feed on her. Her stomach contained a freshly consumed

opossum, and she had minimal abdominal fat (approx. 5 mm). No tracks (not even those of F1) were found in the immediate vicinity of the cougar carcass. However, tracks of an uncollared male had been seen on several occasions within a 2-km radius for several days both before and after her death.

M4. During intensive monitoring on the night of November 11 1990, F2 and her 15-month-old cubs (M3 and M4) stayed in 1 location all night long. We presumed they were feeding on a deer, but at the site where they had spent the night we discovered that they had almost totally consumed M4. Their feeding activity had kept M4's collar from entering mortality mode. The amount of consumption and the locations of the 3 animals on the preceding days indicate that F2 and M3 also fed on him the nights of November 9 (when M4 probably died) and November 10. The trio had been together for several days both before and after M4's death.

Because of the near-total consumption, we could not determine cause of death. M4 could have been mortally injured crossing the Ortega Highway on the night of November 9-10, when the trio crossed the highway. If so, the injured M4 walked 1.3 km (0.8 mi) up Horsetail Canyon from the Ortega (a 220-foot elevation gain). Because Horsetail Canyon offers excellent cover much closer to the road, it is not likely that M3 and F2 dragged his carcass that distance, nor was a drag mark evident on November 12.

M4 could have died of disease, but we have no evidence for this. The final possibility is that he was killed by his brother, his mother, or another cougar. It is extremely unlikely that F2 killed her son after investing 18 months of pregnancy, lactation, teaching, and feeding on him. Fratricide is also maladaptive (on average siblings share 50% of the same genetic material) but siblings do not have the same energetic investment in each other as a mother has in them, and siblings are competitors for their mother's hunting skills. And the fact that M3 enjoyed superior growth during the interval between previous captures (June 5-October 1) suggests that such competition may be intense and that M3 may have been more aggressive, dominating his brother at shared carcasses. If M4 was killed by a cougar other than M3, the most likely suspect would be M2 (the resident male in the area, and the presumed sire of M4). On November 9, M2 was 1.5 km WSW of where M4 died, with only 1 major ridge separating them. However, on the next 2 nights, M2 moved successively further west, and there is no evidence to suggest that he traveled east toward M4 or that he fed on M4. If M2 killed M4, he apparently was not injured in the fight (on Nov 12, we treed and examined him through binoculars, looking for sign of a recent fight).

F6. F6 was killed by another cougar on about May 23 1992. She had been dragged about 70m from the kill site to a location where her carcass was largely consumed. There were several canine punctures in her skull, and the top of the skull had been broken and the brain consumed. There were no tracks at the site clear enough to indicate the sex-age class of the cougar that killed her.

An unusual injury

Between captures on June 5 and October 1 1990, juvenile M3 suffered a severe, non-fatal, and apparently natural injury. His palette had been broken along the midline and the left premaxillary was pressed about 10mm upward into the skull, so that the 3 left incisors no longer occluded with the lowers. There was very little wear on the left incisors, suggesting that the injury occurred early during the interval, but the scar tissue still appeared fresh on October 1. At his death in February 1991, the injury had healed remarkably well but there was persistent malocclusion of the incisors and

canines on his left side. Despite this injury, M3 was otherwise quite healthy on October 1, with ample fat reserves and minimal ectoparasites. His sibling M4 was larger framed than M3 on both June 5 and October 1. Although the animals were of similar weight on June 5, M3 had a thicker layer of subcutaneous fat, despite his injury which must have made feeding painful for several weeks. No other injuries were evident. His skull is now in the Museum of Vertebrate Zoology at the University of California at Berkeley.

Highway mortality and injuries

Nineteen cougars (12 radio-tagged and 7 uncollared) were involved in 20 collisions with automobiles during 1988-1992 (M10 was in 2 accidents). This list (Table 6) probably includes all or almost all accidents during September 1990-January 1993, but almost certainly excludes some accidents involving non-radioed cougars during April 1988-August 1990, especially if they occurred in San Diego or Riverside Counties.

The roads with the most accidents were Santiago Canyon Road (4), Ortega Highway (4), Interstate 15 (4), and State Route 91 (2). All 4 accidents on Santiago Canyon Road were on the 2-km grade leading west from Irvine Lake up to the fire station at the crest of the road. All 3 accidents on the Ortega were in Caspers Park or just west of the Park. Three of the 5 accidents on I-15 were just north of the border patrol station midway between Temecula and Rainbow; the fifth was about 3 km (2 mi.) further south. The cluster of locations on I-15 coincide with the point where M12 successfully crossed I-15, and clearly indicate a threatened point along the critically important corridor linking our cougar population to the only adjacent population.

There was 1 accident on each of the following roads: Pomona Freeway, Interstate-5 (at Las Flores Creek), Clinton Keith Road, Basilone Road, Van De Grift Road, and Fallbrook Naval Weapons Station Road. Eight of the 12 accidents involving radio-tagged cougars were promptly reported to law

Table 6. Fate of 18 cougars involved in automobile accidents. There were no reports of human injury in any accident.

Fate	Cougar
Died near accident site	F8, M8, F12, M10[a], F9, F15, UF1[b], UC1[b], UC2[b], UC3[b], UF2[b], UM1[b], UX[b]
Euthanized at accident site[c]	F13
Did not recover, but survived 30 days	F16
Did not recover, but survived 6 months	M5
Apparently recovered	"FX"[d]
Fully recovered	F2, M10[a], M11

[a] M10 fully recovered from his first accident in May 1991, but was killed in a second accident in September 1992.
[b] "U" = uncollared. UF1 was an adult female killed on Santiago Canyon Road in fall 1988; cub UC1 was killed at the same site 1 week later. UC2 was a 9-month old cub of F3 killed on the Ortega Highway in Aug 1988. In Dec 1992, the small cub UC3 was killed on the Ortega Highway and juvenile female UF2 and adult male UM1 were killed on I-15 at the border patrol station, where UX was killed in October 1990.
[c] shot because she appeared unable to walk away from the accident site. The recoveries of F2, M10, and "FX" suggest that this may not have been necessary. There were no major injuries to bones or internal organs.
[d] We never identified the radio-tagged cougar struck on Fallbrook Naval Weapons Station (Dec 23 1991); when we arrived the next day all collared cougars were at least 1.5 km away and showed no abnormal movements in the days that followed.

enforcement agencies; the non-reported accidents involved F2, F8, F15, and M8.

Eleven of 16 accidents (69%) were at locations where wooded canyons intersected roads; we never precisely identified the location of the other 4 sites. The one clear exception to this pattern of crossing at major drainages is provided by the 3 accidents on I-15 which occurred along a wooded ridge. This site is somewhat surprising because there is an excellent canyon-bottom crossing site 1.5 km north (the Santa Margarita River). This illustrates that crossing points might not always occur where one might guess by looking at aerial photographs.

We documented the nature of some of the injuries sustained. M5 broke his left hip and his right femur just above the knee. F8 died of massive internal injuries. F12 was completely destroyed by the impact. F13 had no apparent skeletal injuries, or any gross internal injuries. M8 broke his pelvis near the midline and again through the right acetabulum (hip socket) and separated his right shoulder, but had no broken limb bones. F2 broke her left femur. M10 broke his left femur in his first accident, recovered, and then died of massive internal injuries in his second accident. M11 broke no major bones and was apparently only lightly injured.

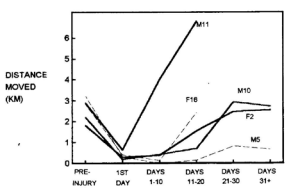

Figure 10: Distance moved by 5 cougars injured in vehicle collisions. Each point (except "1st day") is the average of at least 6 straight-line distances between consecutive locations obtained at least 1 day apart. Dashed lines indicate cougars that eventually died as a result of their injuries; solid lines indicate animals that apparently recovered fully. F16's last point = days 11-30. M11 was shot 20 days after his accident.

Of 5 animals that survived for more than 10 days after their accident, 3 apparently recovered, and 2 eventually died as a result of the injuries. Of the 3 recovered animals, M11 was apparently not severely injured, and F2 and M10 suffered broken femurs. F2 managed to raise her 2 cubs (4½ months old at the time of the accident) and lived for 14 months before dying of an intestinal disease. M10 was photographed in the freeway median with blood trickling from his face 15 minutes after the accident, but he then moved back off the freeway and soon recovered. He lived another 16 months and was of normal weight at death. Figure 10 contrasts the movement patterns of the "recovered" animals to the pattern for the cats that eventually died of their injuries ("temporary survivors"). Each of the 4 animals traveled 200-650m from the apparent accident site to their location the next morning. The recovered cats differed most markedly from the temporary survivors in the average distance moved during the first 10 days: recovering cats averaged over 400m between daily locations versus 0m and 149m for the 2 temporary survivors.

The individual accidents are described below:

F2: Ortega Highway at Cold Springs confluence, December 18 1989. F2 broke her left femur and remained close to flowing water in San Juan Creek during December 18-27. She recovered sufficiently well to kill a deer on December 29, although her tracks clearly showed that she was avoiding her left hind foot at that time. During visual observation on January 6, 1990 this leg was still unable to take the cougar's full weight, but she did

not avoid using it. During diel monitoring on January 6-7 and again on January 14-15, F2 traveled at normal speeds. During recapture on June 5 1990, she showed no evidence of the injury. She successfully raised 2 male cubs (4 months old at the time of the accident) to dispersal age. F2 died in March 1991.

F8: Riverside Freeway at Gypsum Canyon, 3:00 AM August 14 1989. F8 walked 800 m south of the freeway before dying. She died of massive internal injuries, but appeared in otherwise excellent condition with large fat reserves. Her carcass was delivered to Irvine Park so that the mounted skin, skull, and other material could be used in the new Visitor Center in Irvine Park.

"FX" (F9?): Fallbrook Naval Weapons Station Road, 4:00 PM December 23 1991. Camp Pendleton wardens, responding to a report of an accident involving a cougar, observed a radio-tagged cougar on the south side of the road, bleeding slightly from the face. After about 10 minutes, she moved through a 4-strand barbed wire fence into the nearest cover, where she remained out of sight for at least 20 minutes. Then as wardens advanced toward her, she flushed and crossed back through the fence, across the road, and through the fence on the north side, and into a clump of shrubs 20m north of the road. The wardens watched her there for several minutes until she got up and walked over a slight grassy rise (20 ft elevation) and out of sight to the north. We investigated the scene on foot the following morning, and with hounds on December 25, but found no evidence of a cougar in the area. Evidently the animal's injuries were less severe than any we have previously documented, because she apparently moved away from the scene fairly rapidly.

We had located all of the cougars with functional radio-transmitters on the morning of the accident and again on the morning after the accident. The only feasible victim with a functioning transmitter was F15. However, F15 had been 3.5 km from the site 6 hours before the accident, and by December 24, she was about 6 km from the accident site, and on succeeding days she moved distances typical of an uninjured animal. Most likely the injured animal was F9 (whose collar had failed in August 1988 and was later killed on I-15). The accident site was within F9's home range.

F9: I-15 south of Temecula, 8:30 PM March 1 1992. The accident site was near the Flynn Nursery at the north end of the village of Rainbow, at the southern edge of the last potential corridor linking the Santa Ana Mountain Range with the Palomar Range. F9 weighed 92 pounds, was not pregnant, had a scant 5mm of subcutaneous abdominal fat, but appeared in otherwise good condition. F9's transmitter had failed in July 1988.

F12: Interstate 5 at Las Flores Creek, 2:00 AM December 21 1990. F12 was demolished by multiple impacts. She weighed 103 pounds (the heaviest female weight we have recorded in this population), was 5-6 years old, and had been in excellent physical condition.

F13: Ortega Highway, 7:00 PM October 10 1990. F13 was killed about 1 km north of the Caspers Gate while crossing from east to west. This crossing point was used by several cougars, and lies about 300m north of a 12-foot wide culvert unused by cougars. She was in excellent condition and suffered no major injury in the accident, but was euthanized by a law officer at the scene because she appeared unable to walk. Her carefully skinned hide was also delivered to Orange County Harbors Beaches and Parks.

F15: Van De Grift Road, June 6 1992. Starting June 6, F15 stayed in a very small area in a dense riparian thicket in the Santa Margarita River, where she died on June 15, having moved no more than 100m during June

9-15. Her left pelvis had been shattered at the hip socket, with several bone fragments (up to 2 inches long) separated from the rest of the bone, and no visible growth of scar tissue. The femur was not damaged.

F16: Clinton Keith Road, 06:30 AM August 15 1991. The yearling F16 was struck near the crest of the road west of Murietta. She remained in a wooded canyon with flowing water at the accident site during August 16-27. She left the accident area by August 31 1991 and traveled considerable distances around Mesa de Burro, Mesa de Colorado, and upper De Luz Creek during August 31- September 16. Her movements seemed to reflect recovery from the accident, but she died about September 19. F16 had been accompanied by her mother 24 hours before the accident, but never after the injury. F16's sister (F17) dispersed from her mother a few days later and perhaps the accident occurred during agonistic interactions accompanying family breakup. The accident injuries combined with the stress of being newly independent were the primary factors in her death.

M5: Santiago Canyon Road, 6:00 AM April 23 1991. Shortly after the accident M5 moved about 400 m from the accident site into a well-wooded canyon. He moved very little for 3 weeks after this collision. A small seep about 250m away was M5's nearest source of water but a lack of tracks suggests that he went a full week without water. Tracks show that he did drink from the seep between April 30 and May 5; the seep dried up between May 7 and May 11. He also appeared not to have eaten for the first 7 days. A thorough search on April 30 turned up 1 dried scat from his last meal before the collision. An opossum that died at the seep about April 28 rotted there untouched by M5. A fresh scat indicated that M5 killed and ate an opossum on about May 10. On May 17, M5 moved 3.5 km (2.2 miles) to Peters Canyon Reservoir, which had ample water, dense woody cover, and abundant small prey; for the next 3 weeks he remained in the small dense willow forest surrounding this lake.

For the remaining 5 months of his life, M5 moved very short distances per day, repeatedly covering the same short travel routes in areas of very level terrain. M5's preference for level terrain brought him into areas of intense human use (described in greater detail in Chapter 9), including Irvine Regional Park, Santiago Oaks Regional Park, and Santiago Creek downstream from these parks. In 6 post-accident months of travel in such areas, there were only 2 reported sightings of M5, and this underweight animal never acted in a way that threatened humans or their pets. His only documented kills after the accident were opossums. On about September 22 1991, M5 died in the willow forest behind Villa Park Dam. All of his daytime locations (n = 10) during the preceding 3 weeks had been within 400m of the death site and within the level impoundment area. There was no sign of fresh injury on his carcass. He was markedly underweight for a 3-year-old male (82 pounds), but his skull and skeleton were of normal size for his age.

His skeletal remains revealed 2 severe leg injuries from his accident. His right femur was broken about 2 cm above the knee, and had rotated backwards about 90°, and laterally (outward) about 20°. Massive scar tissue had created a solid replacement bone, and the wear pattern on the femur and tibia indicated that the knee joint functioned normally in this new position. The more severe injury was to M5's left hip. The ball joint on his left femur was completely sheared off at its base, and was no longer part of the joint. New articular surfaces had formed on the fracture surface at the top end of the femur and on the dorsal ridge of the acetabulum (socket). The articular surface on the femur was about 1 cm^2 and rubbed against a worn area at least 6 times this large along the entire upper half of the socket ridge. Thus this replacement hip joint must have been weak and

sloppy. Large rough tuberosities had grown around the acetabulum and on the medial surface of the upper 6 cm of the femur. It is remarkable that he survived 5 months with injuries this severe.

M8: Pomona Freeway, about May 1 1990. M8 had a separated right shoulder and internal injuries, but no broken bones. His carcass was found about 3 days after the accident in weeds alongside the road.

M10: Riverside Freeway at Coal Canyon, 9:00 PM May 7 1991. M10 was hit broadside, breaking his left femur and both car headlights, and knocking off the car's front license plate. He was photographed in the freeway median with blood trickling from his face 15 minutes after the accident, but when police arrived he moved south of the freeway. He spent the next 7 days in a small canyon along the freeway. Then on the 8th and 9th nights he moved 0.7 and 2.0 km, respectively. We monitored his movements overnight on May 22-23 and again on May 23-24; he exhibited almost normal movement patterns, and killed and ate a skunk at 0030 on May 24. For the next 15 months, his movement patterns suggested no impairment of his locomotor abilities, and he weighed a normal 137 pounds at his death in September 1992. However, his elongate temporary home ranges were located along the urban-wildland interface, suggesting that he remained a subordinate male, probably because his injuries prevented him from attempting to defend a territory.

M10: Santiago Canyon Road, about 10:00 PM September 15 1992. At death, M10 weighed 137 pounds, had ample fat reserves, and appeared to have been in good condition. His spleen had ruptured and there was extensive bleeding in the abdominal cavity.

Illegal take and harassment

We encountered little evidence of illegal take and harassment of cougars. Chasing cougars with hounds (the dominant method of capture) is a high-profile activity and is difficult to hide in most of the study area. Access is strictly controlled on Camp Pendleton and is limited by topography and lack of roads on most National Forest land in the study area. The owners of private wildlands in Orange County actively discourage trespassers, who would be very conspicuous in these large holdings. However, on the Santa Rosa Plateau and north and west of the Plateau there are many small and medium-sized private ownerships, many non-resident landowners, ample roads, and relatively good access to National Forest land. This area offers the greatest potential for cougar harassment, and 3 such incidents were related to us during 1988-1992. Doubtless other cases were not brought to our attention. In none of these incidents do we have proof that local cougars were harassed or killed. The 3 incidents were:

1. In March 1992 we learned that CDFG wardens had seized a cougar skin several months earlier at an estate residence on upper De Luz Creek. The warden indicated that there was substantial evidence that the homeowner had captured the animal locally, had raised it in a cage on his property for 4 years, and had then had it killed and mounted because of the difficulties of continuing to maintain it in captivity. The evidence (statements that homeowner allegedly made to several other persons) was not strong enough to prove in court that the animal was trapped locally.

2. In spring 1992 we were called by an Orange County resident who had been hiking in the National Forest near the Santa Rosa Plateau the previous day. Near dusk he was approached by some tired dogs wearing radio-collars and tags with a phone number. When no one came

looking for the dogs for about an hour, the reporting party took the dogs home and called the owner, who came to pick up the dogs the next day. When the dog owner came by, he stated that he had been using his dogs "to chase mountain lions."

3. F10 disappeared in mid-October 1991. Our last ground fix on her and her family was October 11 1991, when tracks indicated that F10 and 2 or 3 cubs (born July 1991) were alive in Roblar Canyon. Since then, we were unable to locate her or any sign of her cubs, despite many telemetry flights, intense track searches, and a 5-week trapping effort. In the latter effort, we put 5 snares in the core of her home range and checked them daily during November 19-22 and November 25-December 24 1991. It is unlikely that she and her cubs could have avoided these areas for 5 weeks, and they probably died. On January 31 1992, a person telephoned us to report that a female cougar had been poached by 2 orchard workers in a western tributary ("Conquistador Canyon") of lower Sandia Canyon on October 19 1991. The caller claimed that he had confronted the 2 men as they were dragging out a live male cub wired to a makeshift noose-pole. He says he took the cub from the 2 men and announced his intention to release the cub. The 2 men responded that they had just killed the mother and that release would probably be fatal to the cub. The caller claimed that he kept the cub and that the cub was then (January 1992) nearly 40 pounds in weight and being kept by his "brother in Ohio." The man called us because the cub was becoming difficult to keep and he wanted some sort of permit that would enable him to legally transfer the animal to a better facility. We advised him to contact CDFG for how to dispose of the cub, and promptly relayed the report to CDFG wardens. We cannot confirm that the incident took place, and have no firm evidence that F10 and her cubs were involved if it did take place. However, Conquistador Canyon had been part of F10's home range.

The only evidence of illegal harassment in Orange County comes from 3 observations on Irvine Ranch property north of Santiago Canyon Road; the most recent occurrences were March 27 1991 and April 13 1992 (we failed to record the date of the first incident). On each occasion tracks of several hounds, 2-3 men, and 1-2 cougars strongly suggested that long chases had taken place within the previous 24 hours. These apparent chases occurred in Gypsum, Weir, Blind and Fremont Canyons. In none of the cases was there any evidence that a cougar had been killed. After the second incident we asked the cattle lessee on that property if he was aware of the activity; he claimed he had been out at night trying to break his dogs from chasing deer.

A final observation may or may not be related to illegal harassment. On July 17 1991, we recaptured F5 to replace the transmitter deployed in May 1989. In the interim she had lost all but the basal 31cm of her tail. Scar tissue had formed over some small wounds (apparently canine punctures) on her tail and left hip, but not on the surface of the stump, so the tail loss appeared more recent than the other injuries. Based on his experience with hounds, field assistant Duggins Wroe believes the tail and other injuries were inflicted by dogs. However, the injuries could also be cougar-inflicted.

Depredation

All depredation losses involved cougars being shot for eating goats or sheep. Although there were 4 large cattle operations in the study area, to our knowledge there were no requests for depredation permits due to loss of calves or cows. We were aware of only 1 large sheep operation in the study area, namely the sheep-grazing lease on Camp Pendleton. Since 1989, Camp Pendleton has required the sheep lessee to bear the cost of depredation losses without

recourse to depredation permits. Most goats in the Santa Ana Mountain Range were kept as pets or for fuel control near rural homes; most owners had 1-3 goats. We were aware of only 3 ownerships with more than 5 goats, 2 of which attempted to generate some revenue from them.

Depredation losses are summarized below.

Sheep: In February 1988, M1 and an uncollared adult female cougar were shot on Camp Pendleton.

Goats: On January 28 1992, an uncollared male cougar (2 years old, excellent condition, 135 lbs) was shot near Bolero Peak in Santiago Canyon. His carcass was donated to Irvine Regional Park which will mount the skin for display in their visitor center. At about 9 PM March 4 1992, M2 (4-5 years old, excellent condition, 155 lbs) was shot by the same goat rancher. On January 26 1993, F11 (about 8 years old, excellent condition, blunt and worn teeth normal for age, 80 lbs) was shot about 3 km east of Redondo Mesa, and about 5 km (3 mi) outside the home range she had used during the previous 5 years of monitoring. On February 4 1993, 2 uncollared male cougars were shot by the same livestock owner that killed F11. The CDFG official reported that the first male was about 1-2 years old, in good condition, and weighed 88 lbs, and that the second male was 5-6 years old and weighed 114 lbs. If the latter age estimate was accurate, then the older male was markedly underweight.

Synthesis: a population model

Population dynamics involves only 4 basic processes, namely birth, death, immigration, and emigration. This study has provided some information on each of these processes. However, to move from observed data to an understanding of population dynamics is much more complex, because these processes vary with age and sex of the animal, population density relative to carrying capacity, area of habitat available, and availability of movement corridors. Forecasting how the cougar population will grow or decline in the future requires a mathematical method of integrating these data and projecting them over time.

To do this, we developed a simulation model to forecast the likelihood that a cougar population can persist, under various estimates for the important biological parameters (birth and death rates, carrying capacity, etc.) and various projections about management decisions (amount of habitat protected, preservation of habitat corridors). This model is described in detail by Beier (1993, included as Appendix 1 in this report); this paper should be considered one of the most important parts of this Final Report. In brief, the model demonstrates that if thousands of square miles of suitable habitat containing cougars were divided into isolated chunks, each less than 500 square miles in size, cougars would inevitably become extinct over the entire area because of this fragmentation. However, if the habitat areas are instead connected by movement corridors, the cougar population will likely survive.

All models are defective to some unknown degree, and extinction is a serious consequence. Therefore, in evaluating the results of this sort of model, an "acceptable" level of risk is generally at most 1-2% (Shaffer 1987). Model predictions are also sensitive to errors in our estimates for carrying capacity, birth rates, or survival rates (Beier 1993). As mentioned elsewhere, the model used a birth rate estimate that may be higher than the true rate ("Reproductive Activity" earlier in this chapter), and true carrying capacity may also be somewhat lower than the estimate used in the model (last section in Chapter 7). Both of

these errors would cause the results shown in Figure 11 to underestimate the extinction risk.

With respect to the cougar population in the Santa Ana Mountain Range, the model makes several clear predictions (Figure 11):

- The 2070 km2 of habitat remaining is precariously close to the smallest isolated area that can support a cougar population.
- Without a corridor for immigration from the Palomar Range, every additional parcel of habitat lost to urban growth increases the risk of extinction.
- If only the central habitat block (Figure 1, Table 1) is preserved, the extinction risk is 33% in the short term, and a virtual certainty in the long term.
- With a high-quality corridor to Palomar and good connections among existing protected lands, the extinction risk can remain low even while adding thousands of new homes and losing many acres of wildlands to urbanization.
- Loss of the Coal Canyon Corridor would cause the extinction of cougars from the Chino Hills. Because the Chino Hills is 8% of the total habitat area in the Mountain Range, this also would increase the risk to the larger population and push the population to the steeply rising part of the extinction risk curve (Figure 11).
- Without corridor protection, cougars will be lost from Limestone Canyon-Whiting Ranch Regional Park and all smaller protected parcels in the Mountain Range.

Perhaps the most surprising result of the model is the finding that a corridor that allows even rare immigration (1-4 juvenile immigrants per decade) dramatically reduces extinction risk. The model results are made much more meaningful by 2 additional findings in this study:

1. Our data on dispersal of juvenile cougars (Chapter 6) show that cougars will find and use corridors. In particular, dispersing cougars used all 3 major corridors (Coal Canyon, Pechanga Creek, Arroyo Trabuco) in the study area.

2. By closely following radio-tagged cougars, especially on intensive monitoring sessions, we have mapped the actual routes by which animals move between protected habitat parcels. Although many of these routes are now pristine open space, they will become corridors (at best) as urban growth removes the adjacent habitat. These maps have been provided to the County and other appropriate agencies in previous reports.

Finally, the model and related data underscore the need for regional planning. The Santa Ana Mountain Range straddles 5

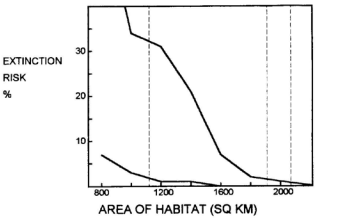

Figure 11. Extinction risk (percent of simulated populations that went extinct within 100 years) for the cougar population in the Santa Ana Mountain Range. The upper line gives the risk if the Pechanga Corridor is lost to urban growth, and the lower line the risk if that Corridor can be maintained. From *right* to *left*, the dashed vertical lines indicate total habitat available in 1992, total habitat available if the Coal Canyon corridor is lost, and total area of the protected and interconnected habitat block (Table 1, Figure 1).

counties and abuts 17 incorporated cities. Two freeway-building agencies and the world's largest water district also make critical land-use decisions. Because the cougar population needs large habitat areas and viable connections between protected habitat parcels, no single agency takes account of the cumulative impacts of land-use decisions on viability of this cougar population. For instance, the short wildlife corridor at Coal Canyon lies within the jurisdiction of Yorba Linda, Anaheim, and CalTrans, and the latter 2 entities refused to engage in a multi-jurisdictional attempt to preserve the corridor. Without dramatic changes in land-use plans at a regional scale, there is little hope for survival of this cougar population.

CHAPTER 5. UTILITY OF TRACK SURVEYS

Track surveys for cougars can be used for 3 purposes: (1) to detect simple presence of cougars, (2) to detect increases or decreases in population size, or (3) to estimate the total number of animals in a population. The first type of survey is relatively inexpensive and potentially useful, and is discussed in the first part of this chapter. The second type of survey is very expensive and has low power to detect change in numbers. It is nonetheless feasible and is discussed at the end of this chapter. The third type of track survey (to estimate numbers) would be extremely expensive, probably requires surveying more road mileage than exists in our study area, would produce estimates of low precision and unknown accuracy, and will not be discussed further.

Surveys to detect cougar presence

There are frequent reports of cougar sightings within County Parks. Under most circumstances it is unlikely that County Parks would want to use a track survey to validate or discredit a report, because valuable manpower would be spent without gaining any new information. However, in certain circumstances (e.g., a report of a cougar engaged in unusual or bold behavior) a track survey to detect cougar presence might be appropriate. Track surveys for presence are also useful to detect whether cougars are still using an area that has been impacted by urban growth.

Most cougar sightings are bogus and do not need validating

In our experience during 1988-1992, at least 75% and perhaps as many as 95% of the routine sightings were cases where the observer has misidentified a bobcat, coyote, domestic dog, domestic cat, raccoon, or deer. The following 3 examples illustrate that even people with extensive experience with animals mistakenly identify other animals as cougars, even under ideal viewing conditions.

1. In 1988 we received occasional reports of cougar sightings from security personnel at the TRW facility on Rancho Mission Viejo. These reports seemed credible because the guard station had a fine view, because 2 radio-tagged cougars used the areas within their view, and because each guard spent 40 hours a week in the station. At about 8:00 on December 25 1988, as one of the study team drove up to the guard station, 2 guards excitedly stated that they had been watching a cougar in the canyon below, using binoculars, from a distance of about 250 yards, for about 5 minutes. They pointed to a shrub behind which the animal had just walked. A minute later a coyote walked out from behind the shrub.

2. Rancho Carillo is a community completely surrounded by designated wilderness areas, inhabited by about 70 families who have chosen a remote lifestyle. They live in the middle of cougar habitat, and we tended to believe many of their reports of cougar sightings. In July 1989, a resident of Rancho Carillo reported that for 2 days a cougar had been resting near a woodpile and trailer about 200 feet from his house. He had watched the animal several times, during the daytime, using a spotting scope, and several of his neighbors had also seen it. When 2 members of the study team went to investigate on the morning of July 28 1989, the informant and several other observers said they had just seen the cougar bed down behind the trailer. The informant stood by his spotting scope while we went to investigate. As we approached the trailer, a house cat ran out from under the trailer and the observers shouted: "There goes the lion."

3. At 12:45 PM on February 5 1990, Orange County Animal Control called to report that an adult cougar and a spotted cub were in a clump of pampas grass at 24252 Cataluna Circle in the City of Mission Viejo. An animal control officer had been called to the scene by a local resident, saw the cats himself, watched the cats enter the pampas grass at noon, and had watched the clump of grass continuously since that time, calling for assistance with his hand-held radio. The officer was certain that he was watching so closely that the cats could not have escaped. When we arrived we crawled into the pampas grass to flush the animals into the open where the assembled Animal Control Officers and CDFG wardens could attempt to shoot the cougars with tranquilizer darts. We flushed a 10-pound yellow house cat.

Finally, the power of suggestion can greatly increase the number of reported sightings. We usually received fewer than 6 reported sightings per month during 1988-1992. However, as a result of publicity surrounding the court hearings on the Laura Small case, we received about 6 reported sighting per week. We could investigate only a fraction of these reports; none of them could be verified by the presence of cougar tracks or other sign.

Given the unreliability of sightings, we make the following conclusion:
If
(a) the report did not allege that the cat acted aggressively toward people, and
(b) the Park is already known to be cougar habitat,
then,
it is a waste of time to investigate the report, **because**
(a) the report is probably in error, and
(b) even if the report is confirmed, no new information will be gained from the effort. If the park was known to be cougar habitat before the sighting, a confirmed sighting would not change this fact in any way.

When a track survey for presence may be warranted

If a reported sighting of a cougar includes an account of unusual behavior (e.g., the cat deliberately approached the park visitor at close range) or if the sighting occurs in an area thought to be outside cougar habitat (e.g., any park west of I-5), Harbors Beaches and Parks (HBP) may wish to validate these reports. There may be reasons why HBP may prefer not to investigate; for instance, HBP may feel that chasing phantasms is diverting resources from important work or they may decide to refer the report to CDFG. Our purpose here is merely to point out that if HBP wishes to validate a report of unusual cougar activity, a prompt track survey can be a useful approach.

Track surveys for presence can also be used to monitor the success of wildlife movement corridors impacted or created by human activities. In approving projects with narrow habitat strips for animal movement, planners often decline to require wider corridors because it is impossible to know in advance that the narrow corridor won't work. However, we would soon gain such knowledge if we monitored animal use of such habitat strips (Beier and Loe 1992:438). If track surveys are used to detect cougar use of a site, it may be necessary to rake the ground or import dirt to increase the detectability of tracks, and sites should be checked at dawn (before nocturnal tracks are degraded). Because cougar home ranges are so large, track monitoring should take place at least twice a week for several months, with equal sampling intensity before and after project impacts. Further suggestions for such monitoring are given by Beier and Loe (1992:438).

Using tracks to verify a reported sighting

In the course of investigating many reported sightings, our staff and the personnel at several county parks have developed a simple procedure for using tracks in an attempt to verify a reported sighting. If the followup investigation is carried out within an hour of the sighting, there will usually be some useful evidence. Fresh dog or bobcat tracks at the very point where the sighting occurred would disprove the sighting. Fresh cougar tracks in the vicinity would verify the report. In some cases the sighted animal will still be present if the investigator arrives promptly. However, we caution that in some cases no useful evidence will be found; such lack of evidence should be used neither to accept nor to reject the sighting. We first presented the following procedure at a seminar for HBP Rangers at Santiago Oaks Regional Park on September 5 1991.

1. Have the informant describe the animal in their own words. Prompt the informant by asking questions such as "What colors did you see on its coat?" and "Describe the tail." Do not ask leading questions such as "Was it brown all over?" or "Did it have a real long tail?"

A cougar has a black tip on its tail, but no black elsewhere. If they describe "some black" on the sides or belly, it was probably a bobcat. A cougar's tail appears nearly as long as its body (although it's not really that long), and is usually held so that it nearly touches the ground.

2. If the informant described a cougar, visit the site promptly to look for tracks. Hikers, bikers, equestrians, and winds can obliterate tracks within minutes. When you go to the site, bring a track identification guide (Figure 12). If possible, have the informant take you to the exact location where they saw the animal.

3. While holding a track identification guide (Figure 12) in your hand, check for tracks everywhere within about 400 m (¼ mile) of the sighting area. If the cougar walked in a dirt trail it will almost always leave tracks. If the cougar was not reported to have walked in a trail, check nearby portions of the trail anyway.

4. If you find cougar tracks in an unusual location (e.g., west of I-5, in a city park) or in connection with reported aggressive behavior, document the fact with photographs. Use a camera that can focus on a track a few inches from the lens. Take under-exposed photos in addition to normally exposed photographs; overexposed photos do not reveal the details needed for a positive identification. Try to get strong side-lighting so that the edges of the tracks cast big shadows. In low light,

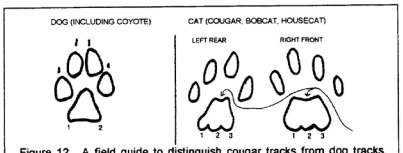

Figure 12. A field guide to distinguish cougar tracks from dog tracks. Size is worthless as a criterion: some dog tracks are larger than cougar tracks. If you can see claw marks, it is a dog track; however, tracks without claw marks can also be dog tracks. **The critical field marks relate to track *shape***: A dog track has a roughly triangular 'heel' pad with 2 lobes at rear, and near-perfect symmetry (you can rarely tell right from left). The 'heel' pad of a cat track has 3 lobes at the rear margin and a dimple in front (arrows). A cat track is also asymmetric: you can tell right from left. If the heel pad of a cat track is over 37 mm (1.5") wide, it is a cougar track; if narrower, it is a bobcat or housecat.

use a lantern, auto headlights, or a detachable flash to create strong side lighting.

Surveys to monitor population trend

By resurveying dirt roads and trails on an annual or multi-annual schedule, it would be possible to detect long-term changes in population size. In the case of the Santa Ana Mountain Range, such information could be used to detect whether cougar numbers are declining, so that remedial measures could be taken. We do not feel that such monitoring would be useful, however, because simulation modeling (Chapter 4 and Beier 1993), present population size (Chapter 2), the near-isolation and accelerating fragmentation of the population (Chapter 3), and highway mortality (Chapter 4) all clearly indicate that our cougar population faces a bleak future unless careful land-use planning is implemented rapidly. Data from an expensive long-term track survey would add little to the urgency that already exists, and could be used to delay effective action.

Such a survey also has limited ability to detect change in numbers. As Kendall et al. (1992:428) cautioned, a well-designed track survey for trend "will not detect small, annual population fluctuations but may reveal long-term trends or impending disaster.... We emphasize that, at best, such data will reliably detect only substantial, potentially threatening declines, and then only with large sample sizes [and] relatively abundant sign." Similarly Van Dyke et al. (1986) and Van Sickle and Lindzey (1992) found weak correlations between track density and cougar numbers (r^2 = 0.38 and 0.73, respectively) and the latter cautioned that the technique can detect "only relatively large changes in cougar population size."

Despite these reservations, a trend survey using tracks is technically feasible and managers may decide to implement such a survey. Based on our experience and our survey of the literature, we offer the following survey procedures, designed to detect a 20% decline in cougar numbers with a statistical power of 0.8 (80% chance of detecting a real decline) and significance level of 0.1 (10% risk of falsely suggesting a decline, one-tailed test). We chose a procedure that uses presence-absence data on each mile surveyed, rather than track density because the 2 types of data provide highly correlated results (Kendall et al. 1992), because our procedure avoids subjective judgments of whether or not a new track occurrence represents a different animal, and because our procedure (by allowing the observer to stop observing in each 1-mile segment after a track is detected) is much less expensive. This is not a highly sensitive procedure, but further sensitivity would require considerably greater effort. Indeed the limited length of dirt roads in the mountain range may preclude design of a more sensitive survey.

If such surveys are to be carried out, the following simple procedures are recommended:

1. Train observers to recognize cougar tracks. On a map, allocate dirt roads in the Santa Ana Mountain Range into Routes, each 30 miles long. This is the maximum distance that can be covered by a single observer in a single session. Some Routes can consist of a few short roads totaling 30 miles, with minimal transit time between the road segments. For statistical purposes, each Route must be run 3 times per year, and there must be at least 900 total miles (30 Routes) surveyed. Foot trails can also be used. Arrange the routes so as to achieve an even coverage of the entire mountain range. The 900-1000 miles needed probably approaches the total mileage of dirt roads and trails in the mountain range. Try to select routes that will not be paved in the future.

2. To reduce vehicle and manpower costs and increase detection of tracks, use a single observer driving a motorcycle on dirt

road Routes. Alternatively, it is equally effective (but with added costs and safety concerns) to use a team of 1 driver and 1 observer in a car or truck, the latter riding on the hood of the vehicle.

3. When driving each Route, start at dawn (before winds and vehicle traffic obliterate nocturnal tracks), maximize the time spent driving into the sun (this increases track detection), and stop before the sun is high. On roads with no vehicle traffic and calm daytime winds, late afternoon is also an acceptable time to survey.

4. Drive at about 5-8 mph, scanning the ground in front and alongside the vehicle carefully for tracks. When cougar tracks are suspected, stop and look closely. For each mile as measured on the odometer, record whether or not cougar tracks were detected. Do not attempt to determine how many different cougars made tracks. Thus if a cougar track is detected at 0.1 miles, you can stop looking for the rest of the mile and resume looking at the next whole mile. Use the same data form for each of the 3 surveys during a single year; if a track was detected on a given mile during 1 the times that Route was previously surveyed in a given year, you can omit checking on that mile.

5. Repeat the routes 3 times per year. The 3 repetitions should be run at the same times each survey year. We suggest running them about June 1, August 1, and October 1, because dusty road and trail conditions maximize track detection and the interval is sufficient to insure that you will never count the same track twice. The 2-month interval also increases the chance of detecting a mother with cubs whose restricted movements might not be detected if all 3 surveys fell in the early neonatal period. There is no particular advantage to longer (e.g., 3-4 month) intervals, and such spacing would risk encountering rain, floods, or washed-out roads.

6. The index of cougar density is simply the fraction of the 900-1000 miles sampled that had cougar tracks at least once during the year. Compute the standard error following Kendall et al. (1992).

7. Repeat the entire procedure every 2 or 3 years, looking for changes in the index since the last survey.

CHAPTER 6. ACTIVITY PATTERNS

Daily activity patterns

We carried out 180 intensive monitoring sessions, during which we determined location of the focal animal every 15 minutes. Most of the early sessions were for 24-hour periods (usually noon-to-noon). Because these early sessions showed that cougars were overwhelmingly nocturnal in their movements, later sessions started 1 hour before sunset and ended 1 hour after sunrise. Data from these sessions were analyzed by computing the straight-line distance moved between 1 location and the next location (15 minutes later). In each 15 minute interval, the cougar's behavior was categorized as traveling (distance > 0) or as static (distance = 0). Consecutive intervals of traveling or stasis were termed "travel bouts" or "periods of stasis," respectively. By simple addition, we computed the total elapsed time (always a multiple of 15 minutes) and distance traveled in each bout ot travel or stasis. Travel speed was computed as the distance traveled divided by the duration of a travel bout. Percent of time moving was computed separately for daylight and dark hours.

For the entire monitoring session, total distance was computed as the grand total of all 15-minute distances, and net distance was computed as the straight-line distance between the first and last location of the session. All times were converted to Pacific Standard Time before averaging across sessions.

On the day following most sessions, we walked the animal's route, often assisted by hounds, looking for prey remains, scats, or other evidence that would allow us to identify the behaviors associated with several distinct movement patterns. In this chapter, we summarize data from the first 78 sessions of monitoring (almost all of them for a full 24 hours). We are preparing a manuscript for scientific publication using all 180 sessions, but these analyses were not completed in time for this report.

There were 4 distinctive movement patterns. Our followup showed these patterns were associated with 4 different behaviors. Each of these 4 patterns is discussed in greater detail in the following sections:

1. walking all night (which we refer to as "hunting" although in fact we do not know what motivated the cougar to move steadily all night long),
2. feeding on a previously killed deer,
3. killing a deer during the session and then feeding on it, and
4. killing and eating smaller prey.

We observed the hunting pattern on half (49%) of the sessions; on these days the cougar walked steadily and our followup suggests that it did not kill anything as large as an opossum. This was a surprising result, and suggests that cougars frequently went several days without eating. The patterns and our followup show that cougars killed an opossum-sized animal about once very 6 days (13% of sessions), killed a deer about once every 10 days (10% of sessions), and fed on a previously killed deer carcass on 23% of the sessions. The latter 2 frequencies suggest that cougars fed on a single deer for about 3½ nights (including the night of the kill). Thus days of non-feeding alternate with days of only-feeding creating an overall pattern of "feast or famine."

Three other behavior types were observed. (1) The focal animal was primarily involved in social interactions (breeding, or prolonged vocalizations between adult females) in 5% of the sessions. These movements usually followed a pattern similar to feeding on a previously-killed deer. (2) In 6 sessions the focal animal was an adult female with young (< 6-week-old) cubs; these sessions showed the "hunting" pattern for the first half of the night, and the mother usually spent the rest of the

night with her cubs. Thus the movements plotted against time resembled the pattern when a deer was killed near midnight (Figure 13: curve B). However, the starting and ending location was always the site where the cubs were hiding. (3) Dispersing juveniles generally displayed a "hunting" pattern, but were doubtless exploring at the same time; data from these animals were excluded from the results presented here.

Table 7. Summary statistics for cougar movement patterns while presumably hunting. Data are from 33 monitoring sessions, in which the focal animal was located every 15 minutes.

Trait measured - units	Average	Modal class[a]	Range
percent of night time traveling - %	51	41-50	25-83
percent of daylight time traveling - %	13	0-10	0-42
total distance traveled in 24 hours - km	9.0	8.0-8.9	2.1-19.4
traveling speed - meters/hr	920	500-750	120-3400
number of travel bouts per 24 hours - n	9	8	4-14
number of travel bouts per night	7.4	7	3-14
number of travel bouts in daylight	1.6	1	0-6
duration of travel bout - hours	0.91	0.25&0.75[b]	0.25-6.75
duration of periods of stasis (night time) - hours	0.78	0.25	0.25-3.75
distance traveled in 1 travel bout - m	975	50-250	50-9800

[a] In some cases the mode (the most frequently occurring value or class) is a better indicator of "typical" behavior than the average.
[b] bimodal

Hunting

This pattern consisted of walking most of the night, with no period of stasis longer than 3.75 hours. Because the cougar moved steadily and almost certainly did not kill any prey as large as an opossum, we have labeled this pattern "hunting" although the cougar may have been moving for some other reasons.

Data from 33 sessions showing this pattern are summarized in Table 7. A "hunting" cougar spent about half the night traveling, and did virtually no traveling during daylight hours. On only 2 of the 33 sessions did the cougar travel over 3 km during the daytime. Hunting cougars usually traveled at a leisurely pace of about 900m/hr. Travel occurred in about 9 short bouts per day, each typically less than 1 hour in duration and less than 1 km in distance moved. Night-time travel bouts alternated with shorter periods of stasis. The overall pattern thus consisted of short, slow-speed travel bouts, during which the animal probably searched for prey or moved to a new site, alternating with shorter periods of stasis, during which the cougar probably stalked prey or waited in ambush. During some periods of stasis, the cougar may have fed on small prey, drank water, or rested. Daytime sedentary periods typically lasted all day; during these periods the cougar probably simply rested.

The overall pattern exhibited by a "hunting" cougar is illustrated and contrasted to other patterns in Figure 13 (line A).

Killing and/or feeding on prey

In contrast to the steady alternating between travel and stasis, a very different pattern was evident when cougars made a kill or fed on a previously-killed deer. In the sessions when the focal cougar fed on a previously-killed a deer, the cougar traveled very little, with virtually no activity between 8AM and 2PM, and very little movement at night (Figure 13: line C). The peak activity periods were at dusk and dawn, reflecting movements between the carcass and a daytime rest site.

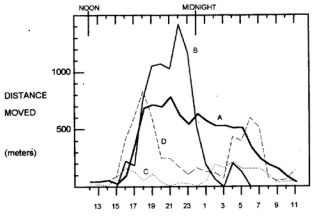

Figure 13. Twenty-four hour patterns of distance moved per hour by radio-tagged adult cougars that (A) were presumably hunting, (B) killed a deer near midnight, (C) fed on a previously-killed deer, or (D) killed and ate an opossum.

When the cougar killed a deer during a monitoring session, the "hunting" pattern was evident up to the time of the kill, after which the cougar moved very little for the rest of the night (Figure 13:line B). After some deer kills, there was a travel peak near dawn; in some cases this reflected a quick movement to water and a quick return to the carcass, and in other cases the cougar moved to a daybed site at some distance from the carcass.

Cougars killed medium-sized prey (mostly opossums) on 13% of the sessions. In these sessions, the movement pattern resembled the "hunting" pattern up to the time of the kill, and returned to that pattern after about 6 hours (at which time the prey was fully consumed) (Figure 13: line D). In most cases the medium-sized prey was killed about 3-4 hours after sunset.

Seasonal changes in distance moved per day

We used "net daily distance" moved per day as an index of activity. "Net daily distance" is simply the straight-line distance between 1 animal's locations on 2 consecutive days. We calculated about 2800 such distances, and then averaged them for each cougar in each month, deleting any case based on fewer than 3 distances. To evaluate seasonal changes in cougar activity, we plotted average net daily distances against month (Figure 14).

Males traveled much longer net distances per day (average = 5.7 km) than females (average = 3.2 km). The variation

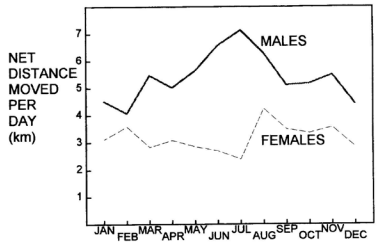

Figure 14. Seasonal pattern in average net distance moved in 24 hours by adult cougars. Males moved much longer distances. Within sex, there was no significant differences among months.

among months was not statistically significant (ANOVA, P > 0.50 for both males and females).

Dispersal movements of juveniles

Dispersal is the movement of an animal away from its place of birth to establish a new home range elsewhere. For cougars, the process of dispersal usually begins at 12-24 months of age, and continues for several months, during which the animal searches for suitable habitat that has minimum risk of conflict with other resident adults of the same sex. Adult males are especially intolerant of a young male taking up residence within the adult's range. As a result, juvenile male cougars usually travel into a different mountain range to find an area without an adult male. In Nevada, 75% of the yearling males and 20% of the yearling females moved out of the mountain range in which they were born (Ashman et al. 1983).

Juvenile dispersal in cougars is important in maintaining small populations and for recolonizing habitat where chance local extinction has occurred (Hemker et al. 1984, Beier 1993). Seidensticker et al. (1973) concluded that recruitment into the adult population occurred mainly via immigration of juveniles from adjacent populations, with the population's own offspring emigrating to other areas. Dispersal may also help maintain gene flow among populations (Greenwood 1980). Data on dispersal can be important in maintaining appropriate habitat for dispersal movements and for conserving genetic variation. Despite its importance, dispersal is "amongst the least understood factors of population biology" (Gadgil 1971:253).

In the Santa Ana Mountain range, dispersal is increasingly impeded by urban growth which has created many impenetrable barriers to animal movement. Pitted against these barriers is an innate tendency to disperse, evolved over millions of years. Our study was the first to examine how cougars attempted to disperse in confined and fragmented habitat.

Urban expansion has also created several narrow corridors, and we were most interested in whether dispersing cougars would find and use them. The 3 main corridors of interest were:

1. The Pechanga Corridor (Figure 7) provided the only possible link to the adjacent cougar population in the Palomar Range (Chapter 3).
2. The Coal Canyon Corridor (Figure 8) provided the only cougar travel corridor to the Chino Hills (Chapter 3).
3. The Arroyo Trabuco (Figure 9) was a redundant corridor in the sense that a cougar can travel between the large wildlands north and south of the Arroyo by a longer route to the east. Nonetheless it was of interest because it was a very long (about 6 km, or 3.8 mi.) and narrow (300-600m , or 0.2-0.4 mi.) strip, hemmed in by dense tract homes on either side, but with excellent cougar habitat within the Arroyo (Figure 9).

We followed the dispersal movements of 8 male cougars and 1 female cougar (Table 7). The juveniles were 9-18 months old at the time of capture, and were monitored until death or a stable adult home range was established. We had radio-tagged the mothers of 7 of these 9 animals, and thus we know their predispersal history in some detail. The other 2 animals (both males) were tagged as dispersers; their predispersal home ranges and ages at dispersal were not known. We found:

1. Mean dispersal age for 6 male cougars was 18.3 months (range 13-21); their ages were accurately known because the dam was radiotagged before birth (Table 1). The males captured as dispersers (M5, M6) were about 19 months of age based on weight and tooth wear (Ashman et al 1983:19-27). At

Table 8. Dates of birth and dispersal, and maximum dispersal distances for 1 female and 8 male juvenile cougars (Felis concolor) in southern California.

ID	birth date	capture date	dispersal start date[a]	dispersal end date[a]	N1[b]	N2[c]
F17	Dec 1989[e]	28 Jul 1991	3-10 Sep 1991	died 6-9 Jan 1992	39	5
M3	5 Aug 1989[f]	5 Jun 1990	26-29 Jan 1991	died 15-18 Feb 1991	14	0
M5	Jan 1989[g]	3 Aug 1990	pre 3 Aug 1990	died 18-24 Sep 1991	163	3
M6	Jan 1989[g]	27 Aug 1990	pre 27 Aug 1990	16 Dec 1991	117	2
M7	15 Jul 1989[f]	23 Oct 1990	28 Mar-4 Apr 1991	continues		1
M8	15 May 1989[f]	29 Oct 1990	4-7 Dec 1990	died 1-5 May 1991	73	8
M10	15 May 1989[f]	25 Feb 1991	22 Mar-3Apr 1991	died 15 Sep 1992		8
M11	9 Aug 1989[f]	4 May 1991	16-22 Jan 1992	died 29 Feb 1992	20	1
M12	9 Aug 1989[f]	15 Aug 1991	25-28 Sep 1991	died 24 Mar-10 Apr 1992	37	3

[a] Starting date range is last date within mother's home range until first date off natal range, or (M5, M6) date captured as a disperser. For death date, range is last date known alive until date found dead. For M6, end date = date on which 60% of the animal's stable home range had been visited (Minimum convex polygon).
[b] number of days with locations between start and end (or death) dates.
[c] number of sessions of intensive (overnight) monitoring between start and end (or death) dates.
[e] F17's mother was also radio-tagged 28 Jul 91, so maternal home range is known, but birthdate is estimate.
[f] ± 4 days; mother was radio-tagged before birth of the juvenile.
[g] Estimate (captured as a disperser, mother not radio-tagged)
[h] In addition, travel path out of the mountain range on about 20 Jan 1992 was traced from tracks and scent.

dispersal, the female was probably about 19 months old based on weight (although tooth wear suggested an age of about 13 months). Littermates (2 pairs) did not disperse at the same time. M12 was the youngest disperser at 13 months of age, 4 months before his brother M11. M8 dispersed at 18 months, and his brother M10 was the oldest disperser at 21 months.

2. Dispersal was often initiated by the mother leaving the cub at one edge of her home range while she moved to the opposite edge of her home range for about 2 weeks. In some cases, the mother moved off of her home range temporarily. The cub usually stayed in a very small area where its mother had abandoned it. After about 2 weeks, the cub abruptly and rapidly moved out of its mother's home range, usually in the direction away from its mother. Dispersal began in January (2), March (2), September (2), and December (1); M6 and M5 were captured as dispersers in August after starting dispersing some days or weeks earlier.

3. Dispersal took several weeks to months, during which a succession of temporary home ranges were occupied; following Hornocker (1970), we refer to these as "transient" ranges. The move from 1 transient range to the next was usually very rapid. Some juveniles returned to their natal ranges several weeks after dispersal and stayed 7-20 days before departing again; no juvenile returned more than once. For males, a transient home range was occupied from 2 weeks-8 months, and was much smaller than (1% to 30%) the size of an area an adult male would use in the same time span. Transient home ranges were usually near the urban-wildland interface, and often elongate along that edge.

4. All dispersers explored extensively throughout the Santa Ana Mountain Range. Cubs born and raised at the southern edge of the range (M8, M10) dispersed northward and cubs born at the north edge (M11, M12) dispersed south, apparent trying to move to a new mountain range.

5. Seven of the 9 dispersers died before establishing a stable home range, usually (4 of 7) as a result of vehicle collisions. In addition to the 4 fatal accidents, dispersers were involved in 2 nonfatal vehicle collisions.

6. Dispersers explored the urban-wildland interface very thoroughly with remarkably little human interaction. All dispersers came within 100 m of urban areas and heavily used parklands for periods of time ranging from several hours to several weeks (following sections, and Chapter 9). Dispersers often crossed and used terrain avoided by adult cougars (e.g., M12's exploration of the grasslands west of San Juan landfill, M11's exploration of the San Luis Rey River, M5's exploration of Temecula Creek, F17's foray to the Anaheim Hills). Such exploration of marginal and edge habitat is very important because it is how juveniles find and use corridors (next point) and how they learn to avoid these areas by adulthood. None of the 9 dispersers behaved aggressively toward humans, although some livestock were taken in rural areas and 3 dispersers entered urban areas, apparently by mistake. We received only 5 reports (involving 3 cats: M3, M5, M11) of a disperser being seen by humans; no case involved cougar aggression.

7. Dispersers found and used movement corridors. Three of the 9 dispersers found and tried to use the Coal Canyon Corridor (2 succeeded and 1 was hit by a vehicle); 1 of them (M6) used the Coal Canyon Corridor (Chapter 3) at least 22 times. In addition an uncollared juvenile cougar also found and used the Coal Canyon Corridor. Three dispersers also found the Pechanga Corridor, 2 of them used it, 1 successfully (M12) and 1 unsuccessfully (M5). In addition, there were 5 vehicle mortalities in this corridor during October 1990-December 1992. At least 2, and probably 3 of the dispersers found, used, and explored the Arroyo Trabuco (M8, M10, and probably M12). Three dispersers each used 2 of the 3 corridors. Only 3 of the 9 dispersers *failed* to find and use at least 1 of the 3 corridors.

The last finding has very important implications for land-use planning, because it clearly demonstrates that efforts to retain and enhance existing linkages will not be in vain. In the following sections, we briefly summarize the dispersal history of all 9 dispersers. We are preparing a manuscript on cougar dispersal for publication in a scientific journal.

Dispersal of M8

After F12 and M8 had spent several days together in the northern part of her home range, F12 abandoned M8 on November 27 1990, moving to the southern edge of her home range. M8 stayed in a small area for several days, then moved off to the north sometime during December 4-7. On December 8 we documented M8's first independent kill of a mule deer (a male fawn). He fed on it for 3 nights. During December 17 1990-January 4 1991, M8 stayed mostly in the small (0.3 km^2) estuary of San Mateo Creek between the Pacific Ocean and I-5, known locally as Trestles Beach (Figure 15: Tr and HR1). M8 stayed in the estuary's thick willow forest and marsh, and there were no reported sightings from the many surfers and beachgoers during his stay.

We believe that no other radio-tagged cougar used Trestles Beach during our study, although the habitat just east of I-5 was regularly used by several cougars. M8 made only short local movements during intensive monitoring December 17-18. On December 23 we documented that he had killed and eaten at least 2 opossum and 2 raccoons in the area. M8 made 2 brief excursions (December 27 and December 31) east of I-5 during his stay at Trestles, crossing I-5 under the San Mateo Creek bridge and moving up to 3 km inland. On his second excursion M8 daybedded near adult male M2 and presumably the 2 cougars encountered each other. M8 returned to Trestles Beach the next day and M2 remained in the vicinity during January 1-5. On about January 4, M8 left Trestles Beach and returned to the center of his mother's home range.

Meanwhile his mother had been killed on I-5 on December 20 1990. On January 15 1991, M8 left his natal area for good, soon moving further north than before. He killed 2 mule deer in Gabino Canyon during January 17-19, consuming only 1 of the carcasses before moving north again.

On January 20-21, we observed M8's movements over terrain that he was exploring for the first time. One hour after sunset on

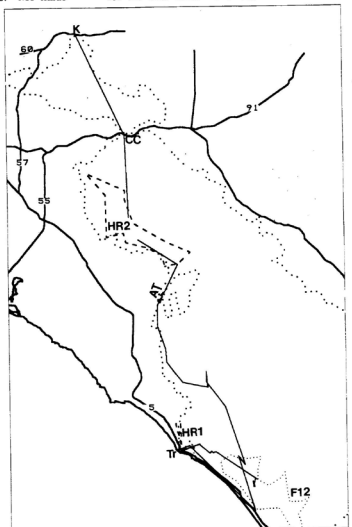

Figure 15: Dispersal Movements of M8. Dotted polygon indicates home range of his mother (**F12**). Heavy dotted line indicates limits of cougar habitat. His initial dispersal movements brought him to a small transient home range (**HR1**) in and near Trestles Beach (**Tr**). After a brief visit back to his natal range, he moved rapidly north, intensively exploring the Arroyo Trabuco Corridor (**AT**) and then using a new transient home range (**HR2**) along Loma Ridge during Feb-Mar 1991. In April he moved into the Chino Hills via the Coal Canyon Corridor (**CC**) and about April 30 was killed (**K**) on SR-60.

January 20, M8 left his daybed in Trampas Canyon and slowly explored or hunted in the upper basin of that canyon for 1½ hours. At 2000, he reached the basin's south rim, and quickly moved west along the rim, then north along the west rim for 800 m before turning west and heading down an unnamed canyon toward the San Juan Capistrano Landfill in Prima Deshecha Canyon. About halfway down, the canyon opened out into a broad grassy slope with no woody vegetation. At this point M8 moved north, quickly crossing 2 small, west-flowing, sparsely-shrubbed drainages; from the intervening ridges he doubtless saw the lights of San Juan Capistrano spread out to his west. The 3rd west-flowing canyon was much larger and contained good woody cover; he stopped there for about 40 minutes. At 2300 he resumed his rapid walk, heading down this wooded canyon all the way to La Pata Avenue. He reached La Pata Avenue (the paved access road for the landfill, which receives no night-time traffic) about 700 m south of the Ortega Highway, walked quickly north 350m along La Pata, turned NE through the nursery at the SE corner of La Pata and Ortega Highway, and crossed the Ortega into San Juan Creek just after midnight. M8 stayed in San Juan Creek for 4 hours, moving very little. At 0415 he walked up San Juan Creek about 400 m, returned downstream to the mouth of Cañada Chiquita and then quickly moved north on the west slope of Cañada Chiquita, staying east of the ridgeline. At 0545 he stopped and daybedded in a wooded canyon west of the Sea Tree nursery, northwest of the Santa Margarita sewage plant.

Although at least 6 radio-tagged cougars used Trampas Canyon, only dispersing animals (M8, M12) used the canyons west of Trampas Canyon. Their rapid pace suggested that they were not comfortable in the area's open grassland.

On the following night (January 21-22), M8 moved another 8 km, discovering and entering the Arroyo Trabuco corridor. He daybedded near the San Francisco Solano site, between the cities of Mission Viejo and Rancho Santa Margarita. During overnight monitoring on the nights of January 22-23 and January 23-24, he spent both nights in local movements (within about 800 m of the San Francisco Solano site), suggesting that he was hunting in the area and exploring small side canyons. Each morning at dawn the ridgetops came alive with earth movers and M8 daybedded near the Arroyo bottom.

On the night of Sunday January 26-27 we monitored the movements of M8. F2 had entered the Arroyo from the south the previous night and was daybedded < 1 km south of M8. We hoped to learn how F2 would react to a juvenile male in her home range. Trespassers traveling by foot, pickup truck, and dirt bike passed near both cats until dusk. Shortly after sunset, both cats started moving slowly towards each other, passing with 250 m (width of the Arroyo bottom at that point) without pause. We presume the cats were aware of each other, but we were not close enough to hear vocalizations. After this non-encounter, F2 continued north and M8 continued south at about 1km/hour. At 2000, a low-flying helicopter shone a spotlight at the radio-tracker (50m from the cougar) and M8 stopped moving for about 30 minutes. At 2130, M8 passed through the Oso Bridge construction site, an area of bare compacted ground with bulldozers, huge steel I-beams and construction debris on the ground, huge steel scaffolds, and a half-complete road bed above. A trespassing vehicle that had earlier broken its radiator was parked under the bridge, and a steamy windshield suggested that its driver was spending the night there.

M8 continued south to the mouth of Corridor Canyon (the large brushy canyon at the south edge of the site of the proposed Las Flores Planned Community). He promptly turned east into Corridor Canyon and walked

halfway up the canyon; his unhesitating move into this canyon suggests that he probably used this route when he first entered the Arroyo on the night of January 21-22. After stopping for less than an hour halfway up the canyon, at 2330 he backtracked to and up the Arroyo. He stopped just north of the Oso Bridge site and spent 5 hours exploring 3 small grassy canyons on the Mission Viejo side of the Arroyo. On several occasions he reached the ridgetop, from which he could see the lights of Mission Viejo < 1 km to the west, but he apparently never walked west of the ridgeline. Two of the 3 side canyons he explored had no woody vegetation, and only about 3 inches of new green herbaceous growth. He spent 2 full hours in the smallest of the 3 canyons, in which a dozen Russian thistles were the largest plants. We presume he was hunting for gophers, voles, and ground squirrels there; a few badger holes were also present. At 0500, M8 returned to the Arroyo and moved north, bedding near his starting location.

On the night of January 28-29, M8 left the Arroyo and resumed his northward travel. He was in Joplin Canyon on January 29, just NE of Cooks' Corner on January 31-February 1, across Santiago Canyon Road in Round Canyon on February 3, and in the Villa Park impoundment (willow forest) on February 8. He had traveled 56 km (35 mi) north of the north edge of his mother's home range.

During February 9-April 10 1991, M8 used an elongate home range pressed against the western edge of cougar habitat, mostly along Loma Ridge and its associated canyons, with occasional forays into Santiago Canyon above Modjeska (Figure 15: HR2). During April 8-10, he moved abruptly north, crossing the Riverside Freeway into the Chino Hills. We were unable to locate him with intense aerial telemetry searches south of the Freeway on April 12, April 15, April 26, and April 30, but on May 3 1991, a motorist stalled in traffic found M8's carcass on the north edge of the Chino Hills, in weeds along State Route 60 between Phillips Ranch Road and Diamond Bar Boulevard in Pomona (Figure 15). He had been struck by a westbound vehicle 3-5 days earlier as he tried to cross to the north side of the freeway. He had no doubt spent his last 3 weeks in the Chino Hills. Lack of tracks in any culvert under SR-91 indicates that he reached the Chino Hills via the Coal Canyon vehicle underpass.

In all his dispersal movements, M8 consistently moved north, hugging the western edge of cougar habitat and occasionally attempting to explore further west, only to find that there was no habitat to the west. This pattern was evident in his use of Trestles Beach, his travel through the grasslands west of Trampas Canyon, his exploration of the west ridge of the Arroyo Trabuco, his temporary home range along Loma Ridge, and his eventual death on SR-60.

Dispersal of M10

M10 (sibling of M8) began dispersal during March 22-April 4 1991, 3 months after his mother's death. He first moved about 16 km (10 mi) north of his mother's home range and stayed near a sheep grazing operation in San Mateo Creek during April 4-16, eating several sheep (Figure 16: HR1), then moved 51 km (32 mi., straight-line distance) north in 16-20 days, reaching upper Coal Canyon by May 6. His northward path was east of that taken by his brother.

On the night on May 6-7, we followed M10's movements down Coal Canyon. He started moving well before sunset and moved 3 km down the canyon at a brisk pace, following the main ridge between Gypsum and Coal Canyon. He approached the Riverside Freeway at 2100, stopping at the debris catchment before the main wash enters the culvert under the Freeway. From the catch basin, M10 had a

clear view of the Freeway and the twin box culverts but not of the vehicle underpass < 100m to his east. After pausing there for 10 minutes, M10 moved west 200 m to a small hill overlooking the freeway.

After 30 minutes, M10 moved west a short distance crossing one tiny canyon and stopping in the second small, parallel dry wash flowing toward the freeway. He spent the rest of the night at the lip where the wash dropped over a cut bank, from where he could see the freeway (200m away) and the darkness of the Chino Hills beyond the freeway. By dawn he could see that the dark area was suitable habitat. Just after the next sunset, at 2100 on May 7 1991, M10 was struck by an eastbound vehicle on the Riverside Freeway, breaking his left femur. He was photographed sitting in the median strip, but soon ran back into the tiny canyon from which he had come.

After a rapid recovery (Chapter 4: highway injuries) in a small post-accident home range (Figure 16: HR2), in mid-June M10 moved south, encountering and traveling the Arroyo Trabuco corridor from north to south, and continuing through Cañada Chiquita and Christianitos Canyon to Horno Creek (Camp Pendleton) at the north edge of his natal home range. He thus moved at

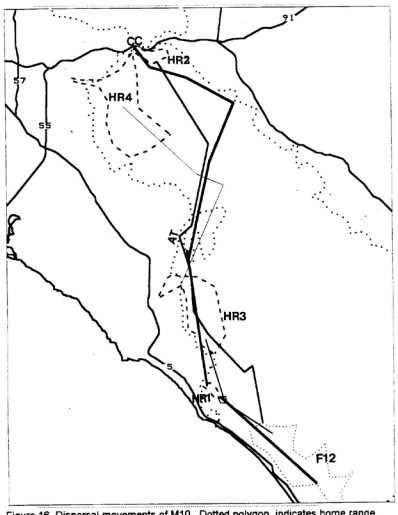

Figure 16: Dispersal movements of M10. Dotted polygon indicates home range of his mother (**F12**). Dashed polygons indicate his transient home ranges; heavy dotted line indicates limits of cougar habitat. The sequence of M10's travels are indicated by progressively thinner lines. After a brief stay in **HR1** (April 4-16 1991), M10 rapidly moved north to Coal Canyon, where he was struck on SR-91 (**CC**) on May 7. After a brief stay in a small post-accident home range (**HR2**), and despite a broken femur, M10 rapidly moved south, using the Arroyo Trabuco Corridor (**AT**) and returning to his natal home range (**F12**). 10 days later he moved north to **HR3**, which he used for 5½ months before moving to **HR4**, which he occupied for 8 months until he died in a second accident.

least 64 km (40 mi) in 14-19 days. He spent 10 days in his natal home range, and then established a transient home range (Figure 16: HR3) that included the area from upper Christianitos Canyon to Cañada Chiquita. After 5½ months in this area, he abandoned it in late January 1992, traveling north for 10 days and establishing another transient home range (Figure 16: HR4) along Loma Ridge and lower Santiago Creek. He remained in that home range until his death in a second vehicle accident on Santiago Canyon Road in September 1992.

Dispersal of M3

In fall 1990 M3 and his brother M4 spent increasingly long periods of time apart from their mother (F2), but they always traveled together within her home range. The longest such period away from their mother lasted for 10 days in early October 1990. Sometime during June-September 1990, M3 received a severe injury to his palate (Chapter 4). M4 died in early November 1990 and was fed upon (and possibly killed by) M3 and F2 (Chapter 4).

M3's dispersal was atypical in that he seemed reluctant to move off his mother's home range, making 2 brief excursions to the east before finally dispersing to the west. During November 26-29, M3 and F2 consumed a deer in the central part of their home range, but 2 days later F2 moved to the western edge of her home range where she spent 2 days near adult male M2 in the Arroyo Trabuco at the west edge of her range, an area she had not visited for over a year. M3 remained where F2 had left him in Bell Canyon.

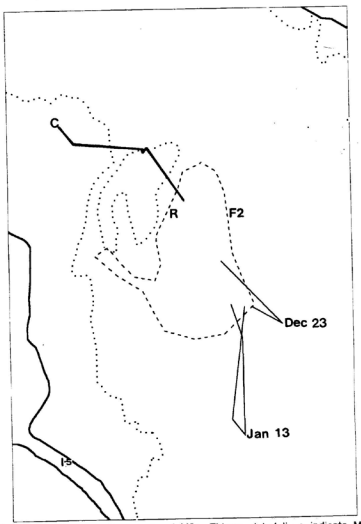

Figure 17: Dispersal Movements of M3: Thinner dated lines indicate M3's predispersal explorations outside his mother's home range, thicker line segments show his short dispersal into Irvine. He was captured in a residential area on 8 Feb 1991(C) and was released at R, where he died 1 week later. The dashed polygon indicates the home range of his mother (**F2**).

On December 4, F2 returned to her son's location for 1 day and then moved 2.4 km off the southwest edge of her normal home range. There she killed a deer (December 10) and fed on it for 3 days. She then moved back to Arroyo Trabuco. Meanwhile M3 slowly moved eastward within and then beyond her home range (Figure 17: Dec 23). Up to this point, the dispersal pattern and timing was typical except that F2 had abandoned M3 near the center, instead of the edge, of her home range.

However after less than a week away from home, M3 returned to the eastern part of his mother's home range on December 28-29. F2, after a month in the southwest parts of her home range, moved east and encountered M3 in her home range on January 7. M3 immediately moved east again, a bit farther this time (Figure 17: Jan 14). However, by January 16 he again returned to the eastern and northern portions of F2's range. F2 remained far to the west and did not encounter her son.

On January 30 1991, M3 moved off again, this time to the northwest (Figure 17). He moved into the north end of the Arroyo Trabuco where he killed and ate a coyote. During February 4-7, M3 continued dispersing northwest, moving along the wildland-urban edge and through areas interspersed with orchards. As he moved from the Oso Lake area into Serrano Creek, a motorist saw him run north across El Toro Road at the sign marking the future crossing of the Foothill Transportation Corridor (6:00 AM, February 5). On February 8 he had moved into avocado orchards further northwest, and was located about 1 km west of Siphon Reservoir, just east of the intersection of Jeffrey Road and Irvine Boulevard. Early on the night of February 8, M3 moved 1 km west, penetrating 2 blocks into a residential area adjacent to the orchards. There he was treed by a German shepherd dog in a yard at 50 Hunter St. in Irvine shortly after dark. At 2100, Animal Control officers tranquilized M3 and released him back into his mother's home range. He remained near the release site and died there 1 week later (Chapter 4: Disease).

Dispersal of M7

M7 left the home range of his mother (F10) in April 1-4 1991, moving slowly northeast while F10 moved to the southern part of her home range. He initially moved northeast from his mother's range to the Mesa de Burro area. This area immediately became the nucleus of a transient home range (Figure 18: HR1).

After 4 weeks he began to enlarge his transient home range. In May he expanded to include the peaks and canyons west of Lake Elsinore (16 km north), and in July to include the upper Santa Margarita River area several km south. On several occasions, M7 was very close to the I-15 bridge and he doubtless encountered this entrance to the Pechanga Corridor. However, we have no evidence that he ever crossed I-15. In mid-September 1991, M7 made a 65-km excursion to the northern edge of the range, reaching Hagador and Main Street Canyons near Corona, and quickly returned to his transient range (Figure 18: thinner line segments).

In late January 1992, after almost 10 months in this transient range, M7 abandoned it for a new home range (Figure 18: HR2). The south edge of his new home range abutted the north edge of his old range, and he had passed through much of this new range in his September foray. As with most transient ranges, both M7's ranges were elongate and had 1 long edge along the wildland edge (Figure 18). In his movements within each home range, M7 often stayed in 1 canyon for 3-8 days and then moved to another canyon. This was very different from the pattern of adults M2, M9, and M6, who rarely stayed in 1 locality for more than 3 days. As of January 1993, M7

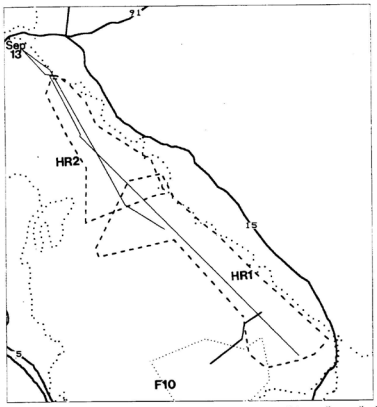

Figure 18: Dispersal Movements of M7. M7 moved a short distance (heavy line) from his mother's home range (**F10**) to a transient home range (**HR1**) which he occupied for 10 months. Thinner line segments indicate a long excursion from HR1 during September 1991. In January 1992 he abandoned HR1 for a second home range (**HR2**) that will probably become the nucleus of his adult home range if he survives. Heavy dotted line indicates limits of cougar habitat.

still occupied this second home range. This area was not overlapped by M6, M2, or M9, and if he lives we suspect it will form the nucleus of his adult home range. However, his movement patterns, and the relatively small size of this home range, suggest that it was not yet a true adult territory.

Dispersal of M12

M12, his brother M11, and their mother F6 had spent 2 weeks traveling together, when F6 and M11 abandoned M12 in a small brushy canyon on September 3 1991. M12 stayed in and near this canyon for 17 days, while his family ranged widely without him, mostly to his north. Tracks indicate that he used nearby dirt roads regularly. Finally, during September 20-22, he started dispersal movements to the south (Figure 19: thickest line segments).

During overnight monitoring on October 1-2 1991, M12 was moving steadily south through previously unvisited terrain when he encountered the noisy and well-lit California Silica Products factory and its adjacent open quarries. His first several attempts to pass by led to parts of the quarry or factory, and it took him 2 hours to select a route that skirted the east edge of the facility. Once past the plant, he rested on a ridge top for 2 hours and then moved west toward Trampas Lake but turned back before reaching the lake. Although M10 was also at the lake, the 2 cats did not meet each other; M12 may have detected M10's scent. M12 returned to his previous resting place, spent another hour there, and then continued southward, crossing into the Christianitos Creek watershed, and walking another 2 km south along the ridge just west of Christianitos Road.

On this initial move south, M12 travelled over 40 km (25 mi), reaching

Margarita Peak on October 17. He then moved rapidly back north and established a transient home range immediately south of this mother's home range (Figure 19: HR1). He spent almost 3 months in this transient range, killing at least 5 domestic goats in at least 3 incidents. In December 1991, he took a second exploration to the south.

This excursion (Figure 19: medium-width line segments) began during December 6-13, when M12 moved to La Paz Canyon, quickly finding the only domestic goats in south Orange County. He killed several goats in a single night before moving west to Trampas Lake. At the start of overnight monitoring on December 23-24, M12 and M13 were both at Trampas Lake (the 2 animals apparently did not encounter each other). About 2 hours after sunset, M12 started moving rapidly west. At 2000 he entered the San Juan landfill in Cañada Prima Deshecha, and spent about 2½ hours exploring heavily-grazed grasslands near the dump. This was the only time we documented a cougar exploring Prima Deshecha and the landfill area. But an even more unusual exploration followed. M12 skirted north of the landfill and moved further west, exploring the big grassy ridge that separates the cities of San Juan Capistrano and Capistrano Beach. M12 walked over 6 km through this 2-km-wide peninsula of marginal habitat fringed by homes. This area is so open and treeless, and so fringed by urban uses, that we had never obtained gate keys to these parcels; our limited access made it impossible to determine his exact travel path. At 0400, he reached an oak grove alongside I-5 between the exits for Camino Las Ramblas and San Juan Creek Road, and he daybedded there on December 24 (Figure 19: W). Tens of thousands of motorists passed within 200m of the cougar on the clogged freeway that Christmas Eve. There were no reported cougar

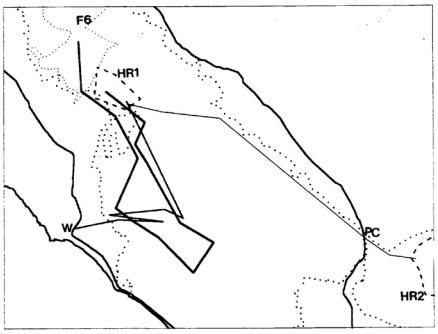

Figure 19: Dispersal Movements of M12. Dashed polygons indicate his transient home ranges; heavy dotted line indicates limits of cougar habitat. The sequence of M12's travels are indicated by progressively thinner lines. His first transient home range (**HR1**) abutted that of his mother (**F6**). On the foray to the west (**W**) (Dec 23-24 1991), M12 moved from Trampas Canyon through open terrain to within 100m of I-5 in San Juan Capistrano; he returned to **HR1** within 48 hours. M12 took less than 8 days to travel from HR1 to **HR2** in the Palomar Range, using the Pechanga Corridor (**PC**) to cross I-15 (see Figure 7 for detail).

sightings. Within 48 hours M12 returned 29 km (18 mi) back to his transient home range. Although this foray did not lead anywhere, it attests to the remarkable ability of dispersing cougars to explore habitat peninsulas and corridors without detection by humans.

On January 13 1992, M12 left his transient home range for the last time (Figure 19: thin line segments). Eight days and 59 km (37 mi) later, he became the first cougar in our study to move into or out of the Santa Ana Mountain Range, crossing I-15 via the Pechanga Corridor into the Palomar Range. We first located him east of I-15 on January 22; he was then in upper Pechanga Creek on the Pechanga Indian Reservation. On the morning of January 23 his tracks leading up to I-15 were fresh enough to be tracked visually and scent-trailed by hounds. M12's eastbound tracks left the Santa Margarita River about 400 m before the I-15 bridge. Although he could not have directly viewed the lights of Temecula from the river channel at that point, he could see the glow of city lights in the sky, and perhaps he gained elevation to better see what lay ahead. He climbed until he reached a dirt road about 50 vertical m above and parallel to the river, and he continued to walk east. As he got closer to the freeway, he left the road and moved southeast and then south, until he was roughly parallel to the freeway. His path took him away from the city lights. Perhaps using darkness as a cue to judge where appropriate habitat might be, he moved away from the bridge that offered the only good crossing under the freeway. Cliffs to his right gradually pinched him closer to the freeway, and where the cliffs met the road, he turned and crossed I-15 at grade about 800 m south of the bridge. On the east side he walked down the embankment 50 m to a paved golf course service road. At this point we lost his scent, suggesting that he traveled south along this road for at least 300m. There were no tracks in the dusty road and sandy stream bed to the north of the crossing point, in Pechanga Creek at several points along the golf course, nor in Pechanga Creek 400 m upstream from the uppermost housing tract. Thus he must have traveled southeast across a series of low wooded ridges for 2-4 km before dropping further east into upper Pechanga Creek where he spent the next few days.

M12 then established a large transient home range north and east of Mount Palomar from January 20 until he died there in late March 1992, apparently of natural causes (Chapter 4).

Dispersal of M11

M11 began to disperse in early January 1992. His pattern of separation was similar to M12's: He and his mother had spent several days together within F6's home range. Then F6 moved about 16 km away toward the northern part of her range (Gypsum Canyon) and left M11 in Round Canyon on Loma Ridge. M11 stayed there, moving little, for about 7 days, and then suddenly began moving south (Figure 20: thick line segments). Within 5 days he had moved 40 km (25 mi). Like many dispersers, he spent several days along Trampas Ridge near San Juan Capistrano.

From the Trampas Lake area, M11 continued south into Camp Pendleton, where he was struck by a vehicle on Basilone Road on the evening of February 4 1992. His injuries apparently were minimal, as he spent only about 48 hours within 1 km of the accident site, and then resumed his exploration of Camp Pendleton (Figure 20: dashed polygon). His period of post-accident recovery was far shorter than that of other accident victims (Chapter 4).

In late February, apparently fully recovered, M11 continued southeast and became the first radio-tagged cougar to move across the open grassland at the south edge of Camp Pendleton to reach the San Luis Rey River (Figure 20: thin line segments). This remarkable movement again illustrates the ability of cougars to move across marginal habitat in their dispersal explorations. However, the San Luis Rey River is too impacted by urbanization to function as a corridor. M11 moved down the River, crossing under I-5 into the City of Oceanside. At 0230 on February 29, M11 was sighted near the River in central Oceanside, about 3 blocks from the Pacific Ocean. At 0600, after about 3½ hours of pursuit through 8-12 residential blocks south of the river, M11 was shot at least 9 times by police officers near the intersection of 6th and Pacific Streets. Although we do not have data showing exactly how M11 reached the San Luis Rey River from Camp Pendleton, the most probable

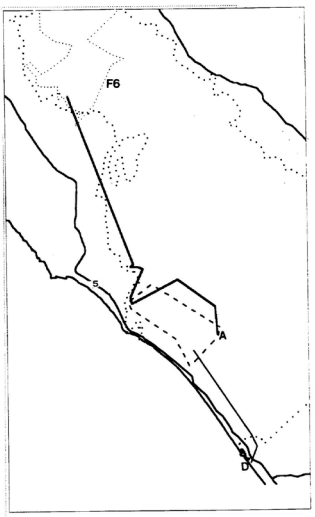

Figure 20: Dispersal Movements of M11. Dotted polygon indicates home range of his mother (**F6**). The thick line segments indicate his movements from Jan 16 1992 until his automobile accident (**A**) on Feb 4. The dashed polygon indicates his post-accident home range (3 weeks). The thin line segments indicate his travels into the San Luis Rey River. He died in Oceanside (**D**) on Feb 26 1992. Heavy dotted line indicates limits of cougar habitat.

routes were Tuley Canyon or Pilgrim Creek.

Dispersal of F17

During August 22-25 1991, F17's mother (F18) moved 16 km northeast of her home range, abandoning F17 in San Mateo Canyon in the center of their home range. After waiting there alone for 2 weeks, F17 started dispersing northwest about September 3. F18 returned during September 3-10.

For the next 123 days, F17 ranged widely over the northern 2 thirds of the mountain range, staying north and west of her mother's home range (Figure 21). During that time she never occupied a transient home range. She traveled a minimum distance of 342 km (214 miles), ricocheting off the east, west, and northern edges of suitable habitat several times (Figure 21).

During September 25-27, F17 spent 3 days in the area where Main Street Canyon leaves the steep mountainous terrain and opens into the alluvial plain, now bearing avocado orchards, on the outskirts of Corona. Curiously, M7 (on a foray from his first transient home range) also spent 2-3 days in the same location on September 17-18 (10 days earlier). During overnight monitoring there September 26, F17 walked near 2 rural houses to enter an abandoned avocado orchard where she killed and ate 2 opossums.

On the night of October 21, F17 moved into a finger of natural vegetation at the extreme northwest corner of the remaining

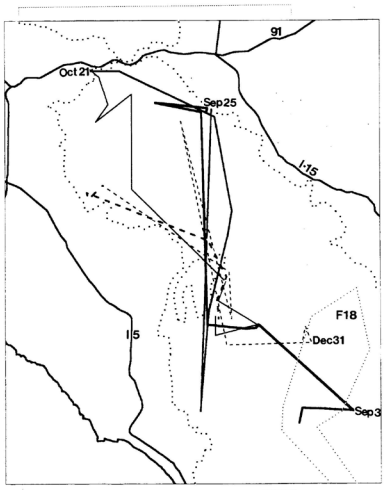

Figure 21: Dispersal Movements of F17. Dotted polygon indicates home range of her mother (**F18**). Heavy dotted line indicates limits of cougar habitat. The sequence of F17's travels are indicated by progressively thinner solid lines, then by progressively thinner dashed lines.

habitat, surrounded by the encroaching urban growth of the Anaheim Hills. She daybedded in the small canyon that contained a small horse stables and The Garden Church, sandwiched south of these facilities and north of a huge area where graders were ripping the terrain for new housing tracts. The Riverside Freeway was 400 m north at the mouth of the canyon. On the ridge to her west carpenters were framing houses on Star View Street. F17 had been exploring the urban edge that night, and had to wait until dark to extricate herself. Dozens of people and machines surrounded her all day long. This is yet another example of the remarkable ability of cougars to explore marginal habitat, habitat peninsulas, and habitat corridors without being detected by humans.

On about December 31 1991, F17 returned to her mother's home range for the first time since her dispersal began. On that date F17 and F18 were located together at the north edge of F18's home range. By January 6 1992, F18 had moved south into the interior of her home range, but F17 was still near her December 31 location. She died there during January 6-9 1992, apparently of natural causes (Chapter 4).

Dispersal of M5

M5 was captured and radio-tagged on August 3 1990 after he was treed by domestic dogs in a Temecula back yard. The capture site was near the tip of the "Temecula cul-de-sac" of the Pechanga Corridor (Figure 7: M5; Figure 22: C). M5 was a dispersing yearling and his presence there was our first evidence that dispersers were attempting to use that corridor. His tracks confirmed that he had moved up Temecula Creek from its confluence with Pechanga Creek, but we could not determine if he had reached that confluence from the west (Santa Ana Mountain Range) or the east (Palomar Range).

M5 was released 22 km (14 miles) west

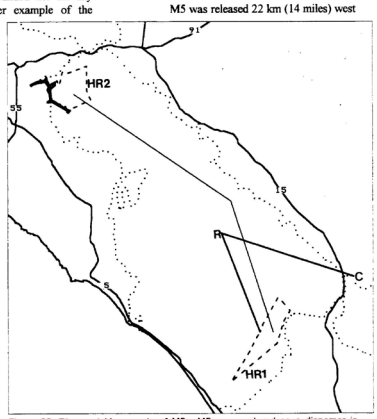

Figure 22: Dispersal Movements of M5. M5 was captured as a disperser in Temecula at **C** and released at **R**, from which he promptly moved to **HR1**. After 6 weeks there, he moved to **HR2** in less than 15 days. After M5 was crippled in an auto accident, he used a very small area (thick solid-edged polygon at west border of HR2) until his death 5 months later. The heavy dotted line indicates limits of cougar habitat.

of his capture site (Figure 22: **R**). By August 12, he had moved to the Santa Margarita River, another 22 km south of the release site. He used a transient home range there for the next 6 weeks (Figure 22: HR1). Like other transient ranges, this was elongate along the habitat edge. After exploring the southern habitat edge, and finding no route further south, M5 rapidly moved north, covering at least 32 km (20 mi) in a 5-day interval, and at least 40 km (25 mi) in the next 10-day interval. By October 7, he had reached Peters Canyon Reservoir, and thus in less than 15 days had moved from the extreme southeast to the extreme northwest edges of habitat in the Santa Ana Mountain Range.

M5 established a medium-sized home range (Figure 22: HR2) in this area, with a favorite daybed in the large willow forest in the Villa Park Dam impoundment area in Irvine Park. This area was adjacent to housing tracts or the developed areas of Irvine Park along nearly half of its periphery. On November 15, we treed M5 and he appeared to have gained about 15 pounds since initial capture. During diel monitoring on December 10-11, M5 began and ended his night movements in the willow forest, but spent most of the night hunting in nearby Weir Canyon, never approaching the housing tracts or the developed parts of the park.

After 6½ months in this home range, M5 was severely injured in an a vehicle accident and died 5 months later (Chapter 4). During his last 5 months he used an extremely small home range pressed up against the urban edge (Figure 22: thick dashed polygon along west edge of HR2). Despite being crippled and within a stone's throw of tract homes for most of those 5 months, M5 was never a threat to human property or safety (Chapter 9).

Dispersal of M6

M6 (like M5) was captured as a disperser and thus we do not know his natal home range. He was captured in lower San Mateo Creek on August 27 1990, weighing 80 pounds and in excellent condition. After release he moved steadily southeast along the coastal hills and coastal plain of Camp Pendleton for 10 days, moving a net distance of 4-6 km per day until he reached the lower Santa Margarita River September 8 or 9 (Figure 23: thick line segments). He used a small home range centered on the river delta for about 2 weeks (Figure 23: HR1), and then moved back northwest along the coastal plain. When he reached the north edge of Camp Pendleton on October 7, M6 began a rapid move north (Figure 23: thin line segments).

Between October 10 and October 15 1990, M6 moved 27 km (17 mi) north to the highlands of O'Neill Regional Park near Oso Lake. He had left this vicinity by October 17 and we were unable to locate him again despite intense ground searches and weekly air searches of all areas wouth of SR-91. M6 suddenly reappeared near the mouth of Gypsum Canyon on May 6 1991. On the night of May 26-27, he moved north across the Riverside Freeway using the Coal Canyon culvert to cross under SR-91. Over the last 1½ years of the study, M6 moved between the Chino Hills and the Santa Ana Mountain Range at least 22 times (Figure 8). Because we searched the lands south of SR-91 so thoroughly during October 1990-May 1992, we conclude that M6 spent that 6½ months in the Chino Hills.

Over the last 1½ years of the study, M6 spent increasingly longer periods of time south of the Riverside Freeway, with increasingly shorter stays in the Chino Hills. On each of 18 crossings, we found M6's tracks in the Coal Canyon culverts. On the other 4 crossings, there were no tracks in any culvert, and we conclude that he used the vehicle

underpass at Coal Canyon. The frequency with which M6 crossed the freeway is precisely the intensity with which that corridor must be used by an adult male to insure that female cougars in the Chino Hills are bred. These data provide yet another striking example of the ability of dispersing cougars to find and use corridors.

The size of M6's home range (Figure 23: HR2) approached that of M2 and M9, both fully territorial adult males. His pattern of movement and his occasional associations with adult females suggest that he was an adult male at the end of the study. However, if he lives, we expect that his home range will continue to increase in size.

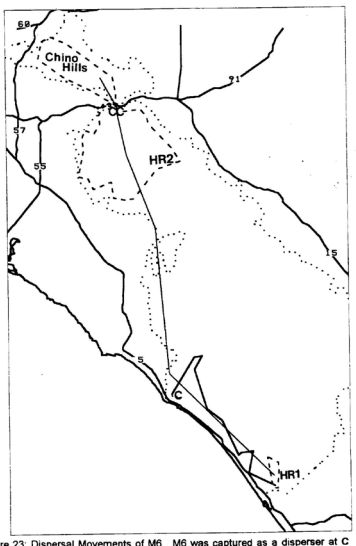

Figure 23: Dispersal Movements of M6. M6 was captured as a disperser at **C** and then he travelled (thick line segments) to **HR1**. After 2 weeks there, he moved rapidly (thin line segments) to the **Chino Hills** where he spent 5½ months before expanding this area into an hourglass-shaped home range (**HR2**). The 2 lobes of HR2 are connected by the Coal Canyon Corridor (**CC**). The heavy dotted line indicates limits of cougar habitat.

CHAPTER 7. PREY RELATIONSHIPS

Prey use based on prey remains

In the course of our routine monitoring activities, we examined 145 cougar-killed prey carcasses. About 59% of these carcasses were deer, and the main secondary prey were coyotes and opossums (Figure 24). Deer were also the largest prey item regularly taken (calves were larger but rarely taken). In terms of mass, the prey carcass data suggest that deer were 78% of the prey biomass eaten, followed by calves (8%), coyotes (3%), and all other species at less than 3% each (using approximate live weights listed in Encyclopedia of Mammals, Fact on File Inc., New York, 1984).

All 3 common species of livestock were taken by cougars. The 4 calves taken were all young animals, and all were killed by male cougars. The chart excludes about 12 killed goats that we learned about when livestock owners reported the losses to state or county authorities. Including these goats would have greatly inflated the apparent importance of goats to cougars because these livestock losses were much more detectable than other carcasses. Only 1 goat and no sheep were present in 176 cougar scats (see below)

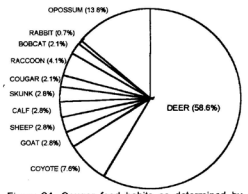

Figure 24. Cougar food habits as determined by examination of 145 prey carcasses. Each prey item = 0.7% of the sample.

suggesting that there is a strong detectability bias even for those livestock carcasses we found without reports. Nonetheless, the impact on the livestock owner is greater than our data indicate, because in many depredations, several goats and sheep would die in addition to the 1 or 2 animals eaten. Most of these surplus victims were killed by the cougar; a few others died with no apparent injury, perhaps due to shock.

The 3 cougar carcasses (F6, M4, and a cub of F3) were consumed almost completely, and 2 of them (F6 and the cub) showed clear evidence that they were killed by a cougar. M4 may have died of other causes, but his fresh carcass was eaten by his mother and brother. In addition, a 4th cougar (F1) died of cougar-inflicted injuries but is not included here because she was not fed upon. These data greatly overestimate the importance of cannibalism because the radio-collars made cougar carcasses 100% detectable. The 160 scats we collected (see below) contained small amounts of cougar fur, apparently from grooming, but no scats contained enough cougar fur to suggest cannibalism.

Almost ¼ the 85 deer carcasses were fawns (table below). Because many fawns, especially those only a few days or weeks old, were consumed completely and left no carcass for us to find, cougars prey much more heavily on fawns than these data suggest. Of the 63 deer carcasses for which we could determine sex, 36 (or 57%) were males. In contrast, adult males comprised only about 20% of live deer in our spotlight surveys (see below: "Deer density estimates and deer herd composition"). Clearly male deer were more susceptible than female deer to predation by cougars. Although capturing the relatively larger male deer yields more food energy per kill, we do not believe that cougars actively select males for that reason. It is more likely that the behavior of male deer (e.g., wide-ranging movements, or lowered vigilance while scouting female deer and sparring with other males) makes males more vulnerable to predation.

For 12 deer killed by cougars in the dry season (Jun-Dec), the average fat content of the femur marrow was 41%, with a standard error of 7%. For 3 deer killed by cougars in the wet season (Jan-May), the average fat content was 49%, with a standard error of 8%. These fat contents indicate fair to poor condition. However, this does not necessarily indicate that cougars are taking weaker deer, because these fat levels may be typical for deer in this mountain range.

Table 9: Age and sex composition of 85 cougar-killed deer in the Santa Ana Mountain Range, 1988-1992.

Sex of deer	Age of Deer (years) 0	1	2	3-10	Adult (age unknown)	Total
Females	2	1	2	12	10	27
Males	4	7	4	17	4	36
Sex unknown	14	0	1	1	6	22
Total	20	8	7	30	20	85

Of the 145 cougar-killed prey carcasses, we examined 130 carcass within a few hours or days of the kill. We found that cougars generally followed a very predictable pattern of prey consumption:

1. Cougars usually spent 3-4 days consuming a deer, and usually ate the entire carcass, often including the brain and some bone marrow. Generally the heart, lungs, and liver were eaten immediately after the kill, and major muscles were eaten over the next few days.

2. Deer were usually dragged a short distance from the kill site to the site where they were consumed; these sites were generally cool canyon bottoms with good hiding cover.

3. Prey consumption was almost entirely at night. Deer carcasses were usually covered with leaves and twigs at dawn and left covered all day. The deer's rumen (major stomach) was almost always buried in a separate leaf mound several feet away from the rest of the carcass; the rumen was never consumed.

4. The cougar usually bedded down for the day near the carcass, but sometimes up to 1.5 km away.

5. Smaller prey, like opossums, raccoons, and skunks, were usually consumed in 3-5 hours; sometimes these carcasses would also be covered.

In contrast to this general pattern, we occasionally observed unusual behavior with respect to prey carcasses. We present several of these anecdotes below:

1. Six of the 145 prey carcasses were abandoned or only slightly fed upon: (A) F2 killed a pregnant 8-year-old doe at 1AM on March 2 1989 and stayed on the kill until the night of March 7, thus spending 5 nights consuming the carcass. During this time she consumed nearly 100% of the carcass, but left the fully-developed deer fetus virtually untouched and left an opossum carcass, with the head and tail and feet neatly bitten off, but otherwise intact. (B) F7 killed a mule deer fawn on July 9 1989, ate less than half the carcass on the night of the kill, and abandoned it in the morning with no attempt to cover it from the sun's heat or scavengers. She did not return to the kill. (C) During overnight monitoring on April 15-16 1992, M9 killed a doe and 2 fawns at about 10:30 PM. He stayed on the kill until about 06:45AM, when he moved 500 m into a nearby canyon. He had consumed 1 fawn and less than 1/4 of the doe, covering the doe and 1 uneaten fawn as if he intended to return. M9 did not return to these kills. (D) During overnight monitoring on May 26 1992, M13 fed on a large buck all night

long, but left most of the carcass unconsumed. In this case, the carcass had been dragged from an open hillside into a narrow canyon where the carcass became wedged before it could be dragged further downstream to a shady location. Quite likely the carcass was so tightly wedged that M13 could not turn it over for feeding. (E) On January 17-19 1991, M8 killed 2 deer and consumed only 1 of them; this occurred early in his dispersal. (F) On June 15 1989, F1 killed a raccoon and an opossum at the same site. She ate the raccoon, but the intact possum was left buried under grass and covered with ants.

2. Almost all prey carcasses had been freshly killed by the cougar. We documented only 1 clear case of scavenging. On the nights of January 21 and 22 1990, F4 fed upon the badly decomposed carcass of a male fawn that had died 1-2 weeks earlier. F4 buried the carcass carefully with grass and leaves for daytime storage and buried the excised rumen separately. F4 avoided eating the most rotten meat (ribs and backstrap), and fed only on the (moderately rotten and maggoty) major limb muscles. This carcass was also in an unusual location, only 50 m from a golf course fairway in San Clemente.

3. The longest distance we documented a deer carcass being dragged was 250 m. In that case (F5, 18 Nov 1989), this distance was necessary to get the deer into a canyon with suitable cover. F5 disemboweled the deer after dragging it about 70m, discarding the rumen at that point. The consumption site was in dense chaparral about 4 feet tall, and in the bottom of a minor drainage. Given the low shrubs and grassy openings in the kill area, she had dragged the deer to the nearest good (or at least marginal) consumption site. In this case F5 daybedded next to the carcass.

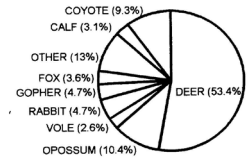

Figure 25. Cougar food habits as determined by frequency of occurrence of fur, claws, and bones in 178 scats (fecal droppings). There were 2 prey in each of 15 scats, for a total of 193 prey items. "Other" prey were raccoons, unidentified canids, domestic cats, unidentified rodents, beavers, badgers, skunks, goats, and moles (each < 2%).

Prey use based on cougar scats

We collected a total of 204 scats (fecal deposits), 28 of which yielded no identifiable cougar prey. Dr. Joel Weintraub of California State University at Fullerton identified 193 prey items in the other 178 scats. Deer were the most common prey item in these scats, comprising just over half the total; the scats contained fur, bones, or claws from 17 other taxa (Figure 25). However, most of these other species weigh a great deal less than deer, and are less important than suggested by the number of animals eaten. In terms of biomass, deer made up 81% of the weight of these 193 prey items. The only other species contributing at least 1% of biomass were domestic cattle (11%), coyotes (3.8%), and opossums (1.0%); the remaining 12 species combined contributed only 3.2% of the total biomass (using approximate live weights listed in MacDonald 1984). All scats containing cow-calf hair were from the early calving season and had reddish short hairs suggesting that young calves were taken.

The data based on prey carcasses are obviously biased toward larger prey items, because smaller prey will often leave no carcass, or only a few tufts of fur that we overlooked in searching for prey remains. Thus scats are a less biased sample of cougar food habits. Nonetheless both sources of data give the same ranking both in terms of prey numbers (deer, opossums, coyotes, and calves) and in terms of biomass (deer, calves, coyotes, opossum). As expected, several smaller prey were found in scats but not as carcasses, namely, voles, gophers, gray foxes, badgers, beaver, moles, domestic cats, and 1 woodrat. Several larger species that were present in the carcass tally were not found in scats, namely bobcats, sheep, goats, and cougars.

Two scats contained remains of domestic cats and 3 others contained remains of unidentifiable canids, which could have been domestic dogs. The geographic locations of these scats suggest that these animals were not backyard pets but were either feral or had been abandoned in the country.

Deer density estimates and herd composition

Deer were clearly the most important prey species for cougars in this study. To better understand cougar-deer relationships, we attempted to estimate deer density and the age-sex composition of the deer population using spotlight transects, data from CDFG helicopter surveys, and data from the deer capture effort carried out by CDFG for the Tollway studies.

Our spotlight surveys for deer covered over 125 km of roads in south Orange County (Rancho Mission Viejo, Starr Ranch, Caspers Park, and adjacent areas) and in north Orange County (Weir, Blind, upper Gypsum, and parts of Fremont and Blackstar Canyons, and Loma Ridge). We repeated these transects on 6 occasions: November 1988, March 1989, June 1989, September 1989, January 1990, and September 1992, covering only the south Orange County areas on the first 2 efforts. Analyses of these data using program TRANSECT (Laake et al. 1979, Burnham et al. 1980) indicated that there were about 1.1 to 2.2 deer per square kilometer (2.8-5.5 deer/mi^2). We believe that these estimates are invalid due to gross violations of the assumptions of the line-transect procedure. Line-transect analysis assumes that detectability of the deer depends mainly on distance from the transect line and that 100% of deer on or near the line are detected. But detectability of deer on our transects depended mainly on topography and vegetation, both of which changed greatly along each transect and were far more important than distance from the transect line. We could have failed to detect deer 5 m from the transect line. As a result, our data yielded a declining function of deer numbers versus distance only after several attempts at reclassifying distance classes, and the resulting detection function was sensitive to these arbitrary classes. In turn, program TRANSECT's estimates are highly sensitive to the shape of the detection function. The line transect estimates are certainly invalid, and we believe they lay far below the true number of deer in these areas.

We suggest that somewhat better estimates are provided by 2 other sets of data: (1) In late October 1990, CDFG observers ran helicopter surveys to determine the age-sex composition of the deer herd in several areas in the Santa Ana Mountains. (2) In January 1990, Blind Canyon (Irvine Ranch) was intensely surveyed from a helicopter just after 14 deer were captured and radio-collared there. Although the surveys were not designed to estimate deer numbers, the observer felt that virtually all deer in Blind Canyon, and at least 70% of the deer in the other areas, were counted. We estimated minimum density by dividing the deer counts by the area surveyed as calculated from maps provided by Esther Burkett (CDFG biologist-observer on all the flights). The Blind Canyon survey was conducted over a period of several hours by a very skilled and aggressive pilot, with more wildlife experience than the pilot on the other surveys. Thus it is quite likely that nearly 100% of the deer in Blind Canyon were seen. The other surveys were conducted in less time

per unit area by a less experienced pilot, and it is certain that some deer were not seen.

Our analyses of these data suggest that true deer density was about 5 deer per km^2 (13 deer per mi^2) in the better habitat and about 1.9-2.3 deer per km^2 (5-6 deer per mi^2) in the poorer habitat (Table 10). We feel this is a much more realistic estimate, and one which is more consistent with our estimates of deer mortality rates due to cougars (next section).

The high density estimate for Blind Canyon was not solely a result of survey methods, but probably also reflects the fact that Blind Canyon contained some of the best deer habitat in the Santa Ana Mountain Range (oak trees, coastal sage, chaparral, grasslands, and water well-distributed throughout). Starr Ranch, Caspers Park, the southern parts of Rancho Mission Viejo, Loma Ridge, and Gypsum and Coal Canyons were probably similar to Blind Canyon in habitat quality and deer density, i.e., about 13 deer per square mile. If adults were about 76% of the population (see end of this section), the adult population density was about 9.9 adults/mi^2 on better habitat.

The chaparral-dominated areas at higher elevation in the mountain range probably supported lower deer densities. Although the estimates are very sensitive to assumptions about the number of deer not counted, these areas probably supported about 5.5 deer per square mile, assuming that half the deer were counted. If adults were about 76% of the population (see end of this section), the adult population density was about 4.2 adults/mi^2 on poorer habitat. It is important to note that most of the protected habitat in Orange and Riverside Counties (i.e., the Trabuco Ranger District) lies in these areas of low deer density. Relatively little of the area with the highest deer density (and consequently little of the best cougar habitat) is protected from urban growth.

These deer density estimates are very crude. We would recommend that future efforts should not use spotlight transects, and that any future helicopter counts should use a skilled and aggressive pilot concentrating on a few target areas that can be clearly delineated both from the air and on maps. The results of the Blind Canyon survey suggest that near-total counts are possible.

Although they provided low density estimates, the spotlight surveys probably accurately estimated the relative proportions of deer in the fawn, adult male, and adult female classes. Although these numbers varied seasonally and among years, the adult population was about 20% males and 80% females (Table below), and about 76% (187/247) of the population were adults. As mentioned above ("Prey use based on prey remains"), 57% of deer carcasses were males, indicating that males were much more vulnerable to cougar predation.

Table 10: Deer density estimates based on intensive helicopter surveys in Blind Canyon (January 1990) and less-intensive helicopter surveys in other areas (October 1990).

Location	Area (mi2)	# deer seen	Deer/mi2 Minimum[a]	Deer/mi2 Estimate[b]
Blind Canyon (Irvine Ranch)	2.33	30	6.0	12.9
upper Blackstar Canyon[c]		0	0	0
Tin Mine Canyon	1.86	6	3.2	6.4
Silverado Burn[d] (Brown, Anderson, and Coldwater Cyns)	12.1	17	1.4	2.8
Cañada Chiquita	5.94	12	2.0	4.0
Wagon Wheel Canyon & west Cañada Gobernadora	3.49	9	2.6	5.2
Average (excluding Blind Canyon and upper Blackstar)			2.25	5.5

[a] based on actual number of deer counted, except for Blind Canyon, which is based on 14 deer captured and collared.
[b] based on the assumption that 50% of the deer present were observed, except for Blind Canyon, which is based on the total number observed in an intense survey.
[c] E. Burkett suspects that overgrazing and poaching in upper Blackstar contribute to this zero count.
[d] The Silverado burn occurred in 1987. The Ortega and San Mateo Burns of 1989-1990 were briefly surveyed and appeared to have very few deer.

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Table 11: Deer herd composition in Orange County as determined by spotlight counts. The March 1989 counts are excluded because age and sex of deer were difficult to discern in that season. The total and mean values for fawn:doe ratio excludes the June 1989 counts because most fawns hide during June.

Date	Males	Females	Fawns	Male:Female	Fawns : 100 Females
November 1988	3	18	6	14%:86%	33
June 1989	10	(38)	(8)	21%:79%	(21)
September 1989	10	43	17	19%:81%	40
January 1990	5	23	9	18%:82%	39
September 1992	17	58	28	23%:77%	48
Total	45	180(142)	68 (60)	20%:80%	42
Unweighted mean				19%:81%	40

Estimation of deer harvest rate and cougar kill rate on deer

Thirty (30) deer were radiotagged and monitored in the northwestern part of the Santa Ana Mountain Range during March 1990-December 1991 (Anonymous 1992) and an additional 11 deer were radiotagged and monitored in south Orange County from Fall 1990 through December 1991 (D. Padley, project leader, pers. comm.). From January through December 1992, we continued to monitor these radio-tagged deer, and we investigated deer mortalities to determine cause of death.

To compute the probability of a deer being killed by a cougar during a year, we analyzed these data using 1-month time intervals and the product limit procedure with staggered entry (Pollock et al. 1989). The product of 12 monthly rates yielded an estimate of annual rate of not being killed by a cougar, and the average of these running products yielded a single point estimate. Subtracting this rate from 1.00 yielded a harvest rate. We analyzed the data to provide separate estimates for adult males (through March 1992, at which time only 3 male radiotags were functioning) and adult females (through December 1992, at which time 19 female radiotags were functioning). Following these procedures, cougars annually killed about 10% of adult male deer and 6% of adult female deer. These harvest rates are considerably lower than we had expected. However, harvest rate of fawns is undoubtedly much higher than on adults, and the harvest rate for all age classes is therefore higher than 6-10%.

Twelve (12) radio-tagged deer died during March 1990-December 1992, and 6 of these mortalities were due to cougar predation. Thus cougar predation accounted for about half of adult deer deaths over this period.

In Chapter 6, we noted that cougars killed deer on about 10% of the intensive monitoring sessions. This yields a rate of about 1 deer killed per 10 days, or 36 deer killed per cougar per year.

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Inconsistency among our estimates

Finally, it is instructive to evaluate the consistency among our various results. In particular, we have estimated:

- **C** = population density of Cougars = 2.5 adults/100 mi^2
- **K** = the Kill rate, or frequency at which cougars kill adult deer = about 1 deer per 10 days = 36 deer/year
- **D** = population density of adult Deer = 990 adult deer/100mi^2 on better habitat and 420/100mi^2 on poorer habitat, probably about 600/100mi^2 on average.
- **H** = % of adult deer Harvested by cougars per year = 7%, sexes combined

Obviously the number of adult deer killed by cougars per 100 square miles per year should be given by either the quantity $\mathbf{C \cdot K}$ or by the quantity $\mathbf{D \cdot H}$. Thus we can state:

$$\mathbf{C \cdot K = D \cdot H}$$

However, when our estimates are inserted into this identity, we obtain:

$$(2.5)(36) = (600)(0.07)$$
$$90 = 42.$$

Clearly one or more of our estimates is in error. This inequality can be turned into an identity by 1 of the following (or by some combination of changes in the indicated directions):

halving our estimate of cougar density, **C**
halving our estimate of kill rate, **K**
doubling our estimate of deer density, **D**
doubling the harvest rate, **H**

Of these 4 factors, we feel that **D** is based on the weakest data, and that **H** was much lower than we had expected. It would be impossible to halve **C** without going below the numbers radio-tagged in 1991, and our **K** is based on extensive data that agrees closely with other published reports. We believe it is most likely that our estimates of **D** and **H** are too low.

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CHAPTER 8. IMPACT OF URBAN GROWTH

Habitat loss and fragmentation

The cougar population is the Santa Ana Mountain Range is clearly in jeopardy of becoming extinct due to habitat loss and fragmentation (Chapters 2, 3, & 4; Beier 1993). Vehicle mortalities associated with increased highway traffic due to urban growth also impact the population (Chapter 4). However, even if vehicle-caused deaths were eliminated, the population will not survive continued massive loss of habitat. If the critical Pechanga corridor is enhanced and most of the other important corridors are preserved (Chapter 3), then considerable areas of cougar habitat can be converted into urban uses without significantly increasing the extinction risk (Chapter 4; Beier 1993). However, if the Pechanga corridor is not protected, every new parcel of habitat lost will add to the risk of extinction (Chapter 4).

There is no evidence that habitat loss and fragmentation cause cougars to become aggressive toward humans, or habituated to humans (Chapters 6 and 9).

Six freeways threaten to fragment habitat

Six major freeway projects have great potential to fragment cougar habitat and induce urban growth that eliminate habitat. Fragmentation could occur due to the physical obstacle provided by the freeway itself, due to the urban growth induced by the freeway, or a combination of these 2 factors. The 3 most important and immediate threats are:

1. The southern half of the Foothill Transportation Corridor (FTC-s) slices deeply through an area with no human residents and only 1 approved urban project. It could potentially isolate several small protected parcels (Arroyo Trabuco, Wagon Wheel Park, the Cañada Gobernadora wetland mitigation area, and the Rancho Mission Viejo Conservancy) from the main block of habitat to the east of the Tollway alignment. The Transportation Corridor Agency (TCA) solicited our comments on these potential impacts. In response to our comments, TCA has planned bridged undercrossings at sites along 5 routes that radio-tagged cougars used to access these smaller parcels. Due to an apparent misunderstanding, our proposed bridge crossing on upper Christianitos Creek northeast of the Rancho Mission Viejo Conservancy was omitted from TCA's modified map in late 1991, but we were assured at that time that this bridge would be added. If no urban growth occurs along FTC-s, these undercrossings would effectively mitigate the impact of the FTC-s on cougar movements. However the Tollway will induce massive urban growth that will block these undercrossings unless further mitigations are implemented. In its EIR for this project, TCA's worst case scenario for predicting impacts presumed that the project area (except 1 parcel) would not be built to greater densities than permitted by the Open Space designation in the general plan.

2. The Eastern Transportation Corridor (ETC) would potentially isolate Irvine Regional Park and the proposed Weir Canyon Regional Park from the main habitat block. We provided comments regarding impacts to wildlife movements on 2 occasions. Our second set of comments reflected our knowledge that the only promised crossing area led into a planned community of 13,000 homes (instead of toward the central habitat block), and newer data indicating that the main cougar crossing area was in upper Blind Canyon. As of spring 1992, the TCA had not modified their plans to reflect these conditions.

3. State Route 91 widening project: CalTrans and a private corporation are co-

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operating to add additional lanes to SR-91 (Riverside Freeway) from the Riverside County Line to SR-55. At least 9,500 homes cannot be built or sold without this widening project (City of Anaheim conditions of approval); these homes include the Cypress Canyon project that would occlude the critical Coal Canyon Corridor (Chapter 3). Despite being informed of these impacts at a meeting on February 6 1992, later that same month CalTrans prepared a statement that the project did not require an EIR on the grounds that the widening project would not be growth inducing, and that, moreover, the urban growth in the project area would occur with or without the project.

In addition, 3 other highway projects have potential impacts that are either less severe or less immediate. Carbon Canyon Road (SR-142) has been proposed for widening, and a superstreet has also been proposed to run through Soquel Canyon just south of SR-142. Such roads would probably break the Chino Hills habitat into 2 halves. However, this impact is overshadowed by the potential loss of the Coal Canyon Corridor, which would eliminate cougars from the entire Chino Hills. A freeway proposed by Riverside County and generally referred to as the "Cajalco Road Extension" would cut east-west across the Trabuco Ranger District at Santiago Canyon, just north of Saddleback Mountain. This road is so early in the proposal stage that it is difficult to determine if there is any chance that it would be built. It would have a severe impact on cougars. Finally, there have been several proposals (one version was called the Santa Rosa Expressway) for freeways to run from either Fallbrook or Temecula, around the north side of Camp Pendleton (traversing the San Mateo Canyon Wilderness Area), and into south Orange County. The impact of this road on cougars, other wildlife, federally-designated wilderness, and Camp Pendleton would be so severe that it is difficult to justify.

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CHAPTER 9. COUGAR-HUMAN ENCOUNTERS

A history of cougar-human encounters

We have previously summarized the record of cougar attacks on humans in the U.S. and Canada during 1890-1990 (Beier 1991, included as Appendix 2 in this report) and updated these observations for 1991 and early 1992 (Beier 1992, inlcuded as Appendix 3 in this report). These 2 papers should be consulted for details beyond this brief summary. During 1890-1990 (101 years) there were 9 attacks resulting in 10 human deaths and at least 44 nonfatal attacks. Attacks on humans have increased markedly during the last 2 decades, probably because cougar numbers and human use of cougar habitats also increased during this time. Most victims (64%) were children; the modal age class was 5-9 years. Of 37 child victims, 35% were alone, 37% in groups of children, and 22% were accompanied by adults; 11 of 17 adult victims were alone at the time of the attack. We believe these data show that attacks are more likely for children, especially unaccompanied children, and more likely for solitary adults than adults in groups. However, the data also clearly show that children accompanied by adults, and even adults in groups, are at some risk of being attacked.

The data also suggest that aggressive human responses appear to be effective in averting an imminent attack and do not support the notion that one should avoid loud shouting or avoid eye contact with the cougar when attack appears imminent. An aggressive response may also be effective in causing a cougar to retreat after an attack has been initiated. There is no empirical support for the efficacy of "playing dead" once an attack has begun. The data suggest that yearling and underweight cougars were more likely to attack humans, but some attackers were healthy adults.

Finally, although attacks were much rarer in previous decades when cougar prey (deer) were market hunted and cougars were aggressively persecuted, the risk was always greater than zero. There has been at least 1 attack in every decade since 1890. It is impossible to reduce this small risk to zero without eliminating either cougars or humans from cougar habitat.

The habituation hypothesis

One popular hypothesis to explain recent cougar attacks is that cougars have become habituated to humans because they are no longer bountied predators, and because in many areas (e.g., wilderness parks, all of California since 1971) cougars are no longer subject to sport hunting. The hypothesis is that as cougars learn to accept humans as a non-threatening part of their environment, they may be more likely to treat humans as prey. However, hunters and animal control agents annually kill about 6-10% of the cougars on Vancouver Island annually (Hebert 1989), a rate that is probably higher than harvest rates in any western state (see references in Smith 1989). Compared to other North American populations, Vancouver's cougar population may be the least habituated to humans and the most subject to aversive conditioning. Nonetheless Vancouver Island has by far the highest concentration of cougar attacks on humans (Beier 1991). This fact is inconsistent with the habituation hypothesis. There is no substantial evidence that habituation has played a role in any particular attack nor in the general recent increase in attacks.

Our study yielded no evidence to suggest that cougars in the Santa Ana Mountain Range are habituated to humans. Cougars entered urban areas with astonishing rarity and were generally unseen by the

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thousands of potential human observers in their midst.

The "repeat offender" hypothesis

The data provide weak support for the "repeat offender hypothesis," which speculates that once a cougar has attacked a human, it is more likely to attack again. Beier (1991, 1992) lists 10 cases in which no cougar was removed after an attack. In 3 of these cases there was a subsequent attack within 80 km and 2 years of the initial attack; in the other 7 cases the offending animal did not attack again. Thus when an attacking cougar was not removed, there was a 30% chance of a second attack within 80 km and 2 years. We believe that for a random set of dates and locations in the current range of cougars, there is a far less than a 30% rate of cougar attacks within the same time and distance. Due to small sample size and the lack of a rigorous test (i.e. actually selecting some random dates and locations), this must be considered weak support for the hypothesis.

Use of garbage and artificial food sources

During this study we had no evidence that cougars directly used artificial food sources. Although the cougar killed in Caspers Park after the attack on Laura Small was reported to have aluminum foil in its stomach, no suggestion of anything other than wild prey has been found in any of the scats we collected and examined.

A possible secondary influence of artificial food sources could occur at garbage dumps where raccoons and opossums and coyotes may feed in considerable numbers, thus offering an abundant and reliable prey base for cougars. We have no evidence for this occurring at the San Juan Capistrano or Irvine Lake landfill sites, both of which are accessible to cougars. It is unlikely that such attraction occurred without detection, because many radio-tagged animals lived near these landfills and we monitored these areas frequently both day and night. In both cases, the extremely open terrain around the landfills probably acted as a deterrent to cougars. It is possible that a landfill in or adjacent to wooded areas could attract cougars to feed on the raccoons and opossums.

We documented 4 occasions when cougars fed on raccoons and opossums near the urban edge; these raccoons and opossums probably did feed from nearby trash cans or other human refuse. Shortly before her death F2 spent about 1 week along the Arroyo Trabuco, just north of the I-5 bridge, feeding on opossums and raccoons within 70 m of a residential area. For the several months after breaking both legs in a vehicle accident, M5 relied mainly on opossums and raccoons in Peters Canyon Reservoir and lower Santiago Creek, almost always within 300 m of residential areas, and on the night of November 18 1990, M3 also killed and ate a raccoon just outside the kitchen house of the Lazy W Camp in Hot Springs Canyon. During her dispersal movements, F17 killed and ate 2 opossums in an abandoned avocado orchard (with much more ground cover than in a maintained orchard) in Main Street Canyon near Corona. In all of these cases, unlike the 2 landfills, the kills were consumed (and presumably made) in dense woody cover close to the artificial food sources.

We conclude that cougars are not directly attracted to artificial food sources, but in rare cases they may secondarily be attracted to areas where raccoons and opossums rely on garbage.

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Aversive conditioning was infeasible

Our original contract suggested testing the use of aversive conditioning to make cougars avoid humans. Such work was not practical on wild cougars, because we did not have the sort of control necessary to (a) apply the aversive conditioning, and (b) monitor its efficacy. We reached this conclusion in our first annual report (May 1989) and indicated at that time that we would not make progress on this objective.

In any event, the cougars in our study were remarkably adept at avoiding contact with humans (next section), and it is difficult to imagine that their behavior could have been more reclusive if we had been able to apply aversive conditioning. The experience of being chased by hounds, and then drugged and handled by humans, may have provided some aversive conditioning to our radio-tagged cougars. However, radio-tagged cougars always returned to the capture site, usually within a few days. Thus apparently they did not associate the negative experience with the location.

The aversive conditioning of being chased by hounds is apparently of limited effectiveness on Vancouver Island, where cougar attacks are relatively frequent despite heavy use of hounds to chase cougars (Beier 1991). Also, a yearling cougar attacked a person in Big Bend National Park 4 months after being chased and handled by humans for radio-tagging (Beier 1991). Aversive conditioning (shooting the cougar with rock salt at close range) was tried deliberately on another cougar after a near-attack in Big Bend NP. That animal returned to aggressive behavior 2 weeks later and had to be removed.

Public warnings

Some wildland parks now offer warnings to visitors about the risk of attacks. Such a policy may be appropriate as part of a park's educational program, or for other reasons. We offer 3 observations:

1. There are serious consequences to consider if parks are *required* to post such warnings. If cougars are dangerous enough to merit a warning, then warnings for many other hazards -- from rattlesnakes to cliffs to poison oak -- seem equally appropriate for thousands of square miles of wildlands, including national parks, national forests, and other public lands. This raises the specter of wilderness areas blighted with guardrails and warning signs or, worse yet, wildlands sanitized of all hazards.

2. It is not clear that a warning reduces the risk to wildland visitors. If a visitor is warned that "There are mountain lions in this wildland; they could bite or kill you," the only risk-reducing action he can take, based solely on this warning, is not to enter the area. After several attacks over a decade, Big Bend National Park (Texas) during 1990-91 attempted to warn every person entering their Visitor Center about the potential for cougar attacks. In the first year of this program, the park is unaware of a single visitor who has turned back because of this warning (P. Koepp, Big Bend NP Director, pers. comm., August 14 1991). In 1 case, a cougar walked through the main campground in Big Bend National Park in daylight, confronting a camper briefly before retreating. After the incident, park rangers warned everyone in the campground about cougars and specifically mentioned the recent incident; no camper (except the person involved in the confrontation) left the Park. Similarly, Caspers Regional Park required every visitor during 1988-92 to sign a statement that he or she had been warned of the potential risk of cougar attacks. Our conversations with Park employees indicate that fewer than 10 people in

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5 years chose not to enter the Park due to this warning.

3. A broad public education effort is an alternative to simple warnings. Recently several public entities have started to educate the public about cougars in a balanced way that includes mention of the aesthetic and ecological role of cougars, the potential risk of attack, and suggestions for how to respond if one encounters a cougar. Within the past 5 years, Colorado Division of Wildlife, Montana Department of Fish Wildlife and Parks, and Big Bend National Park have produced helpful and accurate brochures on cougars. The first 2 agencies provide information targeted not only at wildland visitors but also at people who live in cougar habitat. California Department of Fish and Game has also prepared a similar brochure which is available for distribution.

Cougar use of areas on the urban fringe

Cougars were remarkably adept at using habitat along the urban-wildland edge. In particular, all 9 dispersing juvenile cougars encountered at least one urban area during their explorations. There were no instances of cougars behaving aggressively to humans or taking pets in any of these urban edge settings. (Cougars did take pet goats near rural homes).

The sections of Chapter 6 dealing with dispersal movements of juveniles offer many anecdotes illustrating cougar behavior at the urban edge. Several additional anecdotes follow:

M5 in East Orange. Probably the most dramatic case is presented by M5. After breaking both hind legs (Chapter 4: highway injuries) in a vehicle collision on Santiago Canyon Road on April 23 1991, M5 used a very small home range, and stayed in very level terrain eating mainly raccoons and opossums until his death 5 months later. During this 5 months, his locations were almost entirely within 300m of the urban edge. His favorite haunts were the Villa Park Dam impoundment area, Peters Canyon Reservoir, Santiago Oaks Regional Park, and Santiago Creek *downstream* from Santiago Oaks Regional Park as far as the small (10-ha) forest on the north side of Santiago Canyon Road at Hewes St.

In overnight monitoring at Peters Canyon Reservoir on June 12-13 1991, and in Santiago Creek near Hewes St. on July 29-30 1991, M5 moved in a manner suggesting that he was feeding on small prey. On neither occasion did he enter the surrounding residential areas. We had only 2 reported sightings of M5 by a human, in both cases brief glimpses of M5 moving away from the human. At death M5 was grossly normal except for the healed leg injuries and being markedly underweight. M5 never behaved in a manner suggesting a threat to public safety.

M10 in the Anaheim Hills. During overnight monitoring on June 23-24, June 25-26, and July 6-7 1992, M10 spent the night in a thin shard of habitat north of Santiago Oaks Regional Park, close to residential areas, and in a heavily-used recreational area. This area consisted of a ridgetop and small canyon, and was mostly grassland with some coastal scrub and a few eucalyptus trees. Although the area had less woody cover than is typical for cougar habitat locally, it contained abundant prey. Nearby to the southwest were new homes along Serrano and Maybury Streets. More new homes and powerlines lay upslope (north) of this habitat fragment, and tanks and powerlines occupied much of the artificially-flattened north-south ridge.

In each of the 3 nights that we monitored M10 in this area, many hikers, bikers, and joggers passed close to him. However, there were no reported sightings of M10 by people, no indication that M10 was

interested in humans as prey, and only 1 occasion when he got close enough to a residential area to cause a dog to bark.

In the late afternoon of June 24-25, and continuing into the twilight, many joggers and bikers passed near M10 without incident. Just before 10 PM the Disneyland fireworks show began, and 2 people watched the fireworks from the ridge above (north of) M10. After the fireworks these people walked south passing within 250 m of M10. At 0130, M10 walked into the mouth of the draw and approached Serrano Road, at which point the neighborhood dogs erupted with barking and howling, apparently getting scent of the cat before he entered the residential area. M10 promptly retreated to the draw and apparently hunted there the rest of the night (our followup in the morning did not reveal any prey remains).

Two nights later (June 25-26), M10 started out in the same small canyon and stayed there until about 8 PM, while several joggers and bikers again passed nearby. From 1830-2030 the radio-tracker watched M10 from a nearby rock outcrop. During most of this time M10 was resting in a patch of rather open grassland about 300 m from the observer, semi-hidden by his brown color, laying posture, and immobility. The cat raised his head and looked around in response to nearby barking dogs, singing birds, and perhaps scents carried on the wind (on 2 occasions he sniffed the wind and then looked around). At one point M10 started walking but then stopped when 2 women with 2 small dogs jogged on a trail about 200m away. He sat and calmly watched them pass by, but never crouched or appeared aggressive. During the night, he moved gradually east, and by dawn he had moved into Weir Canyon.

We monitored M10 a third night (July 6-7) in the same area. Once again he hunted close to residential areas, and within 200m of joggers and bikers during the evening hours. He again ended the night in Weir Canyon, far from developed areas.

F2 in San Juan Capistrano. On the night of February 7-8 1991, F2 moved down Trabuco Creek to I-5, and spent the next several days there, north of the Freeway and south of 3 residences (including a small ranch with horses and goats) built right on the creek. This site was 3 km south of that portion of Trabuco Creek that F2 normally uses. This portion of the Creek lay in a channel with cut banks 8-12 feet deep. About 8 homes on the eastern blufftop were less than 200m from F2's daybeds and the large "Village San Juan" housing tract was less than 100 m from the western bluff top.

On February 11, we found remains of 2 raccoons and 2 opossums that F2 had killed along Trabuco Creek. One opossum was extremely large and perhaps it had thrived by raiding nearby garbage cans. There were no reported sightings of F2 from nearby residents, and no indication that she was a threat to the nearby pets, goats, or residents. In 3 visits to the creek we were unable to see or hear her despite approaching to within 10 feet of her, so strong was her determination not to leave the protection offered by the dense bamboo thickets.

M13 in Coto de Caza. During overnight monitoring of M13 on September 25-26 1992, M13 traveled north up Cañada Gobernadora into an area of estate lots at the southern end of Coto de Caza. At about midnight he killed a deer in the creek bottom, near the chain-link fence marking the estate boundary. The kill site was about 50m from the road and a similar distance from a light illuminating the estate grounds. He stayed in this location feeding on the deer until 0530, at which time he traveled south and east about 2 km, skirting the south edge of a freshly graded area and traveling through the northern part of

the new Gun Club site, into Bell Canyon to daybed.

Urban intrusion. Most radio-tagged cougars had urban areas abutting part of their home range, and several cougars experienced urban growth within their home ranges during the study. The cougars did a remarkable job of keeping out of areas immediately after the bulldozers removed the native vegetation. In several cases cougars moved into newly-initiated construction sites during the night, and remained bedded near them while heavy machinery operated nearby the following day. For instance, in early January 1990, F2 made her first visit to the lower Arroyo Trabuco in over 2 years, during which time many changes had occurred. On January 11, she was daybedded in a small canyon on the east rim of the Arroyo Trabuco. To her east, a street sign ("Antonio Parkway") stood incongruously in a grassland and bulldozers were busy making a street for the street sign to mark, with the road cut about 150m east of F2. To the north the cat could easily see golfers on the newly-built Rancho Santa Margarita. To the west (across the Arroyo) hundreds of hammers clattered on hundreds of house frames in Mission Viejo. And less than 1 km south bulldozers were scraping the Arroyo to put in footings for the Oso bridge. During all daylight hours the cougar was surrounded by construction activity. Shortly after dusk she quickly moved back east to the central part of her range.

Human structures in rural areas. Cougars in more remote areas also encountered humans regularly. For instance, within F3's home range were Los Amantes Camp (used for large outdoor parties), the TRW ("Star Wars") plant, the Ford munitions testing facility, and a very large sand mining and processing operation. F3 used all of these facilities when human activity was low, and showed no apparent aversion to passing near isolated buildings or vehicles at night. During one overnight monitoring session, she passed within 200m of Los Amantes Camp when a large outdoor party was in progress, showing no apparent interest in the activity.

Cougars also passed close to rural homes and occasionally ate goats there.

Cougars in parks and near wilderness trails

On several occasions, we documented a cougar (on different occasions: F1, F2, M2, M5, M6, M8, and M10) bedded for the day a few feet off of well-used park trails in Caspers Park, O'Neill Park, the Arroyo Trabuco (closed trails regularly used by trespassers), Whiting Ranch Regional Park, Chino Hills State Park, or Santiago Oaks Regional Park. The cougar doubtless was aware of the hikers, the hikers were completely unaware of the cougar and therefore were at risk of being ambushed. The only reported sighting in all these cases was a single incident in which F2 scrambled up a tree as an equestrian approached.

Given the high human use of Santiago Oaks Regional Park, there is a potential for human-cougar encounters in that Park. Although there may be greater risk at other parks that are more regularly used by cougars, park visitors are probably less aware of the potential for encountering a cougar in Santiago Oaks Regional Park. Because most people approach the park from the heavily-urbanized west, many park visitors tend to regard it (despite its oak forest and other wild traits) as a "city park," disregarding any efforts to make them aware of a potential cougar encounter. A similar disparity between public perception and biological reality exists at Irvine Park.

Many County Parks were cougar habitat (Chapter 3), and thus each had the potential for a cougar attack, although this risk is very low. Neither the historical record nor our data on radio-tagged animals provide a basis for assigning a greater degree of risk to a

particular park. As long as a park is cougar habitat, it has a small amount of risk.

Management practices related to cougars differed greatly among the above County Parks, from signed warnings and a prohibition on minors in Caspers Wilderness Park, to busloads of school children in Santiago Oaks Regional Park, to a largely unpatrolled Wagon Wheel Regional Park. The Parks as a group also differed from adjacent National Forest lands that were open to all visitors.

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GLOSSARY

adult - a cougar over 24 months of age and exhibiting a stable home range.

carrying capacity - the average number of animals that a given habitat area can support in the long term. For cougars, it is usually expressed in numbers of adults per 100 km^2 or per 100 mi^2.

corridor (wildlife corridor) - a linear habitat used by animals or plants to move between 2 larger habitat areas.

cub - a cougar from birth until dispersing out of its mother's home range at 13-27 months of age

depredation - the killing of domestic livestock or pets by a wild predator

dispersal - Movement of an animal away from its place of birth to establish a new home range elsewhere. For cougars, the process of dispersal takes several weeks to months, during which the animal searches for suitable habitat with minimum risk of conflict with other resident adults of the same sex. Cougars in this population dispersed at 13-27 months of age.

hectare (ha) - hectares, a unit of area equal to 10,000 m^2 (e.g., a square 100 m on a side) or about 2.471 acres. To convert ha to acres, multiply ha by 2.471; to convert acres to ha, multiply acres by 0.4047. see also kilometers

home range - The area used by animal in the course of its normal activities of feeding, breeding, resting, and raising young. Home range excludes rare excursions to locations not later revisited.

intensive monitoring - radio-tracking sessions starting before sunset and continuing until after sunrise. During each session, we determined the location of a single cougar (the focal animal) every 15 minutes. also called "overnight monitoring"

juvenile - a term that includes both cubs and subadults, i.e., any cougar that is not yet adult.

kilometer (km) - a unit of length equal to 1000 meters, or about 0.625 miles. To convert km to miles, multiply km by 0.625; to convert miles to km, multiply miles by 1.6. To convert km^2 to mi^2, multiply by 0.386; to convert mi^2 to km^2, multiply by 2.59.

overnight monitoring - *see* intensive monitoring

parturition - the act of giving birth

Santa Ana Mountain Range - The study area, including the Santa Margarita Mountains, the Santa Rosa Plateau, and the Chino Hills. See Figure 1.

scat - fecal dropping

subadult - a cougar from the age of dispersal until a stable home range is established, usually by 36 months of age

transient (home range) - (a home range) used for several weeks or months by a dispersing juvenile cougar and then abandoned. Transient home ranges were smaller than adult home ranges, and were usually elongate and pressed up against the urban edge.

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