the Short Lived Climate Pollutants Act of 2016, the Solid Waste: Diversion Act of 2011, the Solid Waste: Organic Waste Act of 2014 (SWOWA), the AB 32 Scoping Plan, and local requirements – can produce renewable energy and fuel and reduce GHG emissions. As jurisdictions establish organic material recycling programs, the general plan should consider the infrastructure that is needed to support increased diversion of organics from landfills, including the location of new facilities, the possibility of upgrading existing facilities to accommodate organic material specifically, (i.e., co-locating composting and digestion facilities at existing facilities such as transfer stations, material recovery facilities, and landfills), or the creation of new curbside collection requirements for food scraps with yard waste. The land use element should also include a transparent and proactive process to involve potentially impacted or disadvantaged communities in the early stages of facility planning and permitting processes. These issues may also be addressed in the county climate action plan. If relevant, cities and counties should consult with special districts and utilities providers to ensure the proposed land use plan is supported by adequate facilities.

In October of 2015, Governor Brown signed AB 876 (McCarty) to address longer-term planning for organics infrastructure by requiring counties and regional agencies to report the following information to CalRecycle commencing on August 1, 2017:

(1) An estimate of the amount of organic waste in cubic yards that will be disposed by the county or region over a 15-year period.

(2) An estimate of the additional organic waste recycling facility capacity in cubic yards that will be needed to process the amount of organic waste identified.

(3) Areas identified by the county or regional agency as locations for new or expanded organic waste recycling facilities capable of safely meeting the additional organic waste recycling facility capacity need identified.

Addressing the facilities that may need to be expanded or sited to process the organic materials in 15 years will require each county or regional agency to assess its unique situation, including existing facilities and their ability to process the material, and any new or expanded facilities that can be identified.

In addition, the general plan should consider the potential impacts of solid and liquid waste facilities, waste-to-energy plants, and similar facilities on surrounding land uses and access routes as identified in the circulation element. Generally, schools, hospitals, residences, and other potentially sensitive buildings should not be located where nearby facilities could have adverse health impacts. When designating new areas in the land use plan for waste facilities, the city or county should carefully consider whether surrounding areas are already burdened by existing sources of pollutants.

The publication, Model Goals, Policies, Zoning, and Development Standards for Composting and Remanufacturing Facilities, is intended to educate and inform local policy-makers and planners about land use planning approaches and zoning tools to encourage the economically beneficial use of recyclable materials generated in California. It identifies options and model language for general plan goals and policies, as well as zoning ordinance standards related to anaerobic digestion, composting, and remanufacturing facilities using recycled materials. These examples provide a starting point that can be modified to fit individual city or county circumstances.

Planning for Organic Waste Diversion

California has an ambitious goal of 75 percent recycling, composting, or source reduction of solid waste by 2020. Achieving that goal will require the recycling, composting, or source reduction of an additional 23.5 million tons of recyclables annually, a significant portion of which is organic material. To redirect that much organic material by 2020 will require major efforts on many fronts, including the expansion or siting of many facilities to accommodate higher recycling volumes, stronger markets for recycled materials, ideally within underserved regions of the state, that are sustainable and responsive to local needs and opportunities.

In September 2016, Governor Brown signed SB 1383 (Lara, Chapter 395, Statutes of 2016), establishing methane emissions reduction targets in a statewide effort to reduce emissions of short-lived climate pollutants (SLCP) in various sectors of California's economy. Actions to reduce short-lived climate pollutants are essential to address the many impacts of climate change on human health, especially in California's most at-risk communities, and on the environment. SB 1383 establishes targets to achieve a 50 percent reduction in the level of the statewide disposal of organic waste from the 2014 level by 2020 and a 75 percent reduction by 2025. The law also establishes an additional target that not less than 20 percent of currently disposed edible food is recovered for human consumption by 2025. Additional information on the organic waste recycling requirements can be found at CalRecycle's SLCP Webpage.

SB 1383 builds upon California's leading commitments to reduce greenhouse gas emissions and air pollution statewide. Governor Brown identified reductions of short-lived climate pollutant emissions, including methane emissions, as one of five key climate change strategy pillars necessary to meet California's target to reduce greenhouse gas emissions 40 percent below 1990 levels by 2030 as established in SB 32 (Pavley, Chapter 249, Statutes of 2016). SB 1383 will further support California's efforts to achieve other policies, such as increased commercial recycling as mandated by the Solid Waste: Organic Waste Act of 2014, hereafter referred to as SWOWA, and greater recycling by the general public.

To achieve these goals and targets, local agencies are turning to innovative technologies like anaerobic digestion to convert waste into energy and to reduce greenhouse gas emissions that contribute to climate change. Local anaerobic digestion projects provide a number of benefits including landfill disposal cost savings, the ability to meet greenhouse gas reduction and state waste diversion goals, and increased community pride and recognition for their role as an environmental leader. Anaerobic digestion facilities have the option of producing electricity or natural gas with heat as a co-product. Electricity can be used to power the facility itself or can be exported to the electrical grid. Natural gas can be used to fuel natural gas vehicles, including solid waste and recycling trucks, delivery trucks, passenger vehicles, and buses. Either energy choice will generate a revenue stream which can help offset the costs of the facility.

The Sacramento BioDigester started in 2012 with the capacity to process 10,000 tons of food waste per year, and its capacity expanded to four times that amount in early 2015. The 40,000 ton input capacity includes food waste from area restaurants, food processors, hospitals, the international airport, elementary schools, and supermarkets. The 730,000 gallons of biofuel produced annually are used at an onsite fueling station to fuel all of the natural gas trucks of the local trash and recycling collection fleet (24 of 55 trucks) as well as a portion of the city's and county's waste fleets, security cars, California State University, six Sacramento commuter buses, and two local catering companies. The BioDigester also has an exclusive contract to provide natural gas to Sacramento School District's 6-12 buses and is the backup provider for Elk Grove's 6-12 buses. The waste gas that is not clean enough to use for transportation fuel is used to produce one million kilowatts of electricity which powers both the facility and the fueling station. The digestate is used to produce eight million gallons of organic soils and fertilizers for Sacramento area farms.

Alameda County adopted its Community Climate Action Plan in February of 2014. It builds off the county's already exemplary waste management programs by establishing a target of diverting 90 percent of all waste from landfills by 2030 with an interim goal of 82.5 percent by 2020. To achieve this, the county has outlined measures and strategies that include mandatory household and commercial food waste recycling and a corresponding outreach and education program. The Alameda County Waste Management Authority Board, also known as StopWaste.Org, is a joint powers authority. Its members include the county, the fourteen cities in the county, and two special districts that provide solid waste and recycling services. Its education activities aim to encourage businesses to recycle and include technical assistance for waste prevention and recycling, targeted outreach and assistance to large businesses, online resources for smaller businesses, grants for businesses, and a high profile recognition program for businesses that recycle.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Safety and health concerns for vulnerable populations.	Locations of schools and hospitals as well as populations of children and elderly facilities or communities.
Vehicle miles traveled (VMT) effects of waste facility location.	Distances and frequency of truck travel between residential and commercial centers and facilities; local sustainable communities strategies (SCS).
15 years capacity needed for organics recycling.	Capacity needed and available/planned infrastructure.

Greenways

Requirement Description:

A land use element must designate the proposed general distribution, location, and extent of uses of land for greenways, defined by Civil Code 816.52(b) as "a pedestrian and bicycle, nonmotorized vehicle transportation, and recreational travel corridor that meets the following requirements:

(1) Includes landscaping that improves rivers and streams, provides flood protection benefits, and incorporates the significance and value of natural, historical, and cultural resources, as documented in the local agency's applicable planning document, including, but not limited to, a master plan, a general plan, or a specific plan.

(2) Is separated and protected from shared roadways, is adjacent to an urban waterway, and incorporates both ease of access to nearby communities and an array of amenities within an urbanized area and services for the users of the corridor and nearby communities.

(3) Is located on public lands or private lands, or a combination of public and private lands, where public access to those lands for greenway purposes has been legally authorized by, or legally obtained from, the fee owner of the land and, if applicable, the operator of any facility or improvement located on the land, through leases, easements, or other agreements entered into by the fee owner and the operator of any affected facility or improvement on the land.

(4) Reflects design standards regarding appropriate widths, clearances, setbacks from obstructions, and centerlines protecting directional travel, and other considerations, as appropriate, that are applicable for each affected local agency, as documented in the local agency's applicable planning document, including, but not limited to, a master plan, general plan, or specific plan, and that are consistent with plans and facilities for controlling the floodwater of rivers and their tributaries, as applicable.

(5) May incorporate appropriate lighting, public amenities within an urbanized area, art, and other features that are consistent with a local agency's planning document, including, but not limited to, a general plan, master plan, or specific plan."

Planning for greenways should coordinate closely with the circulation, conservation, and open space elements, and consider implications on community health, economic development, environmental justice, and social equity.

Identify and Annually Review Areas Subject to Flooding

Requirement Description:

In addition to the requirement to designate specific land uses, the land use element must "identify and annually review those areas covered by the plan that are subject to flooding identified by flood plain mapping prepared by the Federal Emergency Management Agency (FEMA) or the Department of Water Resources" (Gov. Code § 65302(a)).

When fully informed by applicable flood information and assessments of climate change impacts and management practices, careful land use planning can effectively reduce vulnerability to potential flood damage in cities and counties. Such careful planning can include non-structural flood protection measures, low impact development, and improved stormwater management practices. Federal, state, and local agencies may construct and operate flood protection facilities to reduce flood risks, but some amount of risk will remain for those residing in floodplains. Therefore, increasing awareness can help ensure Californians recognize the potential threat and are better prepared to respond to flood emergencies.

The Land Use: Water Supply Act of 2007 (AB 162, Wolk) requires additional consideration of flood risk in local land use planning throughout California and named the Department of Water Resources (DWR) as a source for floodplain information and technical data for local governments. The Sustainable Groundwater Management Act of 2014, hereinafter referred to as SGMA, considers the connections between groundwater management, land use, and flood management and allows local agencies to customize plans to their regional needs.

DWR published two reports—Implementing California Flood Legislation into Local Land Use Planning: A Handbook for Local Communities and Guidance on General Plan Amendments for Addressing Flood Risk—to provide assistance and recommendations for local government compliance with 2007 flood legislation. DWR also created a sustainable groundwater management toolbox to assist with SGMA.

Local jurisdictions must assess floodplain mapping, groundwater recharge, and stormwater management information and determine any needed changes in the general plan. If new data comes to light, then the existing general plan's background information, maps, goals, policies, and implementation measures may need updating. As flood risk may change over time, cities and counties should establish policies for land use that are consistent with evolving flood risks.

The land use element policies addressing flooding should also be consistent with additional flood control policies required in the conservation and safety elements, as well as any policies related to climate change, and should consider the potential for groundwater recharge benefits for water supply. When linked to consistent policies in other elements, addressing flooding through hazard area identification and land use management policies may help jurisdictions reduce redundancy in their general plans

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Incorporate stormwater capture and low impact development (LID) for water supply benefits and safety into site planning.	Levee flood protection zones; 100-year floodplain maps; 200-year floodplain maps (if available); 500-year floodplain maps; Awareness floodplain maps; Best available maps.
Identify populations with evacuation challenges.	US Census data on disabled persons, the elderly, and households with transportation barriers.
Identify opportunities for integration between habitats.	Choices in site planning – see DWR Land Use Surveys.

Identification of Timberland Production Zone Lands

Requirement Description:

The land use element must designate "parcels of real property zoned for timberland production pursuant to the Timberland Productivity Act of 1982 ..." (Gov. Code § 65302(a)(1)). Under the Z'berg-Warren-Keene-Collier Forest Taxation Reform Act of 1976, land zoned for timber production receives substantial tax benefits. Such timber production zones (TPZ), also known as timber preserve zones, are restricted to the production of timber or compatible use for ten years, followed by annual automatic renewal unless otherwise terminated (Gov. Code § 51114, 51115). These acres of TPZ represent the State's long-term, privately owned forestland base.

As population increases, encroaching development threatens timberland production zones. The state discourages the expansion of urban services into timberlands and "premature or unnecessary conversion of timberland to urban and other uses" (Gov. Code § 51102(a)). Ensuring the continual growing and harvesting of timber is important "to ensure the long-term productivity of the forest resource, the long-term economic viability of the forest products industry, and long-term stability of local resource-based economies" (Gov. Code § 51101(c)). The land use element regarding TPZ should support and remain consistent with policy objectives in the conservation and open space elements

Impact of New Growth on Military Readiness Activities

Requirement Description:

A land use element must include consideration of impacts to the military's operations. Specifically, Government Code section 65302(a)(2) requires consideration of impacts of land use decisions on military. The law states that the land use element of the general plan shall "[c]onsider the impact of new growth on military readiness activities carried out on military bases, installations, and operating and training areas, when proposing zoning ordinances or designating land uses covered by the general plan for land, or other territory adjacent to military facilities, or underlying designated military aviation routes and airspace" (Gov. Code § 65302(a)(2)).

To encourage collaboration between the military and local jurisdictions and to prevent land use conflicts with military installations and training activities, California law created a notification process to inform the military of local land use proposals that might have an impact on military facilities and operations. The law requires that local governments 1) use development permit applications that identify proposed projects within 1,000 feet of a military installation, beneath a low-level flight path, or within special use airspace and 2) notify the military when a proposed project, or an updated or revised general plan, might have an impact on military facilities and operations (Gov. Code § 65944(d)). The California Military Land Use Compatibility Analyst (CMLUCA) can help identify where military operations are in relation to cities and counties. CMLUCA can also generate a report to notify the military when there is a project proposed under military airspace.

Military Compatibility Planning Resources

For more information on military compatibility issues, please see OPR's California Advisory Handbook for Community and Military Compatibility Planning and the Community and Military Compatibility Planning: Supplement to the General Plan Guidelines.

Military staff are available to work with local governments on military compatible land use planning. For more information, and a memo on Government Code section 65352(a)(6)(A) and Government Code section 65944(e) notification requirements, please see OPR's California Strategic Coordination and Engagement Program.

Local military activity or Department of Defense Service points of contact can provide specific information about military installations and training areas within your county or city. It is important to check with the military points of contact to discuss the particular military operations in your area and how a local government's vision for development can be compatible with those operations. In the case of areas with low-level flight paths, it is particularly important to coordinate with the branch points of contact. OPR maintains a list of military branch points of contact.

Each city and county should implement a process to identify, coordinate, and assist in resolving potential land use conflicts within nearby military training areas or under military special use airspace to ensure that new development is compatible with military operations and with mission training and testing requirements. New development should be reviewed and regulated to avoid impact to military operations areas (MOAs) and to maintain public safety. The General Plan Mapping Tool and the CMLUCA both can help map locations of military operations. The local jurisdiction should inform the military officials of any changes by school districts, charter schools or other state level agencies that may affect military readiness.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Map military sites in relation to general plan area.	CMLUCA

Identify Unincorporated Island or Fringe Communities (Cities) or Legacy Communities (Counties)

Requirement Description:

According to legislative findings in Senate Bill 244 (Wolk, 2011), hundreds of unincorporated communities in California lack access to basic community infrastructure like sidewalks, safe drinking water, and adequate waste processing. These communities range from remote settlements throughout the state to neighborhoods that have been surrounded by, but are not part of, California's fast-growing cities. This lack of investment threatens residents' health and safety and fosters economic, social, and education inequality. Moreover, when this lack of attention and resources becomes standard practice, it can create a matrix of barriers that is difficult to overcome.

The purpose of SB 244 is to begin to address the complex legal, financial, and political barriers that contribute to regional inequity and infrastructure deficits within disadvantaged unincorporated communities.

Including these communities in the long range planning of a city or county, as required by SB 244, will result in a more efficient delivery system of services and infrastructure, including sewer and water services, structural fire protection, and other needs. In turn, investment in these services and infrastructure will result in the enhancement and protection of public health and safety for these communities.

The land use element must identify fringe, island, and legacy communities that are disadvantaged unincorporated communities. The identification must include a description of the community and a map illustrating its location. General plan law defines a community as "an inhabited area within a city or county that is comprised of no less than 10 dwellings adjacent or in close proximity to one another" (Gov. Code § 65302.10(a)(1)). SB 244 defines a "disadvantaged community" as a community with an annual median household income that is less than 80 percent of the statewide annual median household income (Gov. Code § 65302.10(a)(2).)[1]

Building infill development can maximize urban space and conserve resources

Image by Urban Advantage, Contra Costa County, CA

1 It should be noted that this definition of "disadvantaged community" is slightly different than the definition that applies for purposes of the environmental justice element required by SB 1000 (Gov. Code § 65302(h)(4)(A)).

"[I]sland communities" are defined as any inhabited and unincorporated territories that are surrounded or substantially surrounded by one or more cities or by one or more cities and a county boundary or the Pacific Ocean (Gov. Code § 65302.10(a)(4)); and "fringe communities" are defined as any inhabited and unincorporated territories that are within a city's sphere of influence (Gov. Code § 65302.10(a)(3)).

"Legacy communities" are defined as any geographically isolated communities that are inhabited and have existed for at least 50 years (Gov. Code § 65302.10(a)(5)).

Certain terms within these definitions can be interpreted differently based on local context. For example, terms such as "substantially surrounded" or "close proximity" can differ greatly between rural and urban communities.

Cities and counties should not rely solely on lists of disadvantaged unincorporated communities compiled by their LAFCO. Instead planners must do their own independent identification of all communities that meet the definition given above. Cities and counties may consult other agencies, organizations and reports that have identified unincorporated communities for assistance.

Planning for Disadvantaged Unincorporated Communities (Gov. Code § 65302.10)

(b) On or before the due date for the next adoption of its housing element pursuant to Section 65588, each city or county shall review and update the land use element of its general plan ... [to] include all of the following:

(1) In the case of a city, an identification of each island or fringe community within the city's sphere of influence that is a disadvantaged unincorporated community. In the case of a county, an identification of each legacy community within the boundaries of the county that is a disadvantaged unincorporated community but not including any area within the sphere of influence of any city. This identification shall include a description of the community and a map designating its location.

(1) For each identified community, an analysis of water, wastewater, stormwater drainage, and structural fire protection needs or deficiencies.

(1) An analysis, based on then existing available data, of benefit assessment districts or other financing alternatives that could make the extension of services to identified communities financially feasible.

(c) On or before the due date for each subsequent revision of its housing element pursuant to Section 65588, each city and county shall review, and if necessary amend, its general plan to update the analysis required by this section.

As part of the analysis of disadvantaged unincorporated communities, the land use element must analyze the water, water supply, wastewater, stormwater drainage, and structural fire protection needs or deficiencies for each community. The analysis should consider both the horizon year and the impacts of a changing climate. This analysis should also consider adequacy of groundwater resources, and be consistent with utilities planning in the circulation element and the fire and flood protection policies in the safety element. LAFCo municipal service reviews can be helpful in supporting this analysis.

The analysis must also review the use of benefit assessment districts or other financing alternatives that could make the extension of services to identified communities financially feasible. Each time the housing element is updated, the analysis for these communities must be reviewed, and if necessary, updated.

For more information, please see OPR's SB 244 Technical Advisory.

Cities and counties should use this chart to ask these questions while undergoing disadvantaged communities analysis:

Type of Infrastructure	What is serving the community now?	What is the need for additional infrastructure?	How can finance mechanisms meet the need?	Which other programs and policies could address the infrastructure deficiency?	What is the community's input?
Required (§65302.10)					
Water					
Wastewater					
Stormwater Drainage					
Structural Fire Protection					
Potential Additional Services					
Police Protection					
Sidewalks					
Lighting					
Libraries, Schools, Community Centers, etc.					
Alleys and other unsafe roadways					
Public transit/ transportation					
Preschools and childcare providers					

The land use element should be updated to include disadvantaged unincorporated communities analysis (Gov. Code § 65302.10). Since all elements of a general plan must be internally consistent, the safety element, the circulation element, and other elements as necessary should be reviewed to ensure consistency (Gov. Code § 65300.5).

The disadvantaged unincorporated analysis should consider where there may be opportunities to provide more efficient, high quality service through consolidation, extension of services, and other regional solutions to address inadequacy of services and infrastructure. In addition, the analysis should consider whether the reorganization will unify or divide any other public agencies such as school districts, transit districts, and flood management agencies.

Correlation with Circulation Element

Senate Bill 375, the Sustainable Communities and Climate Protection Act of 2008 (Steinberg), hereinafter referred to as SB 375, supports the state's climate action goals to reduce GHG emissions through coordinated transportation and land use planning and to create sustainable communities. This concept is discussed further in the circulation element section.

The Land Use Element and Regional Sustainable Communities Strategies

> *California's land is an exhaustible resource, not just a commodity, and is essential to the economy, environment and general well-being of the people of California. It is the policy of the state ... to protect California's land resource, to insure its preservation and use in ways which are economically and socially desirable in an attempt to improve the quality of life in California.* (Gov. Code § 65030).

Most land use approvals occur at the local government level. Nevertheless, local land use elements must reflect their statewide and regional contexts. For example, Government Code section 65030.1 states:

> [D]ecisions involving the future growth of the state, most of which are made and will continue to be made at the local level, should be guided by an effective planning process, including the local general plan, and should proceed within the framework of officially approved statewide goals and policies directed to land use, population growth and distribution, development, open space, resource preservation and utilization, air and water quality, and other related physical, social and economic development factors."

When adopting a general plan, local governments must consult with other entities that may be affected by the plan, such as neighboring cities, counties and special districts, school districts, local agency formation commissions, area-wide planning agencies, federal agencies, the military, water providers, and California Native American tribes (Gov. Code § 65352).

Several regional activities may directly bear on local land use planning. One significant example is the sustainable communities strategy contained within regional transportation plans. While the Government Code states that a sustainable communities strategy does not regulate the use of land (Gov. Code § 65080(b)(2)(K)), local governments should consider and, if appropriate, incorporate applicable policies into local land use elements for several reasons.

First, sustainable communities strategies should already reflect the basic outlines of local plans. Second, some transportation funding is tied to consistency with the regional transportation plan. Third, consistency with the sustainable communities strategy may help streamline benefits under the California Environmental Quality Act of 1970 (CEQA). Fourth, CEQA analysis for the general plan requires analysis of any inconsistency with the regional transportation plan.

A sustainable communities strategy might be relevant to a local land use element in several ways. A sustainable communities strategy should identify locations within the region where land use and transportation investments can be maximized. Therefore, a local government planning agency should consider whether the land use element places development in transportation-efficient locations as identified in the sustainable communities strategy. Other relevant policies include density and intensity maximums and minimums, as well as policies related to active transportation and protection of public health. Incorporating such policies into a local land use element and diagram may assist the local government in avoiding conflicts with neighboring jurisdictions and perhaps more importantly, in maximizing the benefits of transportation funding and regulatory streamlining.

Transit Oriented Development (TOD)

Cities and counties should promote more livable communities by expanding opportunities for transit-oriented development (TOD) so that residents minimize traffic and pollution impacts from traveling for work, shopping, school, and recreation. TOD is defined as moderate to high-density development located within an easy walk of a major transit stop, generally with a mix of residential, employment, and shopping opportunities. TOD encourages walking and transit use without excluding the automobile. According to the California Department of Transportation, "TOD can be new construction or redevelopment of one or more buildings whose design and orientation facilitate transit use." A well-designed, vibrant TOD community can provide many benefits for local residents and businesses, as well as for the surrounding region. Compact development near transit stops can increase transit ridership and decrease rates of vehicle miles traveled (VMT) thereby yielding a good return on transit system investments. TOD can also provide mobility choices, increase public safety, increase disposable household income by reducing transportation costs, reduce air pollution and energy consumption rates, help conserve resources and open space, assist in economic development, and increase the housing supply. TOD is a strategy that may help a community achieve its general plan goals related to circulation, housing, environmental quality, and economic development. Additionally, by improving access to jobs and housing and revitalizing existing neighborhoods, TOD can be a tool for promoting environmental justice. A variety of factors need to be considered during the development and implementation of TOD. These factors include transit system design; community partnerships; understanding of local real estate markets; coordination among local, regional, and state organizations; and providing the right mix of planning and financial incentives and resources. A successful TOD will reinforce the community and the transit system. Transit operators, property owners, and residents should be involved in the development of TOD proposals. Planners should consult data to identify and assess potential locations for TOD during preparation of the land use, circulation, and housing elements of the general plan. An inventory of potential development (and redevelopment) sites within a quarter to a half mile of existing and proposed transit stops may reveal potential locations for TOD. Additional data may be used to verify the optimum location and mix of uses to further refine the viability of TOD at specific transit hubs. These data may include origin and destination studies, transit ridership protections, and information related to the appropriate jobs-to-housing ratio and level of retail services. The appropriate density and intensity will support a high level of transit service. Local governments can promote TOD through general plan policies that encourage supportive densities and designs and a mix of land uses. TOD-supportive policies provide for higher land use densities, reduced parking requirements, decreased automobile traffic levels of service, and increased transit levels of service. TOD policies should facilitate a pedestrian-oriented environment with features such as traffic calming strategies, traditional street grid patterns with smaller blocks, and architecture that orients buildings to sidewalks, plazas, and parks rather than to parking.

Land use policies should align with other elements to provide opportunities for innovation and co-benefits

Image by Urban Advantage, JBG Companies; Duany Plater-Zyberk & Company

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies and examples can be found here

Sample Policy	Example of Application	Relationship to Other Elements
Provide for and encourage the development of a broad range of uses in the [city/county]'s commercial centers and corridors that reduce the need to travel to adjoining communities and capture a greater share of local spending.	La Habra	Circulation, economic development, climate change
[City, county shall] require that new neighborhoods be designed to locate all housing within ½ mile of a central gathering place that incorporates public spaces, shopping areas, access to transit, and/or community-supportive facilities and services.	Sacramento	Circulation, open space, equitable and resilient communities, healthy communities, economic development
[City, county shall] prioritize the provision of necessary major street infrastructure and utility capacities for properly zoned land, consistent with the general plan so that such land can be developed in a timely manner to supports economic development.	Fresno	Circulation, economic development
[City, county shall] review the general plan's residential and commercial capacities every five years and modify, as necessary, to reflect development that has occurred, its impacts, evolving market and economic conditions, and consistency with community values.	Pasadena	Open space, conservation, healthy communities, climate change

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Circulation Element

Introduction

The circulation element is not simply a transportation plan, but rather a strategy addressing infrastructure needs for the circulation of people, goods, energy, water, sewage, storm drainage, and communications. By statute, the circulation element must correlate directly with the land use element, but also has direct relationships with other elements. The provisions of a circulation element affect a community's physical, social, and economic environment, as well as its health. The passage of SB 1000 in 2016 requires local governments to address environmental justice considerations related to circulation–such as access to transportation systems, air quality related to transportation, delivery routes and transit options for nutritional food access, and promotion of physical activity—upon the next revision of two or more elements in their general plan after January 1, 2018.

Government Code Section 65302 (b)

(1) A circulation element consisting of the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, any military airports and ports, and other local public utilities and facilities, all correlated with the land use element of the plan.

(2) (A) Commencing January 1, 2011, upon any substantive revision of the circulation element, the legislative body shall modify the circulation element to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan.

(B) For purposes of this paragraph, "users of streets, roads, and highways" mean bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, users of public transportation, and seniors.

Transportation systems are essential to any city or county and its economy, and can be designed to enhance opportunity and improve equity. However, the implementation and maintenance of infrastructure and resources is costly, impacts the environment, and affects human health. Transportation planning in California is rapidly changing, driven by a number of key factors:

- An increasing focus on access to destinations (connectivity) rather than just mobility, and transportation solutions involving proximity that better accomplish livability and environmental goals
- Constrained local government budgets
- A mismatch of anticipated revenue and future maintenance obligations under current policies
- An increasing focus on greenhouse gas emissions reduction and an ongoing focus on air quality

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- An increasing recognition that we cannot "build our way out of congestion," in part because new capacity encourages more driving, but that congestion can be addressed with roadway pricing measures
- An increasing recognition of the transportation network's effect on land use, and in turn the effect of more disperse land use on the environment and human health
- Demographic and social trends creating increased demand for infill and walkable neighborhoods
- Emerging transportation solutions such as carshare, rideshare, and bikeshare services, which can reduce automobile dependence
- Enhanced technology and information such as Nextbus and Intelligent Transportation Systems (ITS) making navigation of multiple transportation systems more simple and convenient and in some cases influencing transportation choices.
- Introduction of emerging technologies such as partially or fully autonomous vehicles with potential to sharply increase VMT and alter land use scenarios

Further, recent legislation has driven change in the way local governments approach transportation and the types of solutions available:

- The Complete Streets Act
- Global Warming Solutions Act (AB 32)
- SB 32
- The Sustainable Communities and Climate Protection Act (SB 375) and the completion of Sustainable Communities Strategies
- CEQA Streamlining for infill projects (SB 226)
- Shift in CEQA transportation metric away from LOS to VMT (SB 743)

Many California communities are substantially revising their circulation elements to respond to and take advantage of this new legislation.

CORRELATIONS AMONG ELEMENTS

	Land Use	Housing	Conservation	Open Space	Noise	Safety	EJ
Circulation	IN STATUTE	RELATED	RELATED	RELATED	IN STATUTE	RELATED	RELATED

■ Identified in statute ■ Closely related to statutory requirements

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Completeness Checklist

Local agency staff can use the following checklist to help ensure that the draft circulation element addresses all required issues. Please note that use of this checklist is purely advisory, and only contains issues that are legally required in Government Code section 65302(b). Circulation elements may address additional issues at the discretion of the local government. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied

Statutory Citation	Brief Description of Requirement
Gov. Code, § 65302(b)(1)	Existing and proposed major thoroughfares
Gov. Code, § 65302(b)(1)	Existing and proposed transportation routes
Gov. Code, § 65302(b)(2)	• Public transportation
Gov. Code, § 65302(b)(2)	• Bicycle
Gov. Code, § 65302(b)(2)	• Pedestrian
Gov. Code, § 65302(b)(2)	• Automobile
Gov. Code, § 65302(b)(2)	• Commercial goods
Gov. Code, § 65302(b)(1)	Existing and proposed terminals
Gov. Code, § 65302(b)(1)	Military airports and ports
Gov. Code, § 65302(b)(1)	Other local public utilities and facilities
Gov. Code, § 65302(b)(2)	Needs of children, persons with disabilities, and seniors?
Gov. Code, § 65302(b)(1); Fed. of Hillside & Canyon Assns. v. City of Los Angeles (2004) 126 Cal. App. 4th 1180, 1196	Identified funding for infrastructure identified in circulation element?
Gov. Code, § 65302(b)(1)	Circulation element is correlated with the land use element?

Required Contents

The circulation element must, consistent with Government Code Section 65302 (b), include the location and extent of existing and proposed

- Major thoroughfares
- Transportation routes
- Terminals
- Military airports and ports
- Public utilities and facilities

Statutory Requirements

The Government Code requires that any revision of circulation elements after Jan 1, 2011 must plan for a "balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan." Users are defined in statute as "bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, users of public transportation, and seniors." For more information on integrating complete streets concepts to help address these requirements, see OPR's "Complete Streets and the Circulation Element."

The circulation element must identify funding for capital, operations, and maintenance of planned additions to the network, additions that would be triggered by policies in the element, and the existing network.

Relationship with Regional Planning

California courts have recognized that general plans must reflect the regional context. Circulation elements must, therefore, account for both regional transportation plans and, in some cases, congestion management plans.

Regional Transportation Plans

Metropolitan planning organizations and regional transportation planning agencies prepare regional transportation plans in cooperation with Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Caltrans, the Air Resources Board, the Department of Housing and Community Development and other stakeholders, including system users. The purpose of the regional transportation plan is to establish regional goals, identify present and future transportation needs, deficiencies and constraints, analyze potential solutions, estimate available funding, and propose investments. In most regions in California, the regional transportation plan includes a sustainable communities strategy that aligns transportation investments with a land use pattern designed to reduce regional greenhouse gas emissions. In order to be eligible for federal and state funding, transportation projects must be consistent with the adopted regional transportation plan, including an applicable sustainable communities strategy.

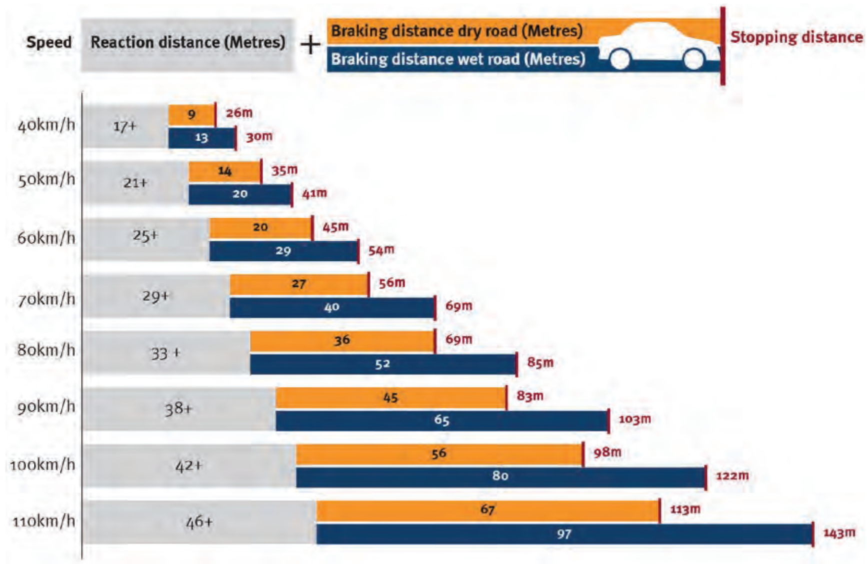
Regional transportation plans are required to reflect certain population growth and distribution assumptions contained in local general plans. As a practical matter, circulation elements should also reflect the adopted regional transportation plan to ensure access to transportation funds. If adopting a circulation element that is not consistent with the regional transportation plan, that inconsistency and its impact on regional greenhouse gas reductions also should be discussed in the environmental analysis under the California Environmental Quality Act. (See, e.g., CEQA Guidelines § 15125(d).)

Correlation with the Land Use Element

Requirement Description:

Creating connected, accessible, and complete systems of circulation networks and ensuring access to opportunities within a community and region requires coordination between land use and circulation planning. Due in part to the connection between transportation funding and greenhouse gas reduction established in SB 375, vehicle miles traveled (VMT) is an increasingly important metric of impact in the circulation element. Because the circulation element is required to correlate with the land use element, it should account for the features of the particular community. For example, the circulation element can demonstrate connectivity between residential uses, services and employment centers. Lack of transportation options from identified disadvantaged communities to essential destinations, such as grocery stores, may be improved through circulation (e.g. working with transit provider to increase transit frequency) or land use (e.g. new commercial development). Mapping transportation options as part of the general plan process may help identify gaps to address. The land use and circulation elements are useful places to plan for equitable access for all community members. Pedestrian and bicycle routes in the circulation element should connect residential areas identified in the land use element with jobs centers, parks, schools, and other destination centers. Truck routes should be directed away from noise- and emissions-sensitive residents and designated instead to serve areas designed for commercial and industrial uses in the land use element. The design speed of a roadway should equal its target speed (in other words, a street should be designed to accommodate intended auto speeds, not faster speeds).

Figure 4: How long a stop takes based on speed (driving an average family car)



Source: https://www.qld.gov.au/transport/safety/road-safety/driving-safely/stopping-distances

Regional Transportation Plans, SB 375, and Sustainable Community Strategies

The Sustainable Communities and Climate Protection Act of 2008 (Sustainable Communities Act, SB 375, Chapter 728, Statutes of 2008) supports the State's climate action goals to reduce greenhouse gas (GHG) emissions through coordinated transportation and land use planning with the goal of more sustainable communities.

Under the Sustainable Communities Act, ARB sets regional targets for GHG emissions reductions from passenger vehicle use. In 2010, ARB established these targets for 2020 and 2035 for each region covered by one of the State's metropolitan planning organizations (MPO). ARB will periodically review and update the targets, as needed.

Each of California's MPOs must prepare a "sustainable communities strategy" (SCS) as an integral part of its regional transportation plan (RTP). The SCS contains land use, housing, and transportation strategies that, if implemented, would allow the region to meet its GHG emission reduction targets. Once adopted by the MPO, the RTP/SCS guides the transportation policies and investments for the region.

Special attention should be paid to ensure that all transportation facilities are designed to be safe, accessible, and connected for all users. Simply putting a sidewalk or a bike lane on one street, for example, without a complete system that connects residents and destinations, may not address the needs of a community. Using context sensitive, flexible designs can help increase access for all users while improving overall conditions or addressing common issues such as storm-water runoff, air quality, and bicyclist and pedestrian safety. For additional information on the design of complete streets, see NACTO Street Design Guidelines and Caltrans Complete Street Guidelines.

As noted above, the circulation element and the land use element must correlate. One of the most recent appellate court cases addressing the correlation requirement explained:

> [T]he internal consistency and correlation requirements do not require a city or county to limit population growth or provide traffic management measures to ensure that its transportation infrastructure can accommodate future population growth. The Planning and Zoning Law (Gov. Code, § 65000 et seq.) does not require a city or county to avoid adverse impacts on transportation. Rather, the city has broad discretion to weigh and balance competing interests in formulating development policies.... *(Federation of Hillside & Canyon Assns. v. City of Los Angeles* (2004) 126 Cal. App. 4th 1180, 1196.)

In characterizing the correlation requirement, the same court explained that "the circulation element of a general plan must provide meaningful proposals to address changes reflected in the land use element, and the land use element must provide meaningful proposals to reflect changes reflected in the circulation element" (Ibid). A proposal is "meaningful" if the element identifies reasonably reliable funding sources (Id. at 1196-1197). An element that identifies proposals with no reasonable expectation of implementation (i.e., funding) is not meaningful, and therefore would not satisfy the statutory correlation requirement (Id.; see also *Concerned Citizens of Calaveras County v. Board of Supervisors* (1985) 166 Cal. App. 3d 90, 103).

Proposals should address not just capital costs, but also costs associated with operations and maintenance. Because the circulation element addresses both transportation and local public utilities, the statutory correlation requirement applies to utilities infrastructure as well.

Appropriate fiscal analyses should be prepared to support the conclusion that the circulation element is capable of supporting the land uses planned in the land use element. Certain transportation funds are tied to consistency with regional sustainable communities strategies, so consistency with regional plans should be part of this analysis.

Tools are available to allow comparison of total infrastructure costs and benefits across several build-out scenarios. These tools enable communities to make decisions regarding land use patterns with long-term infrastructure costs and benefits in mind. More information on these tools and how to use them is available here.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Examine potential policies for local implementation of SCS	Modal split rates, transportation emissions data, transit access maps
Identify gaps in network connectivity	Transit maps, bicycle and pedestrian infrastructure maps, major destinations, and residential centers

Major Thoroughfares

Requirement Description:

Consideration must be given in the general plan to the development and improvement of major thoroughfares, including future acquisitions and dedications, based on proposed land use patterns and projected demand. Cities and counties should consider the location and design of major thoroughfares in new developments, as well as street patterns (curvilinear, grid, modified grid, etc.), multi-modal use and safety, coordination with other infrastructure such as utilities, and relationships between destinations and transportation systems. Relationships between intended users of streets, including freight trucks, transit, automobiles, bicyclists, and pedestrians, should be considered. Design standards for local streets (including, but not limited to, width, block size, speed, and accommodation of parking and bicycle and pedestrian traffic) may also be included in the circulation element. Information on safety elements of design is available in Appendix B. Providing charging stations and alternative fuel stations can facilitate use of zero emissions vehicles, reducing air pollutants and greenhouse gas emissions.

Transportation Routes

Requirement Description:

The transportation system consists of means to transmit vehicles and people (e.g. roads, sidewalks), docks to station vehicles at their destination (e.g. parking lots, ports), and the vehicles themselves (e.g. busses, bicycles, cars). In developing a general plan, a jurisdiction should consider its overall objectives, and develop policies for each of these three components that support those objectives.

Local governments should coordinate transportation routes with larger regional route plans, such as regional or state freight plans, regional transportation plans, and regional transit corridors. Consideration of multiple modes as part of a transportation system, combined with data on projected needs and uses, and local land use data, may help prioritize routes based on community needs. For example, a county may designate a freight corridor to run parallel to existing regional transit lines, utilizing the same infrastructure where possible, and directing both away from sensitive land uses such as schools.

Roads

Requirement Description:

The underlying goal of transportation is to provide connectivity (also called "accessibility" or "access to destinations)." Connectivity is provided by mobility (increased speed) and proximity (reduced distance). The transportation system has traditionally been evaluated primarily through a mobility lens, measuring speed (e.g. via delay metrics like Level of Service). In addition, the primary focus of mobility has been on Automobile Level of Service (LOS), a localized (intersection or roadway segment) measure of auto-mobility. The Complete Streets Act of 2008, as well as recent changes in CEQA and congestion management law, highlight a need for circulation elements to have a broader focus that includes other modes.

Upon review of existing policies, many local governments may find that existing automobile LOS standards are not sustainable or even desirable. For example, a high automobile LOS may be too expensive to maintain, may be unsafe for non-auto users, and may force different uses to be spread so far apart that travel becomes inconvenient.

Ideally, going forward, the circulation element of the general plan will include a discussion of the transportation system designed using metrics that capture connectivity (the fundamental purpose of transportation) rather than mobility (just one facet of connectivity). Examples of such measures include number of jobs accessible within 30 minutes, number of retail destinations reachable in a ten-minute walk, and number of hospitals accessible by a 45-minute transit ride. Even where metrics like Level of Service are still used, local governments should consider the following ways to account for limitations:

- Use Level of Service during the planning process to size roadways, but not as a measure of individual project impacts.
- Level of Service should be balanced with other metrics when used, rather than triggering decisions by itself. Other metrics are needed to measure the efficacy, comfort and safety of other transportation modes, and to measure the proximity benefits conferred by infill development. It is important to estimate the cost of achieving any Level of Service threshold, in order to determine whether that threshold is fiscally feasible, and to identify, where possible, funding for long-term maintenance costs associated with building to any Level of Service thresholds.
- Set Level of Service thresholds in consideration of the tradeoffs between mobility and other goals. Accommodating automobile traffic has direct tradeoffs with greenhouse gas emissions, other emissions that affect air quality, pedestrian collision risk, and active mode share and the resulting public health benefits. It also leads to sparser land development patterns, creating indirect tradeoffs with consumption of agricultural land and sensitive habitat, energy use, water use, and water runoff affecting water quality and flood risk. A general plan should consider these tradeoffs when recommending a Level of Service objective.

Planning for safe transportation systems has often used LOS to attempt to streamline automobile flow, accommodating driver error in an effort to reduce crash rates. This method of planning for safety may not most effectively increase safety or protect all users of the system. Rather, proactive roadway design, reduced speeds, and reduction of overall VMT may be more effective. For more information on analyzing transportation safety impacts, see Appendix B.

Transit

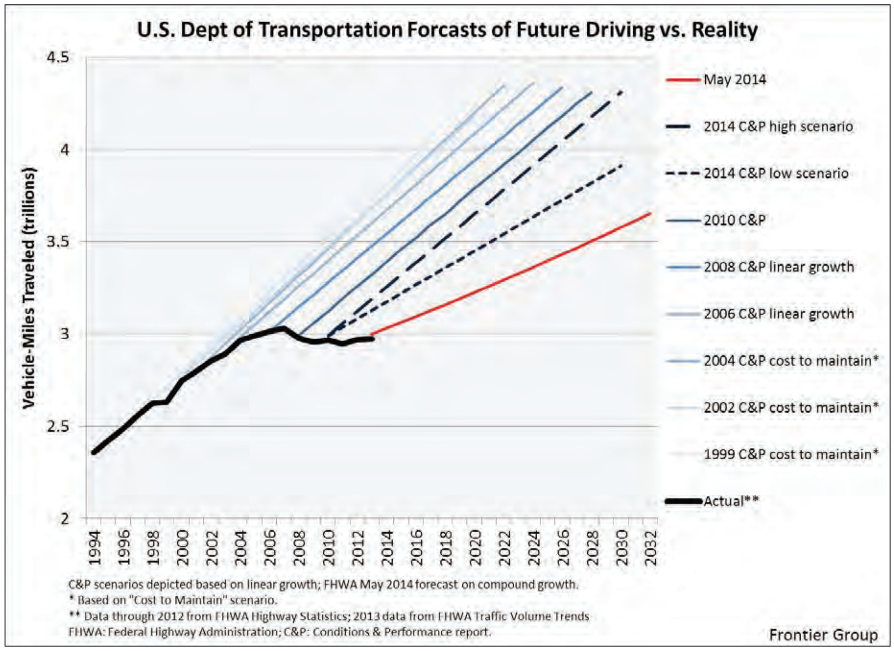
Requirement Description:

As more of the population chooses alternatives to driving, roadway capacity becomes filled, and California strives to reduce VMT and GHG emissions, transit availability becomes increasingly important. There are many important considerations for transit in general plans. Policies, such as increasing density around transit corridors and increased transit infrastructure, can promote and prioritize high quality transit, aligned with housing and economic development policies, which in turn increases efficiency of the overall transportation system. Promotion of equitable access to transit, through the analysis of available data to make decisions, can help ensure all community members have access to core destinations, such as employment centers, schools, and retail, and contribute to fulfillment of environmental justice requirements. Transit providers should be involved in general plan processes, ensuring their alignment with community priorities.

Well-planned transit infrastructure can improve access to opportunity by making job centers, housing, schools, and other major destinations accessible to a high numbers of residents. Providing infrastructure at transit stops for convenience and safety, such as proper lighting, covered shelter, and safe crossings; implementing transit priority on streets and bridges, such as priority lanes, signals, and other types of infrastructure; and utilizing technology to communicate transit patterns in real time can help speed transit vehicles, shorten travel times, promote safety, and attract additional passengers.

Coordinating transit stops, stations, and routes with bicycle and pedestrian infrastructure can help create first and last mile connections, promoting reduced VMT for short trips and potentially increasing transit ridership for a greater range of residents.

Figure 5: People are choosing to drive less and less, at rates higher than expected



Source: Frontier Group http://www.uspirg.org/resources/usp/us-dept-transportation-forecasts-future-driving-vs-reality

Developers and employers can also incentivize transit ridership, and general plan policies can promote such programs through general visions and goals or through specific transit zones in the plan.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Assessment of potential needs for new transit routes	Maps highlighting residential centers, commercial centers, employment opportunities, schools, and recreation areas
Identifying potential targets areas for policies incentivizing transit use	Major employment centers, existing and planned transit routes, residential areas with demographic information

Active Transportation: Bicycle and Pedestrian Networks

Requirement Description:

The Active Transportation Program, enacted via Senate Bill 99 in 2013, funds pedestrian, bicycle, and Safe Routes to School programs (SRTS). This program ensures that at least 25% of investments benefit disadvantaged communities. Increasing safe, connected bicycle and pedestrian networks in a city or county improves health, economic mobility, GHG emissions, and increases accessibility for numerous populations. Ensuring that infrastructure is safe for residents from ages 8 to 80, if possible, captures the needs of recreational riders, ADA users, bicycle and pedestrian commuters, and all people in between. The Complete Streets Act (2008) requires cities and counties to plan for the development of multimodal transportation networks in the circulation element of their general plan. Caltrans and NACTO offer guidelines on complete streets implementation. The Sustainable Communities and Climate Protection Act of 2008 (SB 375), promotes regional coordination of transportation and land use planning, including support of active transportation. Prioritizing more forms of active transport policies in general plans will strengthen potential for regional transportation plans to meet GHG reduction targets established pursuant to SB 375.

Safe Routes to Schools (SRTS)

Less than 15% of children living within a 2 mile radius of a school walk or bike to school, and over half are driven in vehicles. Recognizing the implications of these statistics for childhood health, worsening air quality, and congestion around schools, the Safe Routes to School program established in one jurisdiction in 1997 quickly became a model to promote safe, accessible routes to schools nationwide. With federal funding through the Transportation Alternatives Program, state funding, and programming across the US, SRTS promotes infrastructure, design, policy, and education to promote active transportation for children and parents. Many jurisdictions have incorporated SRTS into their circulation and land use elements, and the national partnership offers numerous resources and examples to help communities implement safe routes to school.

Bicycle and pedestrian networks should be complete systems for transportation, including coordination with land use plans, housing, and transit systems. Bicycle and pedestrian networks should connect residents to employment centers, community centers, schools, commercial districts, and transit stops. Active transportation can be used to fill the gap in transit systems- the first and last mile between transit stops and destinations. Promoting infill and TODs may create additional opportunities for active transportation by decreasing the distance between origins and destinations.

Circulation elements should promote equitable distribution of active transportation networks that link residents to key destinations, and ensure equitable allocation of infrastructure investments and maintenance. Where feasible given right of way restrictions, cost, and other limitations, protected or buffered bikeway should be prioritized to reduce injuries and promote biking. Paths and facilities, both on and off road, should include user amenities such as shade trees, benches, and drinking fountains. Complete Streets policies should be integrated into bicycle and pedestrian policies as well. Some jurisdictions have separate bicycle and pedestrian plans, which should correspond and align with the general plan.

Terminals

Requirement Description:

Airports, seaports, bus and train stations, and other terminals play an important role in a region's transportation, social, and economic makeup. As such, the circulation element should include these facilities in its transportation discussion, and include operators in the general plan process. Often, terminals bring a specific set of land use issues that may need to be addressed as future growth occurs in existing infill areas. These issues include pollution, noise, traffic, and public safety. The location, type, and height of development in areas surrounding airports, should be considered in the context of the local Airport Land Use Plan. Airport Land Use Plans must coordinate with general plans' land use elements, but should be considered in relation to circulation and safety as well. Some actions to consider in the circulation element include:

- Assess the adequacy of navigable waterways and port and harbor facilities, including the need for expansion and improvements.
- Project future demand based on new or expanded economic activities and recreational trends
- Assess the adequacy of and safety hazards associated with existing aviation facilities and the need for expansion and improvements.
- Limit potential noise and safety hazards posed by port activities to surrounding land uses
- Mitigate aviation-related hazards posed to and by aircraft
- Make access to and from aviation facilities available by all modes of transportation

Military Airports and Ports

Requirement Description:

The Department of Defense (DOD) has a significant presence in the State of California, using 10% of the State's land. Consequently, military ports and airports impose demands on local circulation infrastructure that should be factored into the overall analysis of local circulation planning in a general plan. Furthermore, changes to circulation patterns and routes may affect military operations. For example, development along formerly rural roads can significantly increase urban traffic and limit the use of routes for military transport purposes. Such changes can impede military operations, especially for units that commute to conduct training operations. On the other hand, improvements to circulation routes, such as ports, can contribute to operations. Additional information on military specific development can be found in the California Advisory Handbook for Community and Military Compatibility Planning.

Public Utilities and Facilities

Requirement Description:

In addition to transportation routes, the circulation element must identify the location and necessity of public utilities and facilities. Relevant utilities include water, sewers, storm-water systems, telecommunications and broadband, electric vehicle charging stations, electricity, and natural gas lines. These facilities relate directly to the land uses planned in the land use element, consequently, the circulation element should consider not just "right sizing" such infrastructure to serve only that growth that is actually planned in the land use element, but also placing infrastructure in areas that maximize efficiency and minimize impacts to the community. California courts have noted that plans for infrastructure should follow determinations regarding desired growth that reflect resource constraints and other broader considerations. (See, e.g., *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal. App. 4th 931, 949-950.)

"Dig once" policies can help ensure efficiencies and reduce costs among circulation infrastructure. The underlying premise of a "dig once" policy is to coordinate conduit construction with unrelated civil works projects, such as digging up the roads and sewer construction, to create a usable infrastructure for future network deployment/provisioning. Dig once policies are flexible and may come in many forms. The goal and emphasis should be on impacting the rights of way as few times as possible by inviting multiple parties to lay their infrastructure together. While not always feasible, coordinating between circulation infrastructure agencies may help reduce costs and impacts on the local community. In identifying existing infrastructure and planning for future needs, local governments should work closely with any relevant service providers, including water districts, utilities and others.

Infrastructure needs of Disadvantaged Unincorporated Communities

In 2011, local governments were required to plan for infrastructure needs of disadvantaged unincorporated communities through Senate Bill 244. The bill requires the land use element to analyze needs for infrastructure in these communities. To ensure consistency, the circulation and land use elements' policies and programs should be coordinated. For additional information on planning for disadvantaged unincorporated communities, see the Land Use Element chapter of the GPG and Senate Bill 244: Land Use, General Plans, and Disadvantaged Communities Technical Advisory.

Broadband

Both state and federal governments are implementing various funding programs that serve the goal of expanding broadband access to unserved and underserved areas. Within California, the California Public Utilities Commission (CPUC) manages the California Advanced Services Fund (CASF), which invests hundreds of millions of dollars annually in broadband deployment. The state also created the California Emerging Technology Fund (CETF), which was designed to be a public-purpose venture capital fund.

Dig once policies can substantially reduce costs for providing broadband service to communities. A new provider can run fiber through leased conduit space at a fraction of the costs, incentivizing more private actors to deploy or reducing costs to the city if self-provisioning broadband services. For example, if conduit construction was promoted along ongoing civil work projects, fiber deployment costs drop by $30,000- $100,000 per mile. On average, 60 to 90 percent of network deployment costs come from civil works as opposed to equipment and maintenance.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Understanding transportation choices and multi-modal needs	Percentage of pedestrians and bicyclists commuting to work and other trips (National Household Travel Survey, California Household Travel Survey, American Community Survey)
Identifying necessary safety improvements	Number or % of injuries and fatalities (Transportation Injury Mapping System)
Analysis of existing and needed active transportation networks	Transit stops and centers, existing and planned bicycle routes, pedestrian facilities, destination centers

4

Other Considerations

Transportation and Climate Change

Transportation is a significant source of greenhouse gases. In California, transportation is the largest source of emissions: according to the California Air Resources Board, about 37% of the state's GHG emissions come just from vehicle tailpipe emissions,[i] as compared to 28% nationally.[ii] Considering life-cycle emissions (extraction, fuel refining, fuel transport, roadway construction, etc.) in addition to tail pipe emissions, transportation is the source of over half of California GHG emissions. An update to the circulation element presents an opportunity to integrate measures for reducing vehicle travel that are critical to meeting our State's GHG reduction goals.

Strategies to reduce transportation-related GHG emissions fall into three general categories: vehicle efficiency, switching to low-carbon fuels, and reduction of vehicle miles traveled. General plans' most important policy levers focus on VMT reduction, by setting out low-VMT land use patterns and specifying transportation network characteristics and travel demand management strategies. Further, general plans can help jurisdictions become "ZEV-ready", e.g. by specifying provision of alternative fuel fueling and charging stations.

Parking

Many general plans set forth the goal of providing their communities with "adequate parking." Historically, this has meant directing new land use projects to exceed the full demand for free parking. This has resulted in a substantial subsidy to automobile users of roughly $20-40 Billion per year in California.[iii] Free parking is a community choice, but should be recognized as one that entails costs and leads to additional vehicle travel, which in turn can impact community goals for livability, mode shift, environmental protection, emissions reduction, and fiscal benefits.

The circulation element of a general plan provides a jurisdiction the opportunity to evaluate various tradeoffs, including the costs and benefits of parking, in conjunction with other planning goals. Tradeoffs a jurisdiction might consider include:

- Parking demand may change over time due to numerous factors including adjacent land uses, densifying urban development, transit and active transportation infrastructure, and emerging vehicle technologies such as automated vehicles
- Ready parking availability can induce increased vehicle miles traveled (VMT), leading to increased traffic and greenhouse gas emissions.
- Parking requires land that might be occupied by other land use, which may provide greater benefit (including fiscal benefit).
- Parking areas paved with standard asphalt can exacerbate impacts on water quality and runoff control.
- Free parking subsidizes drivers at the expense of transit users, pedestrians, and cyclists.

Many jurisdictions are already confronting parking tradeoffs and addressing these issues by managing parking demand and parking supply.

Managing Demand for Parking

- Support alternative transportation. Travelers by non-auto modes do not require automobile parking. Quality bicycle, pedestrian, and transit access facilities and services (See e.g. City of Berkeley), and development proximate to those facilities, reduce motor vehicle mode share and therefore parking demand. Adequate, convenient, and secure bicycle parking, including around transit stations, facilitates cycling and increases cycling mode share.
- Convert parking to parklets, which increase public space and can improve neighborhood vibrancy.
- When providing on-street parking, design it in a manner that calms traffic and enhances bicycle and pedestrian safety and comfort. This may include reverse angle parking and parking-protected bicycle lanes.
- Attach a cost to parking. Construction and maintenance of parking is costly. Jurisdictions may wish to consider the benefits of optimizing parking prices to reflect the equilibrium between supply and demand, to help improve traffic flow, or to reduce VMT and GHGs. (See e.g. City of San Diego; City of Sacramento) Further, fees collected can be reinvested in a number of ways, including neighborhood benefits districts, that can increase neighborhood vibrancy.

Increased bicycle and pedestrian infrastructure, including shade, pathways, and safety features, help promote activity

Image by Urban Advantage, Cunningham Quill | Architects

Managing Supply of Parking

- Remove minimum parking requirements. Parking restrictions, such as residential parking permit programs, can be implemented to prevent spillover parking. Parking provision can be left to the market, pricing can be deployed, or parking maxima can be provided.
- Set parking maxima. Especially in TOD or mixed-use development areas, establishing maximum parking requirements instead of minimum requirements will mean that space is available for other uses (See e.g. Sacramento County; City of San Jose).
- Manage the use of existing spaces rather than provide additional parking. Prioritize spaces based on location (e.g. proximity to employment centers) and intended use (e.g. short- or long-term). Implement shared parking or establish parking benefit districts. (See e.g. Sacramento County) Optimizing use of existing parking will help make efficient use of land within the jurisdiction's boundaries.

Traffic Control Around Schools

High volumes of pedestrian traffic, vulnerable users, and other factors create increased need for safety around schools. Considerations in roadway design should take in to account the specific needs of the population, including bicycle and pedestrian access, transit and drop off needs, and safety around crosswalks, intersections, and roundabouts. The Safe Routes to Schools National Partnership, with support from CalTrans' Safe Routes to School program, provides guidance and resources for improving traffic control around schools, including signage, pavement markings, signals, and other infrastructure. For additional guidance on traffic control specifically around schools, see the CalTrans Manual on Uniform Traffic Control Devices, including Section 3c on roundabout markings and Part 7 for traffic control around schools.

Addressing Tradeoffs and Maximizing Co-benefits in Circulation

The transportation network should be designed to accommodate multiple competing interests, as well as to maximize co-benefits. Potential areas for co-benefits, such as safer streets through slower traffic, greater economic activity through improved walkability, and increased positive health outcomes through improved active transportation, should be considered in making decisions around transportation.

The circulation element should address the tradeoffs between various interests rather than listing desirable but mutually exclusive outcomes. The following are some of tradeoffs that a circulation element might address. Some of these tradeoffs will involve agencies distinct from the city or county, such as some transit systems, highlighting the importance of coordination between stakeholders involved in circulation planning and implementation.

- Roadway motor vehicle throughput and speed v. impacts on community along roadway
- Roadway motor vehicle throughput and speed v. capacity for other modes

Aligning circulation and land use improves access and creates economic opportunities

Image by Urban Advantage, Clarion

- Roadway design speed and risk to pedestrians and cyclists
- Breadth of coverage of transit system v. cost
- Provision of bicycle facilities v. provision of additional motor vehicle capacity
- Transit priority measures (e.g. signal priority and queue jump lanes) v. automobile capacity
- Accommodation of potential emergency vehicle turning movements v. design for pedestrian safety
- Accommodation of freight vehicles v. pedestrian safety
- Automobile throughput and speed v. traffic calming measures such as narrower travel lanes, roundabouts, raised medians, speed tables, small curb radii, etc.)

Goods Movement

Freight movement is essential for any community to thrive, by allowing the exchange of needed goods and stimulating local and regional economies. Depending upon geography and community characteristics, local governments should plan for goods movement in multiple modes, including air, rail, ship, and truck. A general plan should address transportation improvements that facilitate the timely movement of goods, meet the needs of local business and industry, and support the efficient transfer of goods between truck, rail, and other transportation modes. These interests of goods movement must be balanced with the trade-offs that may include negative impacts to safety, air quality, and noise described in the previous paragraph. Increasing general purpose roadway capacity on a congested roadway may not facilitate freight vehicle travel, due to induced travel effects (mostly passenger vehicles); freight-only facilities may better accomplish this objective.

While freight moves throughout the state in multiple ways, trucks specifically:

- Emit diesel particulate matter (DPM), which is a localized pollutant that is particularly hazardous to human health
- Generate high noise levels
- Pose special collision hazards because of their size, especially to vulnerable road users, and especially during turning movements, where rear wheels can follow a shortcut-track and collide with pedestrians and cyclists

For these reasons, truck routes should be designed to minimize risk to areas containing concentrations of sensitive receptors and vulnerable road users. Also, goods movement facilities (distribution centers, rail yards, and ports) should be placed in locations that do not bring high levels of truck traffic near residential areas or schools whenever possible. Engaging school boards, goods distributors, and community members to coordinate the land use element with the circulation element, freight mobility plans, and other relevant efforts may help assess tradeoffs and needs in locating facilities.

Land use and circulation elements may also be coordinated for freight movement in congested or high traffic corridors, such as by designating specific freight zones, lanes, or management practices, to improve efficiency overall. Policies specific to the needs of a community, depending on factors such as density, proximity to goods movement facilities, and average daily traffic (vehicle and non-vehicle) may help ease safety and congestion issues associated with urban freight movement.

Congestion Management Plans

Each county that includes an urbanized area must establish a congestion management agency to prepare and adopt a congestion management plan (Gov. Code §65089). The congestion management plan establishes programs for mitigating the traffic impacts of new development, including deficiency programs where congestion is extreme, and monitoring the performance of system roads. The congestion management plan is expected to link land use, transportation, and air quality concerns. At a minimum it must include all state highways and all principal arterial roads. Performance of the congestion management plan is measured through the land use approval process.

As noted above, many jurisdictions have traditionally focused their circulation elements on automobile transportation, planning to certain "level of service" standards. It is important to note, however, that congestion management law does not require general plans to designate level of service standards for every roadway and intersection, only for the "system of highways and roadways designated by the agency," with special considerations for infill opportunity zones. In fact, there are many reasons that a circulation element should not do so, as noted in this section. Moreover, congestion management plans address far more than just automobile transportation. They must also include an evaluation of the performance of multiple modes of travel and provide a program for travel demand management. Notably, projects identified in a congestion management plan must be consistent with the regional transportation plan, and its sustainable communities strategy, in order to be funded (Gov. Code § 65082). In updating a circulation element, therefore, a local government must put the congestion management plan in a context that includes reductions in vehicle miles traveled, and provides for multiple users of the transportation system, including transit, bicycles and pedestrian transportation.

4

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Sample Policy	Example of Application	Relationship to Other Elements
[City, county] shall design intersections and public right-of-ways to include adequate and safe access for all users including pedestrians, bicyclists, and motorists of all ages and abilities.	San Pablo	Land use, safety, equitable and resilient communities, economic development
[City, county] shall balance commercial goods movement with the health and quality of life priorities of the community by routing heavy truck traffic away from residential zones and promoting safety at rail crossings.	San Pablo	Land use, safety, air quality, equitable and resilient communities, healthy communities
[City, county] shall limit parking within the public right of way based upon considerations of safety, street width, visibility and access to properties	San Pablo	Land use, healthy communities, safety
[City, county] shall establish travel demand management programs to reduce peak-hour traffic congestion and help reduce regional vehicle miles traveled	San Pablo, Pasadena	Air quality, healthy communities, equitable and resilient communities, economic development, climate change
Incorporate Americans with Disabilities Act (ADA) requirements throughout the [city, county], but especially in high-volume pedestrian areas.	City of El Monte	Healthy communities, economic development, equitable and resilient communities
[City, county] shall create indoor air quality guidelines for residential and commercial units located along higher density corridors and areas where increased intensity of use may result in higher levels of vehicular traffic on adjacent streets. Identify recommendations for mitigation, including design standards and public transportation	City of Richnond	Land use, air quality, equitable and resilient communities
[City, county] shall provide safe routes to school for children and families walking, bicycling, and taking public transportation to schools in the community	City of Santa Cruz	Land use, healthy communities

4

Housing Element

Introduction

Providing adequate housing for all residents is a priority for cities and counties throughout California. The housing element implements the declaration of State law that "the availability of housing is a matter of vital statewide importance and the attainment of decent housing and a suitable living environment for all Californians is a priority of the highest order" (Gov. § Code 65580). Provisions in the housing element are more specific and directive than other elements, and contain detailed guidance and reviews. The law also provides the Department of Housing and Community Development (HCD) with unique authority over the housing element.

Housing element updates must be consistent with other general plan elements, including the land use element and diagrams. Integrating considerations of general plan goals and policies through the housing element and each update may improve efficiency by ensuring consistency. Additionally, incorporating a holistic view of the document will allow the housing element to compliment other elements in addressing challenges such as climate change mitigation and adaptation, and working towards local goals, such as promoting infill development, Transit Oriented Developments, and healthy, safe, and equitable communities.

Periodic updates assure that local governments "will prepare and implement housing elements…toward the attainment of the state housing goal" (Gov. Code §65581). The law requires that HCD review and certify the housing element and that local jurisdictions submit annual progress reports to HCD. The housing element must be revised and submitted periodically on a four, five, or eight year cycle, depending on various factors (Gov. Code §65588). See the HCD's website for a schedule of statutory deadlines. Specific questions about update cycles and related housing element requirements should be directed to HCD and the HCD website. These Guidelines provide a general overview of the housing element, with links to more detailed information. Because of the more precise requirements applicable to the housing element, users should consult the detailed requirements for each section (following the links provided), including specificity and timelines.

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Conservation	Open Space	Noise	Safety	EJ
Housing	IN STATUTE	RELATED	RELATED	RELATED	RELATED	RELATED	IN STATUTE

■ Identified in statute ■ Closely related to statutory requirements

Completeness Checklist

Local agency staff can use the following checklist to help ensure that the housing element addresses all required issues. Please note that use of this checklist is advisory, and only contains issues that are legally required in Government Code section 65583. Housing elements may include additional content at the discretion of the local jurisdiction. For example, the housing element is well suited to address requirements related to environmental justice and disadvantaged unincorporated communities. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied.

Statutory Citation	Brief Description of Requirement
Gov. Code §65583(c)(8)	Public Participation: description of diligent effort to include all economic segments of the community
Gov. Code §65588	Review and Revise: • Progress in implementation • Effectiveness of the element • Appropriateness of goals- objectives, policies and programs
Gov. Code §65583(a)(1 and 2)	Housing Needs Assessment: Quantification and analysis of existing and projected housing needs Populations and employment trends, including documentation of projections Housing and Household characteristics, including; • Level of payment compared with ability to pay (overpaying households) • Housing stock conditions • Overcrowded households Existing and projected needs for all income levels, including: • Regional Housing Need Allocation (RHNA) • Existing housing need for extremely low income households • Projected housing need for extremely low income households based on RHNA or Census
Gov. Code §65583(a)(7)	Persons with Special Needs: Identification and analysis of any special housing needs including: • Elderly • Persons with disabilities, including developmental disabilities • Large Households • Farmworkers (seasonal and permanent) • Female headed households • Homeless (annual and seasonal) • Other
Gov. Code §65583(a)(9)	At-risk Units: Inventory of at-risk units (10 years from the housing element due date) • Estimate of replacement versus preservation costs • Identification of qualified entities • Identification of potential funding
Gov. Code §65583(a)(5 and 6)	Potential Governmental Constraints: Include an analysis of actual and potential governmental constraints for each of the following: • Land use controls • Building codes and their enforcement • Site improvement requirements • Fees and other exactions • Local processing and permit procedures • Housing for persons with disabilities • Transitional housing and supportive housing as a residential use of property and subject only to those restrictions that apply to other residential dwelli ngs of the same type in the same zone
Gov. Code §65583(a)(5 and 6)	Potential Non-governmental Constraints Include an analysis of actual and potential non-governmental constraints for each of the following: • Availability of financing • Price of land • Cost of construction

Statutory Citation	Brief Description of Requirement
Gov. Code §65583 (a) (3) and 65583.2	Sites Inventory and Analysis: • Listing of properties by parcel number or other unique reference showing for each parcel • General description of environmental constraints to the development of housing • General description of infrastructure (planned/available) including water, sewer and other dry utilities, including availability and access to distribution facilities • For Non-vacant sites, specify the additional development potential for each site within the planning period and provide an explanation of the methodology to determine development potential • Demonstration of zoning to accommodate the housing need for lower income households • Map of sites included in the inventory • Number of units built between the start of the projection period and the deadline for adoption of the housing element (optional) • Number of units proposed using alternative provisions such as rehabilitation, conversion, preservation or accessory dwelling units (optional) • Analysis of whether inventory provides for a variety of housing types (Multifamily rental housing, Factory-built housing, Mobile homes, Housing for agricultural employees, Emergency Shelters, Transitional and supportive housing) • Carryover obligation (AB 1233), if applicable
Gov. Code §65583(b) and (c) (1 through 6)	Quantified Objectives and Housing Programs: Provide statement of quantified objectives; Maximum number of units, by income group, including extremely low-income of: • New construction; • Rehabilitation; and • Conservation.
Gov. Code §65583(c)	Include programs with: • Schedule of specific actions; and • Timeline for implementation with a beneficial impact in the planning period; and Identification of agencies and officials responsible for implementing each program.
Gov. Code §65583(c)(1)	Program(s) providing adequate sites: • Programs to rezone and any other programs needed to address a shortfall of sites to accommodate the regional housing need, if applicable, and any programs included pursuant to Section 65583.2(h) and (i) or carryover obligation pursuant to Section 65584.09. • Programs to rezone and any other programs needed to address a shortfall of capacity for housing for farmworkers that could not be accommodated on sites identified in the inventory, if applicable. • If applicable, programs to facilitate a variety of housing types, including multifamily rental, factory-built housing, mobile homes, housing for agricultural employees, supportive housing, single room occupancy, emergency shelters and transitional and supportive housing.
Gov. Code §65583(c)(2)	Programs to assist in the development of housing for extremely low, very low, low and moderate income households.
Gov. Code §65583(c)(3)	Programs to address governmental constraints and where appropriate and legally possible, to remove constraints to the maintenance, improvement and development of housing.
Gov. Code §65583(c)(3)	Program to remove constraints on housing for persons with disabilities and provide reasonable accommodation for housing for persons with disabilities.
Gov. Code §65583(c)(4)	Program(s) to conserve and improve the condition of the existing affordable housing stock.
Gov. Code §65583(c)(5)	Program(s) to promote housing opportunities for all persons.
Gov. Code §65583(c)(6)	Program(s) to preserve at-risk units.
	Other Requirements
Gov. Code §65583 (c) (7)	Description of general plan consistency.
Gov. Code §65585	Review by HCD and legislative body.
Gov. Code §65588	Analysis of construction, demolition and conversion of housing for lower income households in the Coastal Zone.
Gov. Code §65583 (a) (8)	Description of opportunities for energy conservation in residential development.
Gov. Code §65589.7	Water and Sewer Priority See the HCD Memo at http://www.hcd.ca.gov/hpd/memo_sb1087.pdf. *
Gov. Code §65589.5	Housing accountability act; analysis for rejection.

Required Contents

State law requires the housing element to address particularly detailed statutory requirements. For more information on these requirements, see the HCD's website. A housing element must generally include the following parts, which are described in further detail below and through links:

- Review of previous element
- Housing needs assessment
- Inventory and analysis of adequate sites
- Analysis of potential governmental and non-governmental constraints
- Housing policies and programs
- Quantified objectives

Planning and Zoning Law also requires planning agency staff to: 1) collect and compile public comments regarding a proposed housing element; and 2) provide the comments to each member of the legislative body prior to adoption (Gov. Code § 65585(b)(2)). The scope of the housing element requires a strong relationship to other elements of the general plan, and linkages between sections should be taken in to consideration. The housing element should integrate community health, climate change, and other considerations affecting and affected by housing throughout each section. More information on additional considerations is presented at the end of this chapter.

Public Engagement:

Housing issues affect the entire community, and can be confusing and contentious. The public participation requirement of housing element law presents an opportunity to engage constituents in a dialogue – defining problems and creating solutions. Public participation should include community stakeholders, including residents, and examine how different housing strategies are identified, evaluated, developed, and implemented. An inadequate public participation process may lead to community conflict or anti-development initiatives. Public engagement strategies to address multiple communities are outlined in Chapter 3 of these Guidelines. The housing element must document how outreach and public engagement is carried out, from planning through implementation (Gov. Code § 65583(c)(7)). This documentation should include current and future plans to involve a cross-section of the community in the full process.

Review and Revise:

The review and revise requirement is an important feature of the housing element update. A review facilitates a comprehensive update and ensures that the housing element can be effectively implemented in the next planning period (Gov. Code § 65588). Review and revise requires analysis in three areas:

Progress in implementation: A description of the actual results or outcomes of the prior element's goals, objectives, policies, and programs. The results should be quantified where possible (e.g., number of units rehabilitated) and may be qualitative where necessary (e.g., mitigation of governmental constraints).

Effectiveness of the element: An evaluation of the effectiveness in achieving the objectives of each program, such as analyzing differences between what was projected or planned in the earlier element and what was achieved.

Appropriateness of goals, objectives, policies and programs: A description of what has been learned based on the analysis of progress and effectiveness of the previous element. A description of how the goals, objectives, policies, and programs in the updated element are being changed or adjusted to incorporate what has been learned from the results of the previous element.

Examples of review and revise analysis can be found here.

General Plan Consistency:

The goals, policies, and objectives and various accompanying analyses and text of the housing element must be reviewed in the context of the rest of the elements of the general plan such the land use, circulation, and open space elements (Gov. Code § 65300.5). The element must include a discussion of how internal consistency within the general plan has been achieved and how internal consistency will be maintained throughout the planning period (Gov. Code § 65583(c)(7)). If appropriate, other elements may need to be updated concurrently with the housing element.

Coastal Zone Requirements:

To assist a locality's determination of whether the affordable housing stock in the coastal zone is being protected and provided as required by Government Code Section 65590, the element must contain data on the new construction, demolition, conversion and replacement housing units for low- and moderate-income households within the coastal zone.

Based on this analysis, localities should consider appropriate programs to provide incentives and regulatory concessions in order to preserve housing for low- and moderate-income households within the coastal zone. See also the Coastal Act section of the GPG.

Aligning transportation and land use increases access and vibrancy for all residents

Image by Urban Advantage, Santa Clara Valley Transportation Authority

Internal Consistency in Updates:

Updates to other sections of the general plan often require a review of land use, with consideration to the potential impacts to existing housing stock and the housing element land inventory. For example, should the update of these elements demonstrate that certain parcels within the community would not be able to be developed or require significant mitigation; the sites inventory of the housing element should be updated to reflect these constraints. As a result, new parcels to accommodate the Regional Housing Needs Allocation (RHNA) may need to be identified.

Land Use Element:

Government Code section 65302.10(a) requires that each city and county review and update the land use element of its general plan, based on available data, including, but not limited to, the data and analysis developed pursuant to Government Code section 56430, of unincorporated island, fringe, or legacy communities inside or near its boundaries.

Safety and Conservation Elements: Government Code Section 65302 requires amendment of the safety and conservation elements of the general plan to include analysis and policies regarding flood hazard and management information. In addition, the safety element must be updated to analyze risk and include policies for the protection of the community from any unreasonable risks associated with the effects of wildland and urban fires.

Environmental Justice Element:

Government Code Section 65302(h) (1) requires cities and counties with identified disadvantaged communities to create an environmental justice element, or related goals, policies, and objectives integrated in other elements. The environmental justice element must include objectives and policies to promote safe and sanitary homes.

> Neighborhood-based Policies and Programs: Some jurisdictions will evaluate household and housing characteristics at a neighborhood level to target funding and other programs. For example a jurisdiction could evaluate housing conditions at a neighborhood level to target revitalization efforts or consider tenure and income to better utilize resources for conserving and improving affordable housing stock.

Analysis of Existing Housing Needs

Requirement Description:

An assessment of existing housing needs must include an analysis of population and employment trends and documentation of projections and a quantification of the locality's existing and projected housing needs for all income levels, including extremely low-income households (Gov. Code §65583(a)(1and 2)). The assessment must also include an analysis of household characteristics such as tenure (whether renting or owning) and overpayment; housing characteristics such as overcrowding; and housing stock conditions. The purpose of the assessment is to evaluate existing housing needs to formulate appropriate policies and programs. The assessment can be combined with other areas of the housing element such as evaluation of past programs and comments through public participation. An assessment of housing needs can utilize a variety of quantitative and qualitative information and should use current information when available. An assessment may also evaluate trends over time and consider information or maps at a neighborhood level to better formulate appropriate policies and programs to address existing housing needs in the planning period. Items that must be included, as well as links to more information, are discussed below. The HCD website includes detailed information on housing elements as well as examples, tools, and resources for updating the element. As with all elements of the general plan, the required items provide a base, and jurisdictions can add other considerations as appropriate for their community.

Population and Employment:

In order to understand and prepare for the housing needs of a community, population trends and demographics, including employment trends and needs, must be assessed. The analysis should include current population and employment industry trends, using the most recent Census data available; comparisons in growth rates to countywide and regional rates; and analysis of population by age and other demographic characteristics. Employment analysis should examine shifts and anticipated shifts in employment and the potential impact on the housing market; identification of large employers, job types, and earnings; and analysis of potential methods for improving job-housing relationships.

Existing Housing Needs, Including Extremely Low-income Households:

The element must include a description of existing households by income level, including a specific quantification and analysis of extremely low-income (ELI) households, defined as households with income at 30% or below of area median. Analysis of existing housing needs should include an estimate of existing and projected households with ELI, as well as proposed actions to address identified needs (Gov. Code §65583(a), 65583(c)(2)).

The analysis should assess the resources available to address the housing need, such as the kind of housing available and suitable for ELI households (including Supportive Housing and Single-Room Occupancy [SROs] units) and whether existing zoning permits those housing types.

ELI households often need additional assistance outside of market mechanisms, and may require specific housing solutions such as deeper income targeting for subsidies; housing with supportive services; single-room occupancy (SRO's) and/or shared housing; and rent subsidies (vouchers).

Housing Data

Data for the housing needs assessment may be obtained from many sources. The US Census, American Community Survey (ACS), the Department of Finance and Employment Development Department are the most common data sources for population and employment trends. These data sources can also be used to quantify the number of those living in overcrowded housing conditions, as well as those overpaying for housing. Overpayment data may also be found by utilizing HUD's Comprehensive Housing Affordability Strategy (CHAS) data. Data for at-risk housing can be found via the California Housing Partnership Corporation (CHPC), and data on housing stock conditions may be found by using local sources like a windshield survey or local building department. Many of these data sources are available in one comprehensive site via the General Plan Mapping Tool. Jurisdictions should augment the tool with additional data available locally.

Housing and Household Characteristics

Housing and household characteristics must be assessed in line with population and employment to determine current and future needs for homes available to renters and owners (Gov. Code §65583(a)). A quantification and analysis of household characteristics addresses the number of households and trends and evaluates various factors such as tenure and the level of payment compared to their gross income or the ability to pay (overpayment).

An analysis of overpayment must identify and analyze the number of lower-income households, by tenure, paying more than 30 percent of their gross income for housing and the number of households who pay 50 percent or more of their gross income for housing (Gov. Code §65583(a)). Where possible, the analysis should also identify households most significantly impacted by cost burdens (large families, seniors, etc.). The analysis should also identify potential resources and programs to address the need.

A quantification and analysis of housing characteristics must address housing stock conditions and overcrowding to help determine housing need, potential health impacts, and possible reduction of affordable housing. The analysis can also address a variety of characteristics related to housing such as housing units by type (e.g., single family, multifamily, manufactured housing) and their conditions, housing units by age, vacancy rates, rent and sales prices, and the development patterns of the housing stock by various characteristics.

Analysis of Projected Housing Needs

Requirement Description:

The housing element process begins with HCD allocating a region's share of the statewide housing need to the appropriate Councils of Governments (COG) based on Department of Finance population projections and regional population forecasts used in preparing regional transportation plans (Gov. Code §65583(a)(1)). The COG develops a Regional Housing Need Plan (RHNP) allocating the region's share of statewide need to the cities and counties within the region. The RHNP is generally required to promote objectives that align with the state's priorities, including increasing the housing supply and the mix of housing types, tenure, and affordability in all cities and counties within the region in an equitable manner; promoting infill development and socioeconomic equity, the protection of environmental and agricultural resources, the encouragement of efficient development patterns; and promoting improved intraregional relationship between jobs and housing. The RHNP should align with the region's Sustainable Communities Strategy (SCS), utilizing infill development plans, development around transit and active transportation, and other policies to reduce GHG emissions and enhance sustainability.

Analysis of Special Housing Needs

Requirement Description:

Statutes require an analysis of specific categories of persons with special housing needs, including the elderly; persons with disabilities, including developmental disabilities; large families (households with 5 or more persons); farmworkers; families with female heads of households; and families and persons in need of emergency shelters. Each of these analyses must include detailed quantitative and qualitative data, including estimates of the number of persons in each category, discussions of available and needed resources, identification of housing types and numbers, and analysis of specific needs for identified categories (Gov. Code §65583(a)(7)).

Additional considerations and categories should be identified by each community and analyzed as appropriate. These may include transitional housing, assisted living, homelessness, and any other special housing needs specific to the jurisdiction. Consideration of homelessness specifically may affect estimates of needed housing. The need for emergency shelter must be assessed based on annual and seasonal need, and may be reduced by the number of supportive housing units that are identified in an adopted 10-year plan to end chronic homelessness. To be credited toward the need, these supportive housing units must be either vacant or have funding identified for construction during the planning period.

For assistance with the analysis of housing needs, including a discussion of resources such as existing housing, services and needs, cities and counties should contact local service providers. These include continuum of care providers, local homeless shelter and service providers, food programs, operators of transitional housing programs, local drug and alcohol program service providers, county mental health and social service departments, local Salvation Army, Goodwill Industries, churches and schools. Additional information on local services and needs may also be available by contacting one of 15 countywide Designated Local Boards certified by the HCD's Emergency Housing and Assistance Program.

Sites Inventory and Analysis

Requirement Description:

Local governments must prepare an inventory of land suitable for residential development, including both vacant and non-vacant sites, and an analysis of the relationship of zoning and public facilities and services to these sites (Gov. Code § 65583(a)(3) and 65583.2). The inventory must address the following components:

Inventory of Land Suitable for Residential Development:

The land inventory must identify specific sites suitable for the development of housing within the planning period that are sufficient to accommodate the jurisdictions share of the regional housing need for all income levels (Gov. Code § 65583). Land suitable for residential development includes vacant sites zoned for residential use, vacant sites zoned for nonresidential use that allow residential development, residentially zoned sites capable of being developed at a higher density, and sites zoned for nonresidential use that can be redeveloped for, and as necessary, rezoned for, residential use. The inventory may also list sites by characteristics such as city owned, proximity to services and amenities, infill and equity opportunity areas, transit and other priority development areas and areas potentially eligible for CEQA streamlining. Access to resources, including water, should also be considered (Pub. Resources Code § 21094.5, 21155.1-21155.4; CEQA Guidelines § 15183.3).

Analysis of Sites and Zoning:

The site specific listing must be accompanied by analysis to demonstrate that the land is suitable for development in the planning period and sites and zoning are sufficient and appropriate to accommodate the jurisdiction's share of the regional housing need for all income levels. This analysis should include whether the impacts of a changing climate will affect the suitability of sites and

Targeting Opportunity Sites

One purpose of the site listing is to allow the housing element to function as a working land use document, showing the community and developers where the City intends to target its growth and accommodate households for all income levels. Some jurisdictions identify sites by various characteristics to focus evaluation, resources, incentives and other actions to promote their intended use. For example, some jurisdictions may denote sites within priority development areas, transit priority areas, downtown areas, city-owned sites, areas meeting proximity criteria for funding (e.g., distance to amenities, infill, etc.).

zoning by subjecting sites to risks such as fire, flooding, sea level rise, seismic activity, etc. More information on these risks can be found in the safety and climate change chapters. Including an analysis of sites identified by the previous housing element update, and the factors responsible for projected housing having been built or not built, may help jurisdictions plan with implementation in mind. The site inventory and analysis must be consistent with the land use element and accompanying diagram. Analysis of sites coordinated with other elements of the general plan, including land use, circulation, and open space, will help jurisdictions identify potential co-benefits toward their local goals. For example, identifying sites for higher density, mixed income, or low income housing near transit centers, active transportation routes, employment centers, services, or parks, may promote health and economic development, reduce GHG emissions and climate change impacts, and assist in affordability and quality of life.

Zoning for a Variety of Housing Types:

The analysis of sites must indicate whether the inventory can provide for a variety of housing types, including multifamily rental housing, factory-built housing, mobile homes, housing for agricultural employees, transitional and supportive housing, single-room occupancy units and emergency shelters. Providing development opportunities for a variety of housing types promotes diversity in housing price, style and size, and contributes to neighborhood stability by offering more affordable and move-up homes and accommodating a diverse income mix. Additionally, needs for housing types vary among jurisdictions, from high density needs in urban areas to smaller scale mid density rental housing, additional dwelling units, and other housing types in suburban and rural areas. Determining the analysis of a variety of housing types must account for a number of specific factors. This includes identification of zoning districts where each of the housing types are permitted, discussion of how development standards and processing requirements facilitate development of each of the housing types; and a description of capacity and its suitability to accommodate development or improvement opportunities

In addition, the statute provides flexibility to local governments in identifying sites to accommodate their share of the regional housing need (Gov. Code § 65583).

Adequate Alternative Sites:

Local governments can address up to 25 percent by income group of their adequate sites requirement, under prescribed conditions, including units that are substantially rehabilitated, converted from market-rate to affordable, or where the affordability of certain multifamily housing units are preserved.

Accessory Dwelling Units:

Local governments can address a portion of their adequate sites requirement through the provision of accessory dwelling units based on a number of factors including the number of accessory dwelling units developed in the prior planning period, community need and resources and/or incentives available that will encourage their development. Accessory dwelling units are a valuable housing type that can facilitate affordability for a variety of housing needs. For more information, see the HCD's website.

Jurisdictions may also use other alternatives to accommodate the regional housing need including units constructed since the beginning of the planning period, motel conversions, potential for manufactured housing on rural lots and sites with permanent housing on military bases undergoing closure or conversion.

Accessory Dwelling Unit Ordinance, Santa Cruz

In 2002, the City Council of Santa Cruz supported staff efforts to increase the pool of affordable housing by initiating a comprehensive strategy and implementation plan for promotion of accessory dwelling units which resulted in adoption of the Accessory Dwelling Unit Ordinance. The plan offered approximately a 1:1 match from city in lieu fees, lower interest mortgage loans, partial subsidy of wages for a construction training program for women, and credit for in-kind staff time funded through the competitive award of a state Sustainable Communities Grant from the California Pollution Control Financing Authority. The city produced manuals and design handbooks distributed at no cost. The two pronged benefit accruing to the city would increase rental housing opportunities and strengthen home owner's ability to retain ownership in an increasingly expensive housing market.

The ordinance reduced the uncertainty and risk of application denial, provided technical and design support, facilitated partial loan assistance at a pre-determined low interest tax rate (4.5% in 2002) and programmatic support through the city approval process. Permit fees were revised and reduced and waived for units deed restricted to low and extremely low income renters by depth of affordability. The city subsidized the wages of construction workers hired through the city's training program. The city has since determined how constraints might be further loosened.

Identification of Zoning for Emergency Shelters

Requirement Description:

Every jurisdiction must identify a zone or zones where emergency shelters are permitted without a conditional use or other discretionary permit (Gov. Code § 65583(a)(4)). The identified zone(s) must include sufficient capacity to accommodate the need for emergency shelter as identified in the housing element, EXCEPT that each jurisdiction must identify a zone(s) to accommodate at least one year-round shelter. Adequate sites can include sites with existing buildings that can be converted to accommodate need. Shelters may only be subject to development and management standards that apply to residential or commercial development in the same zone. However, local governments may apply written and objective standards that include maximum number of beds, off-street parking based upon demonstrated need, size and location of on-site waiting and intake areas, provision of on-site management, proximity to other shelters, length of stay, lighting, and security during hours when the shelter is open.

For more information, see the HCD's technical assistance on zoning for emergency shelters.

Analysis of Governmental and Non-governmental Constraints

Requirement Description:

Governmental: The element must describe and analyze governmental constraints for impacts on housing such as costs, supply and approval timing and certainty (Gov. Code §65583(a)(5) and (6)). This analysis must include constraints in land use controls, codes and enforcement, on and off site improvement requirements, fees and exactions, processing and permit procedures, and housing for persons with disabilities. Other governmental constraints specific to localized areas should also be addressed as appropriate.

The analysis of potential governmental constraints must describe past or current efforts to remove them. Where the analyses identify that a constraint exists, program responses to address and mitigate or remove its effects should be included in the element.

Ordinances, policies, procedures, or measures imposed by the local government that specifically limit the amount or timing of residential development should be analyzed as a potential governmental constraint and mitigated where necessary. The analysis will vary depending on the nature of the measure. In general, the measure and its implementation procedures should be specifically described and analyzed as to the impact on the cost and supply of housing.

Non-governmental: The housing element must include an analysis of non-governmental constraints, including land prices, construction costs, and financing availability. Although nongovernmental constraints are primarily market-driven and generally outside direct government control, localities can significantly influence and offset the negative impact of nongovernmental constraints through responsive programs and policies.

Analysis of Energy Conservation Opportunities

Requirement Description:

The energy conservation section of the element must inventory and analyze the opportunities for energy conservation in residential development such as energy saving features, energy saving materials, and energy efficient systems and design for residential development (Gov. Code §65583(a)(8)). Planning to maximize energy efficiency and the incorporation of energy conservation and green building features can contribute to reduced housing costs for homeowners and renters, in addition to promoting sustainable community design. Such planning, development, and building standards can also significantly contribute to reducing greenhouse gases. Updated policies and programs can address a variety of factors related to energy conservation and even broader environmental goals such as climate change by highlighting the environmental significance and operational benefits of employing energy conservation in the siting, building and retrofitting of decent, safe and affordable housing.

Analysis of Assisted Housing At-risk of Converting to Market Rate Uses

Requirement Description:

The element must include a project inventory of assisted housing that could be converted to market rate rents because of expiration of affordability restrictions in mortgage and/or rental subsidy contracts (Government Code Section 65583(a)(9)). Thousands of publicly assisted housing units in California are eligible to change from low-income to market-rate housing during the next decade due to the termination of various government subsidy programs and/or restrictions on rental rates. These units, known as at-risk units, are a valuable source of affordable housing for families statewide and as a result, the housing element must include a detailed analysis and proactive policies and programs to preserve these at-risk units. The at-risk analysis must prepare an inventory of all units at-risk of conversion within 10 years of the beginning of the housing element planning period, assess the conversion risk, estimate and analyze the costs of replacement versus preservation for units at-risk in the current five-year planning period, identify entities qualified to preserve at-risk units, and specify financing and subsidy resources.

Quantified Objectives

Requirement Description:

Quantified objectives must establish the maximum number of housing units by income category that can be constructed, rehabilitated, and conserved over a five-year time period (Gov. Code §65583(b)).

Housing Programs

Requirement Description:

Local governments have the responsibility to adopt a program that implements the policies, goals and objectives of the housing element through their vested powers, particularly over land use and development controls, regulatory concessions and incentives, and the utilization of financial resources. SB 375 amended sections of housing law to include specific requirements, including timelines and consequences, referenced in these guidelines and described here.

Programs are the specific action steps the locality will take to implement its policies and achieve its goals and objectives. Programs must include a specific time frame for implementation to have a beneficial impact toward the goals and objectives during the planning period. Programs must also identify the agencies or officials responsible for implementation. Effective program descriptions also include immediate, short-term and long-term action steps, proposed measurable outcomes, objectives or performance measures, and specific funding sources, where appropriate (Gov. Code §65583(c)).

All housing elements must include programs to address the following six areas:

Adequate Sites: The sites inventory must demonstrate adequate site capacity with appropriate zoning to accommodate the regional housing need for all income groups. Where the analysis of a local government's sites inventory does not demonstrate sufficient suitable and appropriately zoned sites to accommodate the regional housing need by income level, the element must include a program to make sites available during the planning period with appropriate zoning and development standards including meeting specific statutory

Beneficial Impact: Programs must have a schedule of actions, each with a timeline, to have a beneficial impact on the goals and objectives of the housing element within the planning period. The purpose of the clarification is to ensure program effectiveness in addressing housing needs in the planning period to better assist in meeting the housing objectives, including the objectives of SB 375. Programs must include a definitive date or deadline, or benchmarks for implementation early enough in the planning period to realize "beneficial impacts" and successful program implementation within the planning period.

requirements such as permitting residential development without discretionary action and providing sites zoned for owner occupied and rental multifamily residential uses by right. In addition, sites shall be identified as needed to facilitate and encourage the development of a variety of types of housing for all income levels, including multifamily rental housing, factory-built housing, mobile homes, housing for agricultural employees, emergency shelters, and transitional and supportive housing. In coordination with other general plan elements, aligning siting of adequate sites with goals can help communities improve outcomes, such as promoting infill development to address affordability, climate change, and community health issues.

Infill development and circulation improvements can create lively communities for all

Image by Urban Advantage, Joint Venture: Silicon Valley Network

Assist in the development of adequate housing to meet the Needs of Extremely Low-, Low- and Moderate-income Households: Having assessed and identified the housing needs of extremely low-, very low-, low-, and moderate-income households, including special needs households, localities must employ a sufficient number of strategies to assist in developing adequate housing to meet those needs. To address this requirement, localities can utilize a variety of methods such as proactive outreach with the development community, assisting with funding and land acquisition, streamlining entitlement processes and providing concessions and incentives for development. Jurisdictions may also prioritize funding for certain income levels and special needs and focus efforts in priority growth areas.

Address and Remove Governmental Constraints: For each policy, procedure or requirement identified as a governmental constraint, the element must include programs to address and remove or mitigate the constraint.

Conserve and Improve the Condition of the Existing Affordable Housing Stock: The existing affordable housing stock is a valuable resource and the element must include programs to conserve and improve the existing affordable housing stock. Improvement includes physical activities that improve the housing stock such as rehabilitation. Conservation includes both maintenance activity such as code enforcement in deteriorating buildings or in response to complaints and improvements to the housing stock such as weatherization programs which help reduce housing costs or other actions, policies or programs to conserve the affordability of housing such as a mobile home park preservation ordinance.

The housing element can be a tool to identify and address displacement issues by including policies and programs to replace lost affordable housing, conserve existing housing, encourage new opportunities, provide rental subsidies to existing families, and increase the competitiveness of affordable housing development through removal of governmental barriers, assisting with land assemblage, developing a land banking program, or requiring a set-aide for below market rate units.

Promote Housing Opportunities for All Persons: Since State and federal laws uniformly outlaw most kinds of housing discrimination, the local government's role is to identify program strategies that support and implement these laws and affirmatively further fair housing opportunities for all persons. Such strategies may include consultation with fair housing and counseling organizations in the community to document the incidence of housing discrimination, evaluation of the availability of services and identification of opportunities to promote housing and community development choices throughout the community. At minimum, a local equal housing opportunity program must provide a means for the resolution of local housing discrimination complaints and commitment to disseminate fair housing information and information about housing resources throughout the community.

Preservation of Units At-risk of Converting to Market Rate Uses: The nature of conversion risk varies significantly among projects depending on the type of subsidy and related affordability controls. When units are identified at-risk, the element must include actions to preserve the units such as monitoring, assisting with funding, outreach with developers, meeting noticing requirements and actions to assist tenants. Individual program responses should be tailored to the results of the analyses and specific local situations.

Innovation in Affordable Housing and Regional Housing Needs

Moylan Terrace, San Luis Obispo

The City of San Luis Obispo is the largest employment center in San Luis Obispo County, but many workers choose to live in more affordable surrounding communities. Moylan Terrace – an 80-unit for sale town home project – transforms an existing industrial/manufacturing area for smaller, affordable housing units close to downtown, in the Broad Street Corridor. Tandem parking, variable street setbacks and reduced parking and greater height allow for 24 du/ac. Form based coding encourages density and mixed use residential close to public transit, bike lanes and within walking distance of employment centers. Small by design with efficiencies 28-32% above California energy code requirements, the buildings house structurally independent units in an auto court layout have individual entry off of landscaped courtyards.

The land had been purchased a decade ago by the Housing Authority and held for affordable housing. The City provided a long term forgivable loan to cover impact fees, a direct transfer of in-lieu fees from a separate local development, and will again transfer profits upon sale forward to the next affordable housing project under construction in the city. The Inclusionary Housing Program screens applicants intending to insure occupancy over speculative ownership, with an equity gain back to the Housing Authority IHP if a unit does not go to another low income borrower upon resale.

Parc on Powell, Emeryville

Just north of Oakland and directly across the Bay Bridge from San Francisco, Emeryville grew 46% between 2000 and 2010, with double digit growth projected. The city adopted an Affordable Housing Set Aside program in 1990. Parc on Powell received 900 applications for 36 below market rate units. The site is in a transitional area between medium density residential development to the east and mixed use to the west, and is within a one mile radius of shopping including grocery stores, restaurants, two schools, a walking trail, Amtrak station and bus service, a post office and three public parks.

The 166 unit project includes studio, one-, two- and three-bedroom apartments, live/work units and flexible units with 22% units affordable to renter households below 120%. Density bonus, parking, height and setback concessions allowed a density of 71 units in a 45 du/acre zone. The project repurposed an historic building, and incorporates a municipal recycled water system, highly efficient irrigation and surface water management. Two four-level towers include commercial, live/work and flexible units on the ground floor, and the courtyard between the towers connects to an existing public park. City parking on site is decoupled from the unit cost to reduce on-site parking zoning requirements and reduce rents for households without cars.

Other Considerations

Displacement

The opportunity to promote infill and transit oriented development (TOD) can place significant displacement pressures on existing lower income residents; potentially exacerbating the challenge to address important planning objectives such as climate change. As population continues to grow in California, the pressure on housing grows as well. In these circumstances, programs and policies to address displacement issues may be appropriate, such as policies and programs to prioritize the preservation and creation of housing affordable to lower-income households in TOD and infill areas. Additionally, ensuring that various types of housing supply for multiple income levels continue to be built, while protecting existing residents from market forces has many challenges. HCD has compiled a set of best practices to prevent displacement. California's Statewide Housing Assessment examines the need for diverse housing options in the state, and presents both research and options for local governments. Partnerships and collaborations between private developers, public agencies, community groups, and other stakeholders have utilized creative tools to meet housing needs, such as reduced parking requirements, zoning and building codes that support smaller building footprint and design, set back reductions, height increases and density bonuses.

Climate Change

Location and types of housing affect resource conservation in numerous ways, so are worth considering in conjunction with climate change and resource impacts. Infill development can reduce demand on natural resources, and inclusion of additional conservation strategies can reduce the burden even further. Reducing water and energy use can benefit from policies incentivizing conservation, reuse, and recycling in housing developments.

Development patterns influence greenhouse gas (GHG) emissions. Siting housing near services, transportation options, and jobs increases the effectiveness of a multi-modal transportation system. Further, when affordable housing is not available near jobs, people may have to commute long distances, generating high rates of vehicle miles traveled (VMT) and GHG emissions.

Denser forms of development can increase the effectiveness of these relationships, while reducing travel time, travel costs, and the GHG emissions responsible for elevating the risks of climate change. Smaller footprint and parking requirements, mixed uses, innovative ownership strategies and higher densities typical of affordable housing development, are strategies that can contribute to more efficient development patterns.

Transit accessibility is important for housing, jobs, and the environment. Transit hubs record highest levels of ridership within a quarter to half-mile radius. Studies reveal that public transit ridership drops off dramatically after a distance of four miles from transit stations, particularly for those commuting to and from places of employment, as ridership generally depends on variables including quality, frequency of stops and travel time. Lower income households account for nearly one third of all transit riders, and three quarters rely solely on public transportation. Preserving and increasing housing choice for communities that utilize public transit most will continue to contribute to the reduction of carbon emissions.

The housing element is a critical tool in implementing policies and programs that lower GHG emissions and promoting sustainable development. SB 375. Through the housing element's site's inventory, jurisdictions must plan for where housing development will occur and adopt policies and programs to facilitate the development of housing. The jurisdiction can identify sites and adopt programs that direct growth in areas that promote efficient development patterns and transit use and alternative modes of transportation such as biking or walking. Programs to incentivize development such as mixed-use, affordable housing, and transit oriented development could include flexible development standards, fee reductions, expedited processing, and offer by-right permitting of projects that meet sustainability objectives. In addition, the housing element focuses on opportunities for rehabilitation and preservation of existing housing. This provides an important tool to target housing rehabilitation dollars to preserve older housing stock and achieve various objectives such as energy efficiency, health and transit options.

Finally, the impacts of climate change on housing affordability, insurability and viability should be considered.

Utilizing guidance included in the safety element, climate change chapter and the Integrated Climate Adaptation and Resiliency Program (ICARP) can help guide the process of addressing climate change.

Health

Housing affordability significantly impacts health. Affordable housing can provide increased stability, which allows families more resources for other goods and services, health care needs, and basic necessities such as healthy food. Housing location also affects access to parks, recreation, and grocery stores with healthy food, jobs, schools, and other community necessities. Positive health benefits, including decreasing stress-related illnesses associated with long drive times and increased physical activity result from locating housing thoughtfully. Housing opportunities for all income levels should be incorporated throughout cities and counties, rather than concentrated in existing low income neighborhoods. Distribution of affordable housing opportunities, through land use and zoning decisions as well as other tools, can ensure a jurisdiction's commitment to affirmatively furthering fair housing, maintaining equity, and improving health outcomes.

Neighborhoods designed to facilitate active transportation - walking, and biking - facilitate weight control and other health benefits. Walkability is influenced by neighborhood design and accessibility to transit, employment, schools, services and recreational opportunities and amenities. "Safe routes to school," for example, is an important benefit for parents and children. New housing development presents a significant opportunity to engage developers in enhancing the surrounding built environment to promote the health and well-being of residents. Construction and reconstruction efforts can coordinate with infrastructure upgrades, new transit and active transportation facilities, and open space facilities as part of the development project. Cities and counties should consider the needs of the existing community and projected new members and collaborate with developers and stakeholders throughout the process when possible.

Multifamily housing developments are often used as platforms for integrating healthcare, especially for the elderly. A number of housing developments in major metropolitan areas include health clinics and community spaces, and tenant services for special needs populations such as elderly and disabled. Supportive services have multiple benefits, for both tenants and property management. Integrated service delivery plays a critical role with populations at risk of homelessness or institutionalization.

The quality of housing available impacts the health of residents and community members. Factors such as indoor air quality, mold and moisture, pests, safe drinking water availability, lead, and second-hand smoke affect the safety and health of residents' homes. Housing policies can direct housing quality by mitigating or preventing health impacts. For more information on relationships between housing and health, see the air quality and healthy communities chapters. SB 1000 now requires jurisdictions with disadvantaged communities to address promotion of safe and sanitary housing particularly for that population. See EJ section for more details.

Economic Development

Stable housing (adequate, safe and affordable) is a foundation for family economic well-being and thriving communities. Families in stable housing have more income in their budget available for basic living necessities, such as food, utilities, transportation to and from work, school, day care, and healthcare. Planning housing connected to transit, employment centers, services, schools, and destinations reduces living costs and also reduces greenhouse gas emissions.

As a communitywide asset, adequate, stable housing can boost the surrounding economy, through increased local spending, employment, and revenues for local governments. Cost of shelter is the largest, non-negotiable expense for most families. When this cost is excessive, families fall behind on rent or mortgage payments, have little or no disposable income, and often go without food, utilities, or healthcare.

Employers and regional economies are at competitive disadvantages without a sufficient supply of affordable housing. A survey of 300 companies found that one in the three reported that the lack of affordable housing nearby impacts the ability to attract or retain qualified entry- and mid-level workers.

The housing element is a jurisdiction's primary tool to address issues of overcrowding, rehabilitation, and access to affordable housing opportunities. Through the housing element's public participation process, the jurisdiction has an opportunity to identify those housing issues in the community that are of most concern and include policies and programs to address those concerns.

The Location Affordability Index (LAI) gives estimates of the percentage of a family's income dedicated to the combined cost of housing and transportation in a given location. The goal of the LAI is to help individuals, planners, developers, and researchers get a more complete understanding of the costs of living in a given location by accounting for variations between households, neighborhoods, and regions, all of which impact affordability.

Education

Affordable housing is a key ingredient for the educational well-being of families, facilitating educational attainment. Stable and safe housing provides a learning environment. Studies indicate that stable home environments are critical to educational outcomes. Areas of socioeconomic distress may have additional needs for educational support.

The housing element can provide the linkage between housing and education through identifying key resources and policies to promote safe, decent, stable and affordable housing and educational attainment. For example, the sites inventory of a housing element can identify housing opportunities near schools, libraries, and educational services, promote policies to increase affordable housing opportunities, and encourage affordable housing developments to include essential educational programs. Coordination between housing and local school districts can help achieve mutual goals and benefits.

Infill

Housing that is affordable to a broad range of households and income groups is constrained in many communities. Infill development can be an attractive option for accommodating growth and providing a mix of housing choices in many communities – particularly as it can result in lower municipal costs for both capital improvements and long-term operations and maintenance as compared to "greenfield" development. Infill development provides an opportunity to revitalize economically-underutilized land, and also conserves resources and provides environmental and health benefits. Infill development also has the potential to reduce GHG emissions to the extent that it spurs more pedestrian activity, increases transit usage, and reduces the number and lengths of trips. Infrastructure and utilities must be able to support the infill envisioned through the general plan so it is important to coordinate planned infill priority areas with Capital Improvement Plans and other infrastructure investment planning.

The sites inventory requirement of the housing element is one opportunity for identifying opportunities for infill development.

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate A full list of recommended policies can be found here.

Sample Policy	Example of Application	Relationship to Other Elements
[City, county] shall encourage development of residential uses in strategic proximity to employment, recreational facilities, schools, neighborhood commercial areas, and transportation routes.	Long Beach	Circulation, land use, healthy communities, economic development, climate change
[City, county] shall revise County ordinances and fees to encourage development of secondary dwellings, and further promote secondary dwellings. For example, the County will consider revising road requirements and public facility fees for secondary dwellings or according to home size.	San Luis Obispo County	Equitable and resilient communities, economic development, healthy communities, circulation
[City, county] shall integrate and disperse special needs housing within the community and in close proximity to transit and public services.	Long Beach	Land use, circulation, equitable and resilient communities, economic development
[City, county] shall invest in infrastructure and public facilities to ensure that adequate water, sewer, roads, parks, and other needed services are in place to serve existing and future residential developments.	Kings County	Air quality, healthy communities, equitable and resilient communities, economic development, climate change
The [city, county] shall encourage the development of senior housing and assisted living facilities, especially near transit, recreational facilities, medical centers and hospitals, neighborhoods well served by pedestrian facilities, and access to healthy food.	City of Chino	Healthy communities, economic development, equitable and resilient communities

4

Conservation Element

Introduction

The conservation element describes the jurisdiction's natural resources: land, water, ecosystem services and living resources, and the benefits that these resources provide to the community. The conservation element establishes goals and policies for their retention, enhancement and development. The open space element and the land use element should work in coordination with the conservation element to guide conservation and development, balancing community needs with environmental preservation and the effects of climate change. All three of these mandatory elements must be consistent with the others.

Conservation of environmental and agricultural resources is one of the State's three planning priorities, and helps to achieve the State's climate goals. Land conservation policies may have many benefits. Agricultural land conservation can be a foundation for more permanently preserving lands at the edge of cities for their intrinsic open space values. As agricultural activities produce self-sustaining revenue, agricultural conservation can be amongst the most cost-effective means of protecting open space and promoting infill development. By maintaining a buffer zone between urban developments, agricultural lands can reduce sprawl and help to preserve the unique cultural character of separate communities. Prime agricultural lands also help to conserve key environmental values, including quality soil, air, and water. Finally, agricultural lands can provide a critical role in planning strategies to maintain connectivity of conserved lands, successfully preserving wildlife corridors and wetlands.

This section describes the required components of the conservation element, and provides links to suggested policies and tools to help communities in their updates and help to achieve the State's goals.

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Housing	Open Space	Noise	Safety	EJ
Conservation	IN STATUTE	RELATED	RELATED	IN STATUTE	-	IN STATUTE	-

■ Identified in statute ■ Closely related to statutory requirements

Government Code section 65302(d):
(d) (1) A conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources. The conservation element shall consider the effect of development within the jurisdiction, as described in the land use element, on natural resources located on public lands, including military installations. That portion of the conservation element including waters shall be developed in coordination with any countywide water agency and with all district and city agencies, including flood management, water conservation, or groundwater agencies that have developed, served, controlled, managed, or conserved water of any type for any purpose in the county or city for which the plan is prepared. Coordination shall include the discussion and

evaluation of any water supply and demand information described in Section 65352.5, if that information has been submitted by the water agency to the city or county.

(2) The conservation element may also cover all of the following:

(A) The reclamation of land and waters.

(B) Prevention and control of the pollution of streams and other waters.

(C) Regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan.

(D) Prevention, control, and correction of the erosion of soils, beaches, and shores.

(E) Protection of watersheds.

(F) The location, quantity and quality of the rock, sand, and gravel resources.

(3) Upon the next revision of the housing element on or after January 1, 2009, the conservation element shall identify rivers, creeks, streams, flood corridors, riparian habitats, and land that may accommodate floodwater for purposes of groundwater recharge and stormwater management.

Completeness Checklist

Local agency staff can use the following checklist to help ensure that the draft conservation element addresses all required issues. Please note that use of this checklist is purely advisory, and only contains issues that are legally required and the optional issues listed in Government Code section 65302(d)(2). Conservation elements may address additional issues at the discretion of the local government. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied.

Statutory Citation	Brief Description of Requirement
Gov. Code, §§ 65302(d)(1), 65352.5	Water and its hydraulic force
Gov. Code, § 65302(d)(3)	Floodwater Accommodation
Gov. Code, § 65302(d)(1)	Forests
Gov. Code, § 65302(d)(1)	Soils
Gov. Code, § 65302(d)(1)	Rivers and other waters
Gov. Code, § 65302(d)(1)	Harbors
Gov. Code, § 65302(d)(1)	Fisheries

Statutory Citation	Brief Description of Requirement
Gov. Code, § 65302(d)(1)	Wildlife
Gov. Code, § 65302(d)(1)	Minerals
Gov. Code, § 65302(d)(1)	Other natural resources
Gov. Code, § 65302(d)(2)	Reclamation of land and waters (optional)
Gov. Code, § 65302(d)(2)	Pollution of streams and other waters (optional)
Gov. Code, § 65302(d)(2)	Land use in stream channels and other areas (optional)
Gov. Code, § 65302(d)(2)	Erosion (optional)
Gov. Code, § 65302(d)(2)	Protection of watersheds (optional)
Gov. Code, § 65302(d)(2)	Rock, sand, and gravel resources (optional)

Required Contents

The conservation element must address the "conservation, development, and utilization of natural resources including

- Water and its hydraulic force
- Forests
- Soils
- Rivers and other waters
- Harbors and fisheries
- Wildlife
- Minerals, and other natural resources

The Government Code further requires the conservation element to "consider the effect of development within the jurisdiction, as described in the land use element, on natural resources located on public lands, including military installations" (Gov. Code § 65302(d)(1)). Evaluation of a jurisdiction's natural resource systems based on sound science and ecological principles is an important first step in preparing the conservation element. One role of the conservation element is to establish policies that reconcile conflicting demands on those resources. In recent years, some jurisdictions have adopted policies related to mitigation banking, conservation easement programs, and the state and federal Endangered Species acts in their conservation elements. Other local jurisdictions have incorporated policies related to regional greenprints or Natural Community Conservation Planning (NCCP) programs. Both of these methods present a broad-based approach to the regional protection of plants and animals and their habitats while allowing for compatible and appropriate economic activity. The California Department of Fish and Wildlife, Department of Conservation, Natural Resources Agency, and Department of Water Resources are some of the many resources available for examining current and future conservation needs. In addition, resource data is available for jurisdictions through the General Plan Mapping tool. Jurisdictions should assess the current condition of their natural resource systems, the ecological processes and compatibilities upon which they depend and their sustainability based on anticipated uses. Analysis of the sustainability of resource uses should take into account changing burdens on local ecosystems as a result of a changing climate or other environmental conditions, and should measure the values that these resources contribute to the community and state (see above sidebar on nature's services). In their evaluation of natural resources, local governments should identify priority areas to conserve that offer the most effective and efficient protection of the natural resource systems, and focus policies on those resources or areas. Greenprints, or sustainability plans seeking to balance conservation with growth, are one example of incorporating "green infrastructure" into general plans (see more in text box).

Local governments can dramatically impact the type and amount of water used and conserved within their jurisdictions through land use decisions. For example, requiring more compact development types can significantly reduce per capita water use. Limiting new impervious cover in key recharge areas can protect groundwater supplies. Low impact development strategies such as green roofs, bioretention, and soil amendments, can redirect storm water from sewer lines to recharge areas, and thereby enhance water supplies. The California Water Plan provides strategies, resources, and tools for water management and conservation throughout the State.

The following sections include descriptions of each of the requirements with links to model policies and useful information. Some of the requirements will not be locally relevant for all communities. For example, a land-locked county with no river ports would likely not need to address harbors in its conservation element. It is up to the jurisdiction to choose how to arrange their treatment of the various required issues, which may overlap with one another when addressed in the conservation element's goals and policies.

Planning with conservation in mind can create thriving spaces in the community

Image by Urban Advantage, Community Design + Architecture

Water and Its Hydraulic Force

Requirement Description:

The discussion of water in the conservation element must be prepared in coordination with "any countywide water agency and with all district and city agencies, including flood management, water conservation, or groundwater agencies that have developed, served, controlled, managed, or conserved water of any type for any purpose in the county or city for which the plan is prepared," and must include any information on water supply and demand (Gov. Code § 65302(d)(1)).

Specific information must be shared with groundwater agencies. The Sustainable Groundwater Management Act (SGMA) allows local jurisdictions to customize groundwater plans based on their specific needs. Discussion of water should analyze water needs for domestic, agricultural, ecological and industrial uses, and provide for the conservation of water supplies and protection of aquatic ecosystems as a beneficial use. Land use choices affect water demand long into the future. When evaluating the feasibility of possible land use patterns, cities and counties should work with water agencies to consider projected available water resources under a changing climate, and water conservation measures to ensure a sustainable water supply, rather than simply deferring to water

Natural Resources as Nature's Benefits; Greenprints and Conservation

A conservation element can include a quantification and explanation of the benefits that the community obtains from their surrounding ecosystems. Communities' well-being depends on the benefits that nature provides for free, every day and everywhere. For example, we depend on ecosystems such as forests and wetlands, for clean water, fertile soils, food, fuel, storm protection, minerals and flood control.

These benefits, often called "nature's benefits," are commonly categorized into four broad categories. Provisioning benefits include the production of food and water, while regulating benefits include the control of climate and disease. Supporting benefits include nutrient cycles and crop pollination. Lastly, cultural benefits include spiritual and recreational opportunities. To help inform planning decisions, these benefits can be assigned economic values, values that measure other non-monetary benefits to the community, and values that demonstrate the benefits gained when various natural resources mutually reinforce each other. These benefits and services can be expressed in a "Greenprint," such as those developed under the federal sustainable communities initiative, which can help local governments to analyze and plan for these cross-cutting and community-supporting benefits in their general plan updates and apply innovative and successful strategies for implementation. For more information on ecosystem services see

http://www.fs.fed.us/ecosystemservices/

http://www.nature.org/science-in-action/ecosystem-services.xml

agencies to meet any projected demand. Jurisdictions may want to form joint committees to synchronize planning timelines between water and land use, coordinate with local integrated regional water management plans (IRWM), consider using watersheds as their planning area, or explicitly acknowledge their relationship to an existing watershed. Smaller urban development footprints (i.e. concentrated development) protect and enhance the watershed, improving water supply, flood management, and water quality. The California Water Plan currently projects diminishing reliability in water supplies of 3-5% in the next twenty years. Existing water sources may also become less reliable due to climate change and development. The conservation element is inextricably connected to the land use and open space elements.

The decision in *County of Amador v. El Dorado County Water Agency* helps to further clarify the relationship between availability of water and development: "in determining whether and where to permit development, a county must necessarily consider the availability of consumptive water supplies. If additional water supplies are available, growth and development are feasible. Conversely, if that water is not available, growth is necessarily limited." The Government Code and Water Code additionally require water supply districts to prepare water supply verifications and assessments for some large-scale projects, including subdivisions of over 500 dwelling units (Gov. Code § 66473.7)). When amending its general plan, a jurisdiction shall coordinate with any public water agency pursuant to Government Code section 65352.5 to analyze available water supply information and identify adequate water for anticipated growth. Additionally, Urban Water Management Plans, where required, rely on build-out data from general plans, highlighting the importance of consistency and communication between agencies. For specific projects, the water supply verification comes at the final approval stage of project development, and a subdivision cannot be approved if adequate water supplies do not exist at this stage. (Gov. Code § 66473.7(b)(1)).

National Flood Insurance Rate Program maps, dam failure inundation maps, information available from the California Department of Water Resources, U.S. Army Corps of Engineers, the Federal Emergency Management Agency and historical data on flooding all provide useful information for identifying flood-prone areas for floodwater management purposes. Aspects of floodwater management must also be addressed in the land use and safety elements, and local governments may want to consider combining these discussions in their general plans (Gov. Code §§ 65302(a), 65302(g)(2)). The Government Code also provides further requirements on development in flood hazard zones as defined in Government Code section 65007(d) in the Sacramento-San Joaquin Valley (Gov. Code §§ 65302.9, 65860.1, 65865.5, 65962, 66474.5).

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Assessment of existing and projected demands on water supply sources	Inventory of quality and boundaries of watershed, aquifer recharge areas, groundwater basins, and other water resources
Risk assessment for flooding	Flood maps
Examination of ability to align policies, zoning, and goals regarding housing built	Number of housing units allocated through SCS
Assessment of potential housing developments	Documented interest by developers and landowners

Forests

Requirement Description:

The conservation element must provide for the management, enhancement, protection, and potential modification of the current agroforestry practices for wildlife protection, watershed protection, recreation, and aesthetic purposes. Possible topics to address include protection of oak woodlands and urban forests, analysis of possible future development within resource areas, the need for suitable and predicted-to-be suitable habitat management for the mitigation of climate change, precipitation retention for watershed management and attenuation of flood waters, aesthetics, cultural use, commercial value of forests, and protection of timber resources subject to timberland production zoning (Gov. Code § 51104(e-g); 51110-51119.5)

California's forests are valuable assets and their conservation provides many benefits to the natural and built environments. As trees grow and develop, their value to the forest ecosystem and climate change mitigation increases. Older trees sequester significantly more carbon than young trees and are necessary for nutrient cycles for nitrogen and phosphorous. These nutrients are limited, and without proper maintenance, could eventually deplete the soil. Trees and source wood left on site significantly contribute to the abundance of biodiversity and the prevention of habitat loss and displacement. Trees in forest and urban areas act as micro and macro climate buffers by moderating temperatures and moisture.

Conservation of forests should be balanced with the proper action to prevent risk from wildfires (see the safety element for more information). As climate change persists and temperatures rise, wildfires will continue to grow in size, frequency, and total area burned. Throughout its history, California experienced frequent fires by lightning and burning regimes, critical in developing the composition, structure, and pattern of vegetation throughout the state's landscapes.

In order to prevent destructive wildfires and restore and maintain resilient landscapes, policies should be developed that are appropriate for local conditions to mitigate potential losses due to wildfire. Policies for mitigating potential losses should also consider approaches to maintain healthy forests, including prescribed burns, fuel breaks, wildfire protection zones, and forest thinning and grazing. Fuel treatment manipulates and removes fuel to reduce fire intensity with methods such as lopping, chipping, crushing, piling, and burning. Fuel treatment is critical to enhance protection of forests as well as develop resilience. As a guiding resource, OPR's Fire Hazard Planning Technical Advisory includes a detailed discussion about how to incorporate and comply with the fire hazard requirements in a general plan.

Forest conservation practices also present the opportunity to conserve species in their native habitat. Collaboration with local tribes, resource conservation districts, non-government conservation organizations, and other government entities may help determine the best tools for ecosystem restoration, wildfire prevention, and wildlife habitat enhancement.

The management and protection of forests should take into account anticipated changes in coming decades in temperature, the viability or presence of particular wildlife populations in response to warming trends, and the impact on forestry resources of increased extreme weather events and more intense forest fire seasons. For reference, visit http://www.fs.fed.us/maps/.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Analysis of conservation needs	Type, location, amount, and ownership of forests by category
Reduce risk of wildfire and post-fire mitigation needs	Fire hazard zone maps

Soils

Requirement Description:

Soils provide the fundamental resources necessary for the production of food, fiber and other agricultural products. Healthy soil resources, rich in soil organic matter, are essential to crop production, watershed functioning, carbon sequestration, and the support of vegetation. Highly productive soil resources that support agricultural production and ecosystem services are a finite resource; thus requiring long-term conservation. Soil management and conservation practices, such as cover cropping, crop rotation, mulching, and nutrient management, may help support healthy soils and conservation goals.

The Official Soil Series Descriptions (OSDs) and the Storie Index provide useful tools for assessing and inventorying farmland soils, as does the Farmland Mapping & Monitoring Program of the state Department of Conservation. Consultation with the city or county's local Resource Conservation District may also be helpful in assessing soil resources and developing policies focused on the management of agricultural soils; consistent with the Resource Conservation District's broader agricultural strategy. The conservation element should identify soils necessary for agricultural production and include policies that promote the conservation of these resources. Preservation of prime agricultural land, and identification of water availability for that land, can be a foundation for improving and maintaining soil while more permanently preserving lands, improving the economy, and preserving biological resources, and should be coordinated with the land use element. Local governments should identify areas included in agricultural preserves under the Williamson Act (Gov. Code § 51200). Additionally, conservation easements on agricultural lands, working with willing landowners and land trusts, can also serve to protect soil resources and constitute feasible mitigation to lessen impacts on agricultural resources, including highly productive soils. The soils section may also identify areas subject to slides and erosion and include policies focusing on erosion prevention, one of the optional issues listed in Government Code section 65302(d)(2).

Daylighting Existing Waters

Cities and counties across California and the country are recognizing the potential benefits of revitalizing rivers, streams, and creeks long hidden by previous development. Waterways have historically been covered, especially in urban areas, to quickly redirect stormwater, create more room for commercial districts, and enable automobile transport. In the past decade, however, planners have begun to note the possible advantages of daylighting and restoring waterways, including:

- Reducing flooding
- Conserving groundwater
- Reducing heat island effects
- Providing greenspace for the community
- Activating urban spaces

Examples of programs to restore urban waterways include the LA River in Los Angeles, Strawberry Creek in Berkeley, and San Luis Obispo Creek in San Luis Obispo.

Rivers and Other Waters

Requirement Description:

The rivers and other waters requirement examines water quality in local bodies of water. As with water and its hydraulic force, any discussion of water in the conservation element must be prepared in coordination with "any countywide water agency and with all district and city agencies, including flood management, water conservation, or groundwater agencies that have developed, served, controlled, managed, or conserved water of any type for any purpose in the county or city for which the plan is prepared," and must include any information on water supply and demand prepared pursuant to Government Code section 65352.5 (Gov. Code § 65302(d)(1)). Topics to address include identification of existing and potential water pollution sources, the benefits that water resources provide to the community, opportunities for protection and restoration, and identification of water sources for which reclamation is feasible. Policies should take into account the impacts of future development on water bodies and aim to protect or improve water quality. Preservation of flood plains and innovative methods of flood control, such as making "room for the river," can have positive benefits for related elements of the plan. Certain areas may also be important for groundwater recharge.

Rivers, lakes, streams, bays, harbors, estuaries, marshes, and reservoirs might be affected by climate change impacts such as decreased snow pack, changes in precipitation, and sea level rise. Cities and counties should consider taking these projected impacts into account when planning for the protection of their water bodies.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Compliance with total maximum daily load (TMDL) regulations	Current loads, expected project impact

Harbors and Fisheries

Requirement Description:

The harbors and fisheries requirement addresses the development and improvement of port, harbor, and waterway facilities. This issue has significant overlap with the circulation element, and may be combined with it at the local government's discretion. Policies in general plans should be consistent with harbor and port master plans developed under the California Coastal Act (Pub. Resources Code § 30000 et seq.).

Fisheries are an important component of California's economy, and their careful management ensures their viability into the future. Possible topics to address in the fisheries section include evaluation of existing and projected future water quality; temperature; sources of contaminants in bodies of water used for subsistence, recreational, and commercial fishing; expected impacts of climate change on habitat and fisheries and policies that protect and rehabilitate those water bodies; existence and purpose of marine protected areas (MPAs); and preservation of riparian, tidal, and wetland habitat connected to waterways.

Wildlife

Requirement Description:

California is home to a diverse array of wildlife, and the conservation element should provide plans for the protection and preservation of these populations and their habitats. This must include wildlife that is classified as a rare, threatened, or endangered species under state and federal law (Fish & G. Code § 2050 et seq.; 16 U.S.C. § 1531). Planning for wildlife habitats should account for current habitats, health of wildlife, projected changes in such habitat due to climate change, wildlife conservation, furthering responsible development and addressing the needs of a growing human population, habitat connectivity and potential threats to such habitat from development pressures, fragmentation and edge effects. The conservation element's focus on wildlife should be consistent with the State Wildlife Action Plan, California Essential Habitat Connectivity Project, Regional Advance Mitigation Plans, conservation plans developed by the state and regional entities, Habitat Conservation Plans (e.g. California Endangered Species Act (CESA), California Environmental Quality Act Review (CEQA), Lake and Streambed Alteration Program (LSA), Timberland Conservation Program, Natural Community Conservation Planning (NCCP), Conservation and Mitigation Banking, Invasive Species Program, Native Plant Program) and other management plans, and should include coordination with other government agencies involved in wildlife preservation. Due to the considerable overlap between habitat lands and agricultural lands, multiple benefits for wildlife and agriculture may be gained by coordinating conservation plans and strategies. The California Agriculture Vision Document highlights relationships between habitat and agricultural conservation, and presents strategies for the conservation of both.

The Marine Life Protection Act of 1999 (MLPA) recognized the need to safeguard the long-term health of California's marine life. By establishing a statewide network of marine protected areas (MPAs) designed, created, and managed using sound science and stakeholder input, MLPA aimed to protect the diversity and abundance of marine life, the habitats they depend on, and the integrity of marine ecosystems in California. MPAs are named, discrete geographic marine or estuarine areas designed to protect or conserve marine life and habitat. Potential interactions between MPAs and planned land uses may affect wildlife, harbors and fisheries, and other considerations related to conservation and open space in some communities. Cities and counties should consult the interactive MarineBIOS map available from the Department of Fish and Wildlife, or the General Plan Mapping Tool to examine MPAs around their communities.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identify specific tools and approaches to restore natural areas to benefit fish and wildlife as part of a sustainable flood management plan	DWR Conservation Strategy
Project impacts on critical habitat for listed species	Map of critical habitats
Analysis of existing conservation projects	SGC Review of Conservation lands

Minerals and Other Natural Resources

Requirement Description:

According to California Public Resources Code section 2005, minerals "means any naturally occurring chemical element or compound, or groups of elements and compounds, formed from inorganic processes and organic substances, including, but not limited to, coal, peat, and bituminous rock, but excluding geothermal resources, natural gas, and petroleum." While not explicitly required, local governments may also want to consider geothermal, petroleum, and natural gas in their assessment of mineral resources as appropriate. The minerals section should locate and inventory mineral resources designated by the State Mining and Geology Board under the Surface Mining and Reclamation Act (Pub. Resources Code § 2710 et seq.), and include polices that plan for the protection, use, and development of mineral resources. This section should also locate and plan for the protection, use and development of rock, sand and gravel resources, one of the optional issues listed in Government Code section 65302(d)(2) if those resources are found in the jurisdiction.

'Other natural resources' may include agricultural resources, wetlands, urban forestry, air, and energy producing resources. Some cities and counties also include paleontological and archaeological resources in this section. Model policies include those that assess air quality and coordinate with other agencies and jurisdictions to improve it; identify agricultural resources using the Natural Resources Conservation Service's land inventory and monitoring criteria inventory; include plans for the preservation of wetlands; and inventory energy resources including wind, solar, hydroelectric, and biomass resources. Air quality policies should be consistent with regional air quality and transportation plans.

Floodwater Management

Requirement Description:

To address floodwater management in the conservation element, the city or county should collect information concerning its flood plains and its watershed. DWR has updated its Best Available Maps to display the latest floodplains. DWR has expanded the floodplains to cover all counties in the State and to include 100, 200, and 500-year floodplains. The Office of Emergency Services (OES) and DWR have information on past floods and flood levels. Local levee districts and resource conservation may also have information to share.

DWR also completed the 2012 Central Valley Flood Protection Plan (CVFPP), which provides a guide for state participation with managing flood risk along the Sacramento River and San Joaquin River. The CVFPP provides data and analysis that include the locations of flood hazard zones; goals, policies, and objectives based on that data and analysis; and feasible implementation measures designed to carry out these goals, policies, and objectives. The CVFPP includes a Groundwater Recharge Opportunity Analysis, which can also be useful. This document summarizes an evaluation of groundwater recharge project types and general locations that could be used to integrate groundwater recharge and groundwater storage with the flood management system to increase both flood management flexibility and water supply reliability.

DWR also recommends working with applicable agencies to incorporate improvements in flood control channels that provide opportunities for stormwater retention and groundwater recharge, when major upgrades and/or reconstruction are required. Low impact development strategies may also help protect communities from floodwater by redirecting stormwater.

For additional data and analysis related to flood safety, see the safety element. For data and analysis related to identification and annual review of areas subject to flooding, see the land use element.

Optional Issues

Pursuant to Government Code section 65302(d)(2), the conservation element may also cover the reclamation of land and waters; prevention and control of the pollution of streams and other waters; regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan; prevention, control, and correction of the erosion of soils, beaches, and shores; protection of watersheds; protection of habitat connectivity, and the location, quantity, and quality of rock, sand, and gravel resources. Local governments might choose to integrate these optional issues into their analyses of and policies for the mandatory requirements.

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OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here:

Sample Policy	Example of Application	Relationship to Other Elements
[City, county] shall identify and develop a coordinated biological preserve system that includes Pre-Approved Mitigation Areas, Biological Resource Core Areas, wildlife corridors, and linkages to allow wildlife to travel throughout their habitat ranges. Avoid adverse impacts to wildlife movement corridors and nursery sites (e.g., nest sites, dens, spawning areas, breeding ponds).	San Diego County, Yolo County	Land use, open space, climate change
[City, county] shall allow for appropriate public access to open space lands for recreation activities while protecting and restoring the natural ecosystem and minimizing environmental damage, as appropriate	Redwood City	Land use, open space, circulation, equitable and resilient communities, economic development
[City, county] shall in conjunction with new development located along existing creeks and streams and where appropriate, incorporate daylighting for culverted portions or other bank naturalizing approaches for channeled sections as a means of creek and stream restoration.	Redwood City	Land use, open space
[City, county] shall establish a coherent and logical pattern of urban uses that protect and enhance open space and agricultural uses by providing a clear and permanent boundary for urban uses with the [city, county]'s planning area.	City of Livermore	Land use, circulation, housing, conservation, safety, climate change, economic development

4

Open Space Element

Introduction

"California legislative policy strongly favors the preservation of open spaces" (*Gisler v. County of Madera* (1974) 38 Cal. App. 3d 303, 307; see also Cal. Const. art. XIII, § 8). Together with the conservation element, an open space element identifies areas that provide value in an essentially undeveloped condition and creates a plan to preserve such areas. The open space element reinforces the conservation element by guiding the comprehensive and long-range preservation of open space lands that are important to the conservation of the State's natural resources. The conservation element should be used to inform and support both the open space element and the land use element, guiding the identification of resource areas that should remain undeveloped and those that are appropriate for future development. Open space is defined as any parcel or area of land or water that is essentially unimproved and devoted to open-space use (Gov. Code § 65560(b)). Such lands or waters may provide value related to, among other things, recreation, health, habitat, biodiversity, wildlife conservation aesthetics, economy, climate change mitigation and adaptation, flood risk reduction, managed natural resources production, agricultural production, and protection from hazardous conditions.

Because open space issues are broad in nature and overlap those of several elements, consistency among elements must be considered carefully. The open space element is interrelated with other elements, overlapping with the conservation element when referring to open space dedicated to the preservation of natural resources and the managed production of resources; the safety element when considering open space for public health and safety; and the housing and land use elements when determining the suitability of sites for future development.

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Housing	Conservation	Noise	Safety	EJ
Open Space	RELATED	RELATED	RELATED	IN STATUTE	RELATED	IN STATUTE	RELATED

■ Identified in statute ■ Closely related to statutory requirements

Government Code Section 65560

(a) "Local open-space plan" is the open-space element of a county or city general plan adopted by the board or council, either as the local open-space plan or as the interim local open-space plan adopted pursuant to Section 65563.

(b) "Open-space land" is any parcel or area of land or water that is essentially unimproved and devoted to an open-space use as defined in this section, and that is designated on a local, regional, or state open-space plan as any of the following:

(1) Open space for the preservation of natural resources, including, but not limited to, areas required for the preservation of plant and animal life, including habitat for fish and wildlife species; areas required for ecologic and other scientific study purposes; rivers, streams, bays, and estuaries; and coastal beaches, lakeshores, banks of rivers and streams, and watershed lands.

(2) Open space used for the managed production of resources, including, but not limited to, forest lands, rangeland, agricultural lands, and areas of economic importance for the production of food or fiber; areas required for recharge of groundwater basins; bays, estuaries, marshes, rivers, and streams that are important for the management of commercial fisheries; and areas containing major mineral deposits, including those in short supply.

(3) Open space for outdoor recreation, including, but not limited to, areas of outstanding scenic, historic, and cultural value; areas particularly suited for park and recreation purposes, including access to lakeshores, beaches, and rivers and streams; and areas that serve as links between major recreation and open-space reservations, including utility easements, banks of rivers and streams, trails, and scenic highway corridors.

(4) Open space for public health and safety, including, but not limited to, areas that require special management or regulation because of hazardous or special conditions such as earthquake fault zones, unstable soil areas, flood plains, watersheds; areas presenting high fire risks; areas required for the protection of water quality and water reservoirs; and areas required for the protection and enhancement of air quality.

(5) Open space in support of the mission of military installations that comprise areas adjacent to military installations, military training routes, and underlying restricted airspace that can provide additional buffer zones to military activities and complement the resource values of the military lands.

(6) Open space for the protection of places, features, and objects described in Sections 5097.9 and 5097.993 of the Public Resources Code.

Completeness Checklist

Local agency staff can use the following checklist to help ensure that the open space element addresses all required issues. Please note that use of this checklist is purely advisory, and only contains issues that are legally required by Government Code section 65560 et seq. Open Space elements may address additional issues at the discretion of the local government. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied

Statutory Citation	Brief Description of Requirement
Gov. Code § 65563	Long range and comprehensive
Gov. Code § 65563	Plan for preservation and conservation of open space lands, including the following:

Statutory Citation	Brief Description of Requirement
Gov. Code § 65560(b)(1)	Open Space for Natural Resources • Areas required for the preservation of plant and animal life, including habitat for fish and wildlife species; • Areas required for ecologic and other scientific study purposes; • Rivers, streams, bays and estuaries; and • Coastal beaches, lakeshores, banks of rivers and streams, and watershed lands
Gov. Code § 65560(b)(2)	Open Space for Managed Production of Resources • Forest lands, rangeland, agricultural lands (reflecting Department of Conservation agricultural resources maps and inventory) and areas of economic importance for the production of food or fiber; • Areas required for recharge of groundwater basins; • Bays, estuaries, marshes, rivers and streams which are important for the management of commercial fisheries; and • Areas containing major mineral deposits, including those in short supply
Gov. Code § 65560(b)(3)	Open Space for Outdoor Recreation • Areas of outstanding scenic, historic and cultural value; • Areas particularly suited for park and recreation purposes, including access to lakeshores, beaches, and rivers and streams; and • Areas which serve as links between major recreation and open-space reservations, including utility easements, banks of rivers and streams, trails, and scenic highway corridors
Gov. Code § 65560(b)(4)	Open Space for Public Health and Safety • Areas which require special management or regulation because of hazardous or special conditions such as o Earthquake fault zones, o Unstable soil areas, o Flood plains, o Watersheds, o Areas presenting high fire risks, o Areas required for the protection of water quality and water reservoirs and o Areas required for the protection and enhancement of air quality
Gov. Code § 65560(b)(5)	Open Space for Military Support • Areas adjacent to military installations, • Military training routes, and • Areas underlying restricted airspace
Gov. Code § 65560(b)(6)	Open Space for Tribal Resources • Public land containing any Native American o Sanctified cemetery, o Place of worship, o Religious or ceremonial site, or o Sacred shrine • Native American historic, cultural, or sacred sites, that are listed or may be eligible for listing in the California Register of Historic Resources pursuant to Section 5024.1 • Tribal consultation is required to determine the level of confidentiality needed (§ 65562.5)
Save El Toro Assn. v. Days (1977) 74 Cal. App. 3d 64, 73 Gov. Code § 65560(b)	Inventory of the above lands • Include any parcel that is essentially unimproved (i.e., need not be completely vacant)
Gov. Code § 65562(a)	Policies provide that open space “must be conserved wherever possible”
Gov. Code § 65562(b)	Co-ordinated with state and regional plans
Gov. Code § 65564 • § 65566 • § 65567 • § 65910	Action plan • Acquisition and disposal of open space must be consistent with the open space plan • Building permits, subdivision maps and zoning must be consistent with the plan • Open-space zoning pursuant to § 65910 (e.g., exclusive agriculture zones, large-lot zones, overlay zones for hazards areas, etc.) must be consistent with the plan

Required Contents

The Government Code § 65560 requires an open space element to contain detailed information about several categories of undeveloped land. Specifically, the open space element must inventory the following broad categories of open space:

- Open space for natural resources
- Open space for managed production of resources
- Open space for outdoor recreation
- Open space for public health and safety
- Open space for military support
- Open space for tribal resources

The inventory should be reflected on maps, and policies must provide for conservation of such areas wherever possible (Gov. Code § 65562(a)). The General Plan Mapping Tool is a useful tool to help communities identify existing resources, including natural resources, roads, buildings, and demographics, and develop open space inventories accordingly. The tool pulls data from multiple state and federal sources, and allows supplemental data layers from local jurisdictions. The tool allows mapping of known resources, assets, and needs of the community. The local open space plan, together with state and regional plans, must form a comprehensive open space plan (Gov. Code § 65562(b)). Every city and county must prepare, and submit to the Secretary of Natural Resources, an open space plan for comprehensive and long-term preservation of open spaces (Gov. Code § 66563). The plan must include an action program with specific programs to implement the plan(Gov. Code § 65564). These specific requirements are described in greater detail below.

Inventory

Requirement Description:

The open space element must contain an inventory of specified categories of open space resources (*Save El Toro Assn. v. Days* (1977) 74 Cal.App.3d 64, 73). The inventory must include any parcel in one of the listed categories that is: (1) "essentially unimproved" and (2) designated on any local, regional or state open-space plan (Gov. Code § 65560(b)(1)). Note that a particular parcel need not be completely vacant to be included in the inventory. Also, categories of open space are defined in very broad terms in the statute. Thus, designations in local, regional and state plans need not actually use the words "open space" in order to be included in the inventory. In general, a plan should err on the side of inclusion.

Examples of regional and state plans that could include open space designations include, among others:

Sustainable Communities Strategies and alternative planning strategies adopted by metropolitan planning organizations in regional transportation plans

Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs)

Regional greenprints

Regional conservation assessments

Regional park district plans

Agricultural lands designated on Department of Conservation farmland maps

The specific categories of open space that must be included in the inventory are set forth below.

Open space for natural resources

Requirement Description:

The inventory must identify open space for natural resources, including, but not limited to:

Areas required for the preservation of plant and animal life, including habitat for fish and wildlife species. Such areas may include:

- Areas designated in HCPs and NCCPs
- Critical habitat identified pursuant to the Endangered Species Act (ESA)
- Conservation easements
- Marine protected areas (MPAs)
- Areas identified in greenprints and Regional Conservation Assessments (RCAs)
- Parks and trails
- Areas designated by federal, state, regional and local agencies and governments as important habitat
- Existing forest and woodland areas set aside for mitigation
- Areas important for habitat connectivity

Areas required for ecologic and other scientific study purposes. Such areas may include preserves, parks and other land used by universities to study agricultural systems, wildlife habitats, and other natural systems.

Rivers, streams, bays and estuaries; riparian areas; and coastal beaches, lakeshores, banks of rivers

Simple improvements can create better spaces for recreation and activity

Image by Urban Advantage, Canopy

and streams, and watershed lands. Virtually all waters within a jurisdiction should be identified in the open space element. Upland areas connected to such waters should also be identified. Such areas may be identified in basin plans, watershed plans, and other planning documents produced by the State Water Resources Control Board, Regional Water Quality Control Boards, and other regional entities.

SAMPLE OF OPR RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identification of protected areas to preserve	Marine protected areas (MPAs), critical habitat areas, areas identified in local conservation plans
Potential effects of development on water sources	Watershed maps

Open Space For Managed Production Of Resources

Requirement Description:

The inventory must include lands that are used for the production, enhancement, or maintenance of natural resources.

Forest lands must be maintained in an efficient way to support the continued cultivation of timberland (Gov. Code § 51101, § 51102). With an increasing state population, these forest areas need to be protected against encroaching development to preserve their ecological services as well as economic vitality. Timberland Production Zones are designated for the production of timber or compatible uses and should not be converted for urban services.

Forest and rangelands information is available from the California Department of Forestry and Fire Protection's California Forest and Range Assessment. Information regarding agricultural lands is available from the Department of Conservation's maps and inventory, California Protected Areas Database, CCED - California Conservation Easement Database, National Conservation Easement Database (NCED), and Conservation Easements Registry.

Many local governments also produce their own information regarding locally important lands.

Areas required for recharge of groundwater basins: Information regarding groundwater recharge should be available from urban water management plans and integrated water resource management plans. Cities and counties must also confer with any locally designated groundwater sustainability agency (SGMA).

Bays, estuaries, marshes, rivers and streams that are important for the management of commercial fisheries: Information on fisheries is available from the Department of Fish and Wildlife.

Areas containing major mineral deposits, including those in short supply: Information regarding mineral resources is available from the Department of Conservation.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identification of areas to protect in order to maintain groundwater management	Groundwater supply agency, DWR, urban water management plans

4

Open Space For Outdoor Recreation

Requirement Description:

The open space inventory must reflect open space currently used or planned for outdoor recreation. A city or county should consult with any regional park and open space district in identifying such areas. Jurisdictions should inventory existing recreational space, including marine protected areas adjacent to landside parks, and assess present and future demand based on population, demographic, and development trends. Including existing and planned open space for recreation on the land use map can help coordinate future development with anticipated recreational needs.

Access to open space for recreation impacts individual and community health, and should be planned equitably and with accessibility considerations, to ensure underserved communities are included.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Determine level of access to open space facilities	Transit, bike, and pedestrian paths and routes leading to open space centers
Ensure equitable distribution of recreational open space facilities	Demographic information alongside maps of current and planned open space

Open Space for Public Health and Safety

Requirement Description:

Clean air and water, recreational and natural spaces, farms, ranches, and open spaces conducive to active transportation and healthy lifestyles foster health benefits for communities. The inventory should include areas that require special management or regulation because of hazardous or special conditions. These areas are important for protection or enhancement of public health. Hazardous conditions specifically identified in the statute are:

- Earthquake fault zones
- Unstable soil areas
- Flood plains
- Watersheds
- Areas presenting high fire risks
- Areas required for protection of water quality and water reservoirs
- Areas required for protection and enhancement of air quality

(Gov. Code 65560(b)(4)). Information about those areas is available through the State of California Geoportal site. Much of the information and policies related to hazards will also be relevant to the safety element. For additional ideas on data and analysis, see the healthy communities section and safety element.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Risks associated with designated open space areas	Earthquake fault zones, flood plains, and fire risk areas mapped alongside open space
Identification of areas for enhancement or protection of air quality	Air quality levels by area, circulation maps, inventory of trees and greenery

Open Space for Military Support

Requirement Description:

The open space element must identify military installations and training routes. It should include policies for areas adjacent to or related to military activity. For additional information please review the California Advisory Handbook for Community and Military Compatibility Planning.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identify areas to protect from development for military purposes	Mapping of military installations and training routes

Open Space for Tribal Resources

Requirement Description:

Consultation with the appropriate tribes is essential to both accurately identify those areas needing protection, and to protect the confidentiality and dignity of sensitive resources. Jurisdictions must consult with Native American tribes during an amendment or update to a general plan (Gov. Code § 65352). The Native American Heritage Commission can help identify the appropriate tribes to engage in consultation. The following are categories of tribal resources that should be included in the open space element and the inventory of open space resources (Gov. Code § 65560(b)(6)); also see adjacent box):

- Public land containing any Native American sanctified cemetery, place of worship, religious or ceremonial site, or sacred shrine. The Native American Heritage Commission can provide access to such information.
- Native American historic, cultural, or sacred sites that are listed or may be eligible for listing in the California Register of Historic Resources pursuant to Public Resources Code Section 5024.1.

Before the adoption or any amendment of a city or county's general plan, the city or county must conduct consultations with California Native American tribes that are on the contact list maintained by the Native American Heritage Commission for the purpose of preserving or mitigating impacts to places, features, and objects described in Public Resources Code Sections 5097.9 and 5097.993 that are located within the city our county's jurisdiction (Gov. Code § 65352.3(a)(1)). From the date on which a city or county pursuant to this subdivision contacts a California Native American tribe, the tribe has 90 days in which to request a consultation, unless a shorter timeframe has been agreed to by that tribe (Gov. Code § 65352.3(a)(2)).

Government Code § 65560(b)(6):

- Public land containing any Native American
  - » sanctified cemetery,
  - » place of worship,
  - » religious or ceremonial site,
  - » sacred shrine,
  - » burial sites,
  - » historic or prehistoric ruins, or
  - » Native American inscriptions or rock art
- Native American historic, cultural, or sacred site that is listed or may be eligible for listing in the California Register of Historic Resources pursuant to Public Resources Code Section 5024.1
- Tribal consultation is required to determine the level of confidentiality needed (Gov. Code § 65562.5)

Consistent with the guidelines developed and adopted by the Office of Planning and Research pursuant to Government Code Section 65040.2, the city our county shall protect the confidentiality of information concerning the specific identity, location, character, and use of those places, features and objects. (Gov. Code § 65352.3(b)).

In addition, if new areas containing tribal resources are designated as open space after 2005, Government Code Section 65562.5 requires additional consultation. When consulting tribes, refer to Section V of the 2005 Tribal Consultation Guidelines, Supplement to the GPG:

On and after March 1, 2005, if land designated, or proposed to be designated as open space contains a place of cultural significance, and if an affected tribe has requested notice of public hearing under Government Code §65092, then local governments must consult with the tribe. The purpose of this consultation is to determine the level of confidentiality required to protect the specific identity, location, or use of the cultural place, and to develop treatment with appropriate dignity of the cultural place in any corresponding management plan (Gov. Code §65562.5).

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identification of Tribal resources to be protected	Inventory of locations and descriptions of resources, obtained through Tribal consultation

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here

Sample Policy	Example of Application	Relationship to Other Elements
[City/county] shall work with the Park District to seek locations for and the development of neighborhood parks in those neighborhoods which lack park acreage.	City of Citrus Heights	Land use, conservation, healthy communities
[City/county] shall establish an open space acquisition program that identifies acquisition area priorities based on capital costs, operation and maintenance costs, accessibility, needs, resource preservation, ability to complete or enhance the existing open space linkage system and unique environmental features.	City of Riverside	Land use, conservation, economic development, safety
[City/county] shall maximize public benefits in the reclamation of mineral extraction and sanitary landfill areas	City of Rialto	Land use, conservation, safety, climate change
[City/county] shall maintain habitat corridors to connect conservation areas such as parks, [marine protected areas], and open space, protect biodiversity, accommodate wildlife movement and sustain ecosystems	City of Citrus Heights	Land use, conservation, climate change
City/county] shall develop, wherever possible, recreation facilities that have multi-use capabilities and high degree of adaptability to more intensive use or uses as recreation demand changes and/or population density increases	City of Brea	Land use, conservation, equitable and resiliant communities, economic development, healthy communities

4

Noise Element

Introduction

Noise surrounds us; it is a constant presence in everyday life. A noisy community can be an excellent indicator of a healthy community: the noise from busy shops, children playing, and public transportation are all signs of a thriving environment. Noise is often defined subjectively, surrounding busy transportation corridors, recreational areas, construction zones, and schools as unwanted sound, while welcomed when supporting the presence of activity in a commercial business area. In addition, some development goals, such as infill, may create acceptably higher levels of noise. The purpose of the noise element is to ensure that a local planning area limits the exposure of the community to excessive noise levels in noise-sensitive areas and at noise-sensitive times of day.

In 1976, the Department of Health Services Office of Noise Control issued the first Noise Element Guidelines pursuant to Health and Safety Code section 46050.1, followed shortly thereafter by a model noise ordinance.

Although the Office of Noise Control no longer exists, the principles that it developed are still valid and widely used. Its Noise Element Guidelines, which are in Appendix D, are an additional resource that local governments may consult in addition to this chapter to develop noise elements.

Government Code 65302(f):

(1) A noise element that shall identify and appraise noise problems in the community. The noise element shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for all of the following sources:

(A) Highways and freeways.

(B) Primary arterials and major local streets.

(C) Passenger and freight online railroad operations and ground rapid transit systems.

(D) Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.

(E) Local industrial plants, including, but not limited to, railroad classification yards.

(F) Other ground stationary noise sources, including, but not limited to, military installations, identified by local agencies as contributing to the community noise environment.

(2) Noise contours shall be shown for all of these sources and stated in terms of community noise equivalent level (CNEL) or day-night average level (Ldn). The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques for the various sources identified in paragraphs (1) to (6), inclusive.

(3) The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise.

(4) The noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any. The adopted noise element shall serve as a guideline for compliance with the state's noise insulation standards.

Many noise related planning resources are available. The Caltrans Office of Transportation Laboratory publishes the Traffic Noise Analysis Protocol and numerous reports on mitigating transportation noise. The California Airport Land Use Planning Handbook, published by Caltrans' Division of Aeronautics, includes noise information relating to airports. The Federal Highway Administration has published multiple noise reports, including a Construction Noise Handbook, Highway Traffic Noise: Analysis and Abatement Guide, Transit Noise and Vibration Impact Assessment, and Synthesis of Noise Effects on Wildlife Populations.

The process to create the noise element should include, but is not limited to, the following steps:

- Survey the community to determine the type, location and extent of noise incompatibility in the community
- Explore methods of noise attenuation to minimize exposure to excessive noise
- Research methods to protect residences and other sensitive receptors from excessive noise
- Draft implementation measures that offer solutions to existing and foreseeable noise problems

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Safety	EJ
Noise	IN STATUTE	IN STATUTE	RELATED	-	RELATED	-	RELATED

■ Identified in statute ■ Closely related to statutory requirements

Completeness Checklist

Local agency staff can use the following checklist to help ensure that the noise element addresses all required issues. Please note that use of this checklist is purely advisory, and only contains issues that are legally required by Government Code section 65302 (f). Noise elements may address additional issues at the discretion of the local government. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied.

Statutory Citation	Brief Description of Requirement
Gov. Code § 65302(f)(1)	(1) A noise element that shall identify and appraise noise problems in the community and shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for all of the following sources: (A) Highways and freeways.
Gov. Code § 65302 (f)(1)(B)	(B) Primary arterials and major local streets.
Gov. Code § 65302 (f)(1)(C)	(C) Passenger and freight online railroad operations and ground rapid transit systems.
Gov. Code §65302 (f)(1)(D)	(D) Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.
Gov. Code § 65302(f)(1)(E)	(E) Local industrial plants, including, but not limited to, railroad classification yards
Gov. Code § 65302 (f)(1)(F)	(F) Other ground stationary noise sources, including, but not limited to, military installations, identified by local agencies as contributing to the community noise environment
Gov. Code § 65302(f)(2)	(2) Noise contours shall be shown for all of these sources and stated in terms of community noise equivalent level (CNEL) or day-night average level (Ldn). The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques for the various sources identified in paragraphs (1) to (6), inclusive.
Gov. Code § 65302(f)(3)	(3) The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise.
Gov. Code § 65302(f)(4)	(4) The noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any. The adopted noise element shall serve as a guideline for compliance with the state's noise insulation standards.

Required Contents

The noise element should utilize the most accurate and up-to-date information available to reflect the noise environment, stationary sources of noise, predicted levels of noise, and the impacts of noise on local residents. It should be as detailed as necessary to describe the local situation and offer solutions to local noise issues. It must include the considerations of noise levels from:

(A) Highways and freeways.

(B) Primary arterials and major local streets.

(C) Passenger and freight online railroad operations and ground rapid transit systems.

(D) Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.

(E) Local industrial plants, including, but not limited to, railroad classification yards.

(F) Other ground stationary noise sources, including, but not limited to, military installations, identified by local agencies as contributing to the community noise environment.

The general plan's noise element must show contours for these noise sources, to the extent practicable, in either Community Noise Equivalent Levels (CNEL) or Day-Night Average Level (Ldn). These noise contours must be prepared using noise monitoring or accepted noise-modeling techniques. The noise contours must be used as a guide to establish a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise (Gov. Code § 65302 (f)(2), (f)(3)). The noise element must include implementation measures and possible solutions to existing and foreseeable noise issues. Furthermore, the policies and standards must be sufficient to serve as a guideline for compliance with the state's noise insulation standards (Gov. Code § 65302(f)(4)).

The noise element should be used to guide decisions concerning land use and the location of new roads and transit facilities since these are common sources of excessive noise levels. Proposed land uses should be analyzed to ensure they are compatible with existing uses in the surrounding area, especially residential developments and sensitive receptors, such as schools, hospitals, and places of worship. Additionally, construction noise, especially in urban areas, can be mitigated with policies such as limiting construction hours or days.

Definitions

Decibel, dB: A unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

A-Weighted Level: The sound level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

L10: The A-weighted sound level that is exceeded ten percent of the sample time. Similarly, L50, L90, etc.

Leq: Equivalent energy level. The sound level corresponding to a steady-state sound level containing the same total energy as a time-varying signal over a given sample period. Leq is typically computed over 1-, 8-, and 24-hour sample periods.

CNEL: Community Noise Equivalent Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m.

Ldn: Day-Night Average Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after the addition of 10 decibels to sound levels in the night after 10 p.m. and before 7 a.m. (Note: CNEL and Ldn represent daily levels of noise exposure averaged on an annual or daily basis, while Leq represents the equivalent energy noise exposure for a shorter time period, typically one hour.)

Noise Contours: Lines drawn about a noise source indicating equal levels of noise exposure. CNEL and Ldn are the metrics utilized herein to describe annoyance due to noise and to establish land use planning criteria for noise.

Ambient Noise: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Intrusive Noise: That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence, and tonal or informational content as well as the prevailing noise level.

Noisiness Zones: Defined areas within a community wherein the ambient noise levels are generally similar (within a range of 5 dB, for example). Typically, all other things being equal, sites within any given noise zone will be of comparable proximity to major noise sources. Noise contours define different noisiness zones.

Local airports are subject to the noise requirements of the Federal Aviation Administration and noise standards under the California Code of Regulations, Title 21, section 5000, et seq. These standards are designed to encourage the airport proprietor, aircraft operators, local governments, pilots, and Caltrans to work cooperatively to diminish excessive aircraft noise impacts. However, the U.S. Secretary of Transportation must review and approve all local airport noise and access restrictions adopted after 1990, and they must meet specified criteria (49 U.S.C. § 47524).

Proposed school sites within two nautical miles of an airport runway or potential runway in an airport master plan are subject to review by CalTrans Division of Aeronautics (Cal. Code Regs., tit. 21, § 3570, and Ed. Code § 17215). The regulations authorize CalTrans to object to the acquisition or lease of a school site within a 65 decibel annual CNEL aircraft noise contour. If Caltrans recommends against it based on noise considerations, the board may not acquire or lease the site (Ed. Code § 17215(d)).

Specific considerations for noise generated by or related to military facilities can be found in the California Advisory Handbook for Community and Military Compatibility Planning.

Noise Measurement and Modeling

The local planning agency should select the method of measurement or modeling that best suits its needs, either CNEL or Ldn. See Appendix D for more information about these two types of noise measurements and noise descriptors.

Noise should be measured at multiple receptors. The volume of traffic noise, construction noise, and the noise of an environment (such as loud schools, playgrounds, or agricultural areas) depends on many factors, including the location of dwellings and the location and types of trips made in neighborhoods en route to school, work, or shopping.[iv] Measuring noise at multiple receptors throughout a community will ensure that the noise element is accurate. The noise element should address the following:

- Major noise sources, both mobile and stationary
- Ground borne noise, ground borne vibration from public transit, freight trains, or light rail transit lines

- Existing and projected levels of noise and noise contours for major noise sources
- Existing and projected land uses in relation to existing and projected noise sources
- Existing and proposed sensitive receptors, including:
  - Residential land uses
  - Hospitals
  - Convalescent homes
  - Schools
  - Churches
  - Sensitive wildlife habitat, including the habitat of rare, threatened, or endangered species
- Time-of-day, day-of-week, or seasonable variability of noise sources

Projections of future noise sources, noise levels, and anticipated impacts, including health impacts, upon existing and proposed land uses should provide information useful for guiding decisions about land use, locations of noise generating sources, and noise reduction mitigation measures. Mapping noise contours creates an opportunity to engage the community in a practical discussion about noise, and the tradeoffs between noise and other local priorities.

Mitigation Measures

Not all noise can be minimized, and there may even be areas where noise is desired. Some noise sources are inherent to a region, such as noise generated from farming activities in agriculture intensive areas, wildlife noise from nearby habitat, and noise associated with urban infill developments. Creating healthy communities includes minimizing harmful exposure to excessive noise. Local planning areas are encouraged to embrace the noise characteristics inherent to their region and "design with noise in mind" to minimize harmful exposure to excessive noise.

There are many ways to minimize harmful exposure to excessive noise. Mitigation measures include soundproofing with soundproof windows and insulation, landscaping and berms, building design and setbacks, buffer areas, operating hours of major sources, roadway maintenance and traffic flow, quieter pavement strategies, and other techniques.

Noise mitigation measures are not one-size-fits-all solutions: some noise mitigation measures are better suited for some communities than others. For example, while sound walls may be a fitting mitigation measure for a rural area, they may not be the best solution for urban infill areas, because they impair community connectivity. Increased building setback zones or buffer zones are likely not appropriate in more urban areas where land is limited. In areas where available land is limited, alternative mitigation measures should be employed. The noise element should be flexible and consider the different needs of various communities to determine the best measures to minimize exposure to excessive noise.

Caltrans administers several freeway noise control programs. In general, these are applied to residential and school uses that existed before a freeway was constructed. For instance, the New Construction or Reconstruction and Community Noise Abatement programs provide for installation of noise attenuating walls. In addition, the School Noise Abatement Program funds acoustical attenuation of classrooms. Considering possible co-benefits, such as safety improvements, and potential negative implications of soundwalls, such as community isolation and disconnection, is essential to ensure noise mitigation is effective and unobtrusive.

Noise can be the sign of a vibrant community if planned for at appropriate levels and hours

Image by Urban Advantage, Peerless Green

Implementation Measures

Implementation of the noise element may require a variety of methods. Some tools communities may use include

- The adoption of noise impact and attenuation standards, consistent with the noise element guidelines and the Uniform Building Code
- Guidance for zoning and development through the adoption of specified noise mitigation
- The establishment of local standards and guidelines for noise evaluation, including baseline specifications. The evaluation of new residential and other sensitive uses for consistency with noise standards in areas adjacent to major sources of noise
- The review of all land use and development proposals for compliance with noise and land use compatibility standards
- The control of stationary noise at the source through the use of insulation, berms, building design/orientation, buffer areas, staggered operating hours, and other techniques
- The correlation of noise element concerns with the objectives, policies, and plan proposals of the land use, circulation, and open-space elements in order to minimize community noise exposure
- Noise control ordinances-generally used to resolve short-term noise problems, but they can also be helpful when evaluating development that might create a nuisance, or expansion of a major source near sensitive receptors.

Other Considerations

Noise and Health

Exposure to excessive noise can have health impacts.[v] The most common health impact from excessive noise exposure is sleep disturbance. Sleep disturbance can impair cognitive performance, and alter hormone levels, heart rate, sleep patterns, and mood. Other potential health impacts from exposure to excessive noise include increased levels of hypertension, high blood pressure, and cardiovascular disease.[vi]

There are multiple options to minimize excessive noise exposure and reduce potential health impacts. Minimization measures such as soundproofing a residence to reduce outdoor-to-indoor noise and requiring new residences to place bedrooms in the quietest part of the floor plan will minimize exposure to excessive noise and reduce potential health risks.

Ground-borne Vibration and Infill Development Considerations

Ground-borne vibration is manmade noise caused by oscillations of the ground due to explosions, construction, or railway and transit movement. Especially for local planning areas where sensitive use areas are, or will be, located near transit centers or railway lines, ground-borne vibration should be included in the noise element. Ground-borne vibration is already included in the noise section of the California Environmental Quality Act (CEQA) Guidelines Environmental Review Checklist (Cal. Code Regs., tit. 14, § 15000 et seq., Appendix G, subd. XII (b)). Addressing ground-borne vibration in the noise element of a general plan will ensure greater consistency between a general plan and CEQA.

Rail and public transit are key tools for infill development, which helps reduce greenhouse gas emissions and is encouraged as part of the State's planning priorities. Ground-borne vibration associated with new rail and transit should be considered and mitigated during the planning process.

Ground-borne vibration from cars and buses is usually caused by rough or uneven roadways. The repair of any bumps, cracks, and potholes on the roadway surface will dramatically reduce or solve ground-borne vibration from vehicles.

Ground-borne vibration from rail systems typically stems from degraded wheel and rail surfaces. Routine maintenance of wheel and rail surfaces is critical to control ground-borne vibration. When vibration persists despite routine wheel and rail maintenance, other solutions to control vibration from rail systems include:

- Special track support systems such as floating slabs, resiliency supported ties, high reliance fasteners and ballast mats
- Trenches along the railway to act as a vibration barrier
- Reduction in vehicle speed near sensitive use sites
- Building modifications for nearby buildings with vibration-sensitive equipment affected by rail vibration
- Expansion of the rail right-of-way or purchase of a vibration easement

The Federal Transit Authority (FTA) Transit Noise and Vibration Impact Assessment contains further guidelines on ground-borne vibration and various mitigation strategies.

Ground-borne vibration is especially relevant for areas near the route of California's High Speed Rail. The project will stretch from Sacramento to San Diego, with up to twenty-four stations. The project will also invest in local and regional rail lines. Areas near the High Speed Rail route should consider effects of ground-borne vibration in their noise element. See the project's Environmental Impact Report/Statement Noise and Vibration Mitigation Guidelines Technical Appendix for more information.

Resources

Infill Development

- ChangeLab Building in Healthy Infill

Traffic Noise

- Caltrans Quieter Pavement Research Plan
- Caltrans Traffic Noise Analysis Protocol
- Federal Highway Administration Highway Traffic Noise: Analysis and Abatement Guide
- Caltrans Noise and Vibration Studies
- Caltrans Technical Noise Supplement
- Federal Highway Administration's Traffic Noise Model
- Federal Highway Administration, Highway Traffic Noise, Construction Noise Handbook
- Federal Highway Administration, Synthesis of Noise Effects on Wildlife Populations

Airport Noise

- Caltrans Airport Land Use Planning Handbook
- Federal Aviation Administration, Policy, International Affairs and Environment Noise and Emissions

Public Health

- World Health Organization Burden of Disease from Environmental Noise
- World Health Organization Guidelines for Community Noise

Groundborne Vibration Noise

- Federal Transit Authority (FTA) Transit Noise and Vibration Impact Assessment

Construction Noise

- Caltrans Transportation and Construction Vibration Guidance Manual

Military Compatibility Considerations

- California Advisory Handbook for Community and Military Compatibility Planning

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Identify noise sensitive land uses within high impact noise areas	Map of noise contours, land use designations
Plan for potential construction noise in residential areas	Map of planned development areas

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Sample Policy	Example of Application	Relationship to Other Elements
[City/county] shall avoid placing noise sensitive land uses (e.g. residential, hospitals, assisted living facilities, group homes, schools, day care centers, etc.) within the high noise impact areas (over 65 dB CNEL) for (designated airports) in accordance with the (city/county) Airport Land Use Compatibility Plan	City of Riverside	Land use, circulation, healthy communities
[City/county] shall orient buildings such that the noise sensitive portions of a project are shielded from noise sources.	City of San Diego	Land use, circulation, housing, healthy communities
[City/county] shall require new development to include noise mitigation to assure acceptable interior noise levels appropriate to the land use type: 45 dBA Ldn for residential, transient lodgings, hospitals, nursing homes and other uses where people normally sleep; and 45 dBA L eq (peak hour) for office buildings and similar uses.	City of Sacramento	Land use, housing, healthy communities
[City/county] shall protect schools, hospitals, libraries, churches, convalescent homes, and other noise sensitive uses from excessive noise levels by incorporating site planning and project design techniques to minimize noise impacts. The use of noise barriers shall be considered after all practical design-related noise measures have been integrated into the project. In cases where sound walls are necessary, they should help create an attractive setting with features such as setbacks, changes in alignment, detail and texture, murals, pedestrian access (if appropriate), and landscaping	City of Murrieta	Land use, equitable and resilient communities, healthy communities
[City/county] shall integrate noise considerations into land use planning decisions to prevent new noise/land use conflicts.	City of Murrieta	Land use

4

Safety Element

Introduction

The goal of the safety element is to reduce the potential short and long-term risk of death, injuries, property damage, and economic and social dislocation resulting from fires, floods, droughts, earthquakes, landslides, climate change, and other hazards. Other locally relevant safety issues, such as airport land use, emergency response, hazardous materials spills, and crime reduction, may also be included. Some local jurisdictions have chosen to incorporate their hazardous waste management plans into their safety elements.

The safety element directly relates to topics also mandated in the (1) land use, (2) conservation, (3) environmental justice and (4) open-space elements, as development plans must adequately account for public safety considerations and open space for public health and ecological benefits often incorporate areas of increased hazard risk. The safety element must identify hazards and hazard abatement provisions to guide local decisions related to zoning, subdivisions, and entitlement permits. The safety element should also contain general hazard and risk reduction strategies complementary with those of the Local Hazard Mitigation Plan (LHMP). Ideally, the LHMP will be incorporated into the safety element as outlined below in accordance with provision of Assembly Bill 2140, General Plans: Safety Element (Hancock, 2006)(Gov. Code § 65302.6).

The recent introduction of climate risk to the discussion of the safety element, adds a focus on longer term preparation of a community for a changing climate. Policies in a safety element should identify hazards and emergency response priorities, as well as mitigation through avoidance of hazards by new projects and reduction of risk in developed areas. As California confronts mounting climate change impacts, local governments are now required, in accordance with Senate Bill 379, Land Use: General Plan: Safety Element (Jackson, 2015) to include a climate change vulnerability assessment, measures to address vulnerabilities, and comprehensive hazard mitigation and emergency response strategy as explained further in this section

Government Code 65302(g):

(g) (1) A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body; flooding; and wildland and urban fires. The safety element shall include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, military installations, peakload water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards.

(Gov. Code § 65302(g)(4)). Policies may include methods of minimizing risks, as well as ways to minimize economic disruption and expedite recovery following disasters. Since virtually all incidents disproportionately affect individuals with access and functional needs (AFN) (i.e. people with disabilities, seniors, children, limited English proficiency, and transportation disadvantaged). All policies should include consideration of AFN populations.

Climate change will affect and potentially exacerbate the impact of other hazards rather than being solely a distinct hazard with unique impacts. For example, extreme heat and heat waves are existing hazards that will be exacerbated by climate change. The impacts of climate change on the frequency, timing, and magnitude of flooding vary by geography throughout the state. Areas that experience early run off from snow melt coupled with intensified rain or coastal areas experiencing sea level rise may be more greatly impacted by flooding. Hazards that have the potential to be affected by climate change are further outlined in this element and linked resources described below.

Assembly Bill 2140

The federal Disaster Mitigation Act of 2000 (42 U.S.C. § 5121 et seq.), outlines how a Local Hazard Mitigation Plan (LHMP) can be developed individually or through a multi-jurisdictional LHMP. The successful completion of an LHMP makes the jurisdiction eligible to apply for federal Hazard Mitigation Grant Program (HMGP) post-disaster funding, Pre-Disaster Mitigation (PDM) funding or Flood Management Assistance (FMA) funding. See reference in the 44 CFR, Section 201.6(a) and 201.6(a)(2)

At the state level, AB 2140 authorizes local governments to adopt their LHMPs with the safety elements of their general plans (Gov. Code § 65302.6). Integration or incorporation by reference is encouraged through a post-disaster financial incentive that authorizes the state to use available California Disaster Assistance Act funds to cover local shares of the 25% non-federal portion of grant-funded post-disaster projects when approved by the legislature (Gov. Code § 8685.9).

AB 2140 is one of the most important links between general plans and hazard mitigation in California. Adopting the LHMP with the safety element provides a vehicle for implementation of the LHMP. This integration allows hazard mitigation strategies to be

Climate Change

An increasingly important factor affecting disaster management functions is climate change. Climate change reflects new uncertainties and factors shaping and conditioning hazard mitigation planning. Chapter 4.5 in the 2013 California State Hazard Mitigation Plan (SHMP) addresses a specific approach for local communities to evaluate their risk as a result of climate change. The safety element of the general plan plays an important role in ensuring consistency with the Local Hazard Mitigation Plan (LHMP) and the SHMP. The general plan and LHMP both provide a local vehicle for implementation of the SHMP, including the provisions dealing with climate change. The SHMP outlines tools, resources, and a process for addressing climate change at the local level. The resources the SHMP and LHMP guidance materials reference are the same materials referenced in Chapter 8 of the General Plan Guidelines, Climate Change. This provides for consistency across multiple documents such as an adaptation plan, climate action plan, general plan, implementation plan, local hazard mitigation plan, etc.

implemented and local hazard awareness to be upgraded and enhanced. An LHMP must document what existing plans, studies, reports, and technical information were reviewed during the formation of the plan, as well as if and how any of that information was incorporated into the final product (44 CFR, Section 201.6(b)(3)).

Completeness Checklist

Local agency staff can use the following checklist to help ensure that the safety element addresses all required issues. Please note that use of this checklist is purely advisory, and only contains issues that are legally required by Government Code section 65302(g). Safety elements may address additional issues at the discretion of the local government. Because general plan formats may vary, this checklist suggests identifying where the particular government code provision is satisfied.

Statutory Citation	Brief Description of Requirement
Gov. Code § 65302(g)(1)	Identification of unreasonable risks and policies for the protection of the community from such risks.
Gov. Code § 65302(g)(1)	Slope Instability Slope instability leading to mudslides and landslides.
Gov. Code § 65302(g)(1)	Seismic risks, including: Seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; subsidence, liquefaction, and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body • Mapping of known seismic and other geologic hazards. • Address o Evacuation routes o Military installations o Peakload water supply requirements, and o Minimum road widths and clearances around structures
Gov. Code § 65302(g)(2)	Flooding Identify • Flood Hazard Zones • FEMA Flood Insurance Maps • Army Corps of Engineer Flood information • Flood maps from the Central Valley Flood Protection Board • Dam Failure Maps (Office of Emergency Services) • DWR Floodplain Maps • Maps of Levee Protection Zones • Areas subject to inundation in the event of the failure of levees and floodwalls • Historic flood information • Existing and planned development in flood hazard areas • Agencies with responsibility for flood protection Mandatory Goals, Policies, and Objectives • Avoid and minimize flood risks for new development. • Should new development be located in flood hazard zones? If so, what are appropriate mitigation measures? • Maintain the integrity of essential public facilities. • Locate, when feasible, new essential public facilities outside of flood hazard zones, including hospitals and health care facilities, emergency shelters, fire stations, emergency command centers, and emergency communications facilities, or identifying mitigation measures. • Establishing cooperative working relationships among public agencies with responsibility for flood protection. Feasible Mitigation Measures, to implement the policies above.

Statutory Citation	Brief Description of Requirement
Gov. Code § 65302(g)(3)	Wildland and Urban Fires Identification of, and policies for, the protection of the community from, any unreasonable risks associated with wildland and urban fires. State Responsibility Areas and Very High Fire Hazard Severity Zones Consider advice in OPR's Fire Hazard Technical Advisory Identify • CALFire Fire Hazard Severity Zone Maps • Historical data on wildfires • USGS wildfire hazard areas • Existing and planned development within these areas • Agencies with responsibility for fire protection in these areas Mandatory Goals, Policies and Objectives • Protect the community from unreasonable risks • See mitigation measures below. Feasible Mitigation • Avoid and minimize fire risks for new development. • Should new development be located in fire hazard zones? If so, what are appropriate mitigation measures? • Maintain the integrity of essential public facilities. • Locate, when feasible, new essential public facilities outside of fire hazard zones, including hospitals and health care facilities, emergency shelters, fire stations, emergency command centers, and emergency communications facilities, • If essential facilities are located in high fire zones, identify mitigation measures, such as safe access for emergency response vehicles, visible street signs, and water supplies for structural fire suppression. • Establishing cooperative working relationships among public agencies with responsibility for fire protection.
Gov. Code § 65302(g)(4)	Climate Change Adaptation and Resilience Address climate change adaptation and resiliency strategies by using the process in the Adaptation Planning Guide and reflected in referenced tools such as Cal-Adapt. Vulnerability Assessment (Gov. Code § 65302(g)(4)(A)) Create a vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, the following: • Information that may be available from federal, state, regional, and local agencies that will assist in developing the vulnerability assessment and the adaptation policies and strategies, including, but not limited to, all of the following: (I) Information from the Internet based Cal-Adapt tool. (II) Information from the most recent version of the California Adaptation Planning Guide. (III) Information from local agencies on the types of assets, resources, and populations that will be sensitive to various climate change exposures. (IV) Information from local agencies on their current ability to deal with the impacts of climate change. (V) Historical data on natural events and hazards, including locally prepared maps of areas subject to previous risk, areas that are vulnerable, and sites that have been repeatedly damaged. (VI) Existing and planned development in identified at-risk areas, including structures, roads, utilities, and essential public facilities. (VII) Federal, state, regional, and local agencies with responsibility for the protection of public health and safety and the environment, including special districts and local offices of emergency services. Mandatory Goals, Policies and Objectives (Gov. Code § 65302(g)(4)(B)) • Create a set of adaptation and resilience goals, policies, and objectives based on the information above for the protection of the community.

Statutory Citation	Brief Description of Requirement
Gov. Code § 65302(g)(4) CONTINUED	Feasible Mitigation (Gov. Code § 65302(g)(4)(C)) • Create a set of feasible implementation measures designed to carry out the goals, policies, and objectives identified above, including, but not limited to, all of the following: (i) Feasible methods to avoid or minimize climate change impacts associated with new uses of land. (ii) The location, when feasible, of new essential public facilities outside of at-risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in at-risk areas. (iii) The designation of adequate and feasible infrastructure located in an at-risk area. (iv) Guidelines for working cooperatively with relevant local, regional, state, and federal agencies. (v) The identification of natural infrastructure that may be used in adaptation projects, where feasible. Where feasible, the plan shall use existing natural features and ecosystem processes, or the restoration of natural features and ecosystem processes, when developing alternatives for consideration. For the purposes of this clause, "natural infrastructure" means the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days. Other documents (Gov. Code §§ 65302(g)(4)(D)(i), 65302(g)(4)(D)(ii): • If a city or county has adopted the local hazard mitigation plan, or other climate adaptation plan or document that fulfills commensurate goals and objectives and contains the information required pursuant to this paragraph, separate from the general plan, an attachment of, or reference to, the local hazard mitigation plan or other climate adaptation plan or document. • Cities or counties that have an adopted hazard mitigation plan, or other climate adaptation plan or document that substantially complies with this section, or have substantially equivalent provisions to this subdivision in their general plans, may use that information in the safety element to comply with this subdivision, and shall summarize and incorporate by reference into the safety element the other general plan provisions, climate adaptation plan or document, specifically showing how each requirement of this subdivision has been met.
Gov. Code 65302(g)(5) – (g)(8)	Other Considerations: • Cities and counties that have flood plain management ordinances that have been approved by FEMA that substantially comply with this section, or have substantially equivalent provisions to this subdivision in their general plans, may use that information in the safety element to comply with this subdivision, and shall summarize and incorporate by reference into the safety element the other general plan provisions or the flood plain ordinance, specifically showing how each requirement of this subdivision has been met. • Prior to the periodic review of its general plan and prior to preparing or revising its safety element, each city and county shall consult the California Geological Survey of the Department of Conservation, the Central Valley Flood Protection Board, if the city or county is located within the boundaries of the Sacramento and San Joaquin Drainage District, as set forth in Section 8501 of the Water Code, and the Office of Emergency Services for the purpose of including information known by and available to the department, the agency, and the board required by this subdivision. • To the extent that a county's safety element is sufficiently detailed and contains appropriate policies and programs for adoption by a city, a city may adopt that portion of the county's safety element that pertains to the city's planning area in satisfaction of the requirement imposed by this subdivision • Review the safety element for fire and flood impacts upon each Housing Element update, • Review the safety element for climate change at each update to the Local Hazard Mitigation Plan, Jurisdiction may also choose to do a comprehensive review of the safety element upon each housing element update to streamline review.

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Noise	Air Quality	EJ
Safety	IN STATUTE	RELATED	RELATED	IN STATUTE	RELATED	-	RELATED	RELATED

■ Identified in statute ■ Closely related to statutory requirements

4

Required Contents

The safety element must, consistent with Government Code Section 65302(g), provide for the protection of the community from any unreasonable risks associated with the effects of:

- Seismically induced surface rupture, ground shaking, ground failure
- Tsunami, seiche, and dam failure
- Slope instability leading to mudslides and landslides
- Subsidence
- Liquefaction
- Other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body
- Flooding
- Wildland and urban fires
- Climate change

The safety element must include mapping of known seismic and other geologic hazards. It must also address evacuation routes, military installations, peakload water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards.

The safety element must also identify information regarding flood hazards, establish a set of comprehensive goals, policies, and objectives for the protection of the community from the unreasonable risks of flooding, and establish a set of feasible implementation measures designed to carry out the goals, policies, and objectives for flood protection. It is recommended that the safety element do the same for drought impacts.

The safety element must also be reviewed and updated as necessary to address the risk of fire for land classified as

Changes in planning and design can increase community safety and resilience

Image by Urban Advantage, Cunningham Quill | Architects state responsibility areas and land classified as very high fire hazard severity zones. Because climate change will likely increase California's frequency and intensity of fire weather conditions, even historically less vulnerable regions should reevaluate wildfire risk and prevention strategies in their general plan's safety element.

Most of the information needed to complete the analysis for the safety element, can be obtained through a combination of sources: the State Hazard Mitigation Plan and federal requirements outlined in the Disaster Mitigation Act (DMA) of 2000, MyPlan tool, the General Plan Mapping Tool, Cal-Adapt and the Adaptation Planning Guide (APG). Some information may need to be generated at the local or regional level, particularly for those facilities considered critical to the community.

Consultation Requirements

Before the periodic review of its general plan and before preparing or revising its safety element, each city and county shall consult the California Geological Survey of the Department of Conservation, the Central Valley Flood Protection Board, if the city or county is located within the boundaries of the Sacramento and San Joaquin Drainage District, as set forth in Section 8501 of the Water Code, and the Office of Emergency Services for the purpose of including information known by and available to the department, the agency, and the board required by this subdivision. In particular, the Office of Emergency Services can assist local governments with developing their safety element and aligning general plan strategies with those of the local hazard mitigation and emergency operation plans to ensure consistency. The Governor's Office of Planning and Research's Integrated Climate Adaptation and Resiliency Program (ICARP), established by SB 246 (Wieckowski, 2015), also supports local government's compliance with SB 379 (Pub. Resources Code § 71350 et seq.).

Each city and county must provide a draft of its safety element or amendment of its safety element to the California Geological Survey of the Department of Conservation prior to adoption, for review to determine if all known seismic and other geologic hazards are addressed (Gov. Code § 65302.5)(a)). A city or county that contains a state fire responsibility area or a very high fire hazard severity zone must provide a draft of its safety element or amendment of its safety element to the State Board of Forestry and Fire Protection for review before adoption, and the Board may recommend changes regarding uses of land, policies, or strategies for reducing fire risk (Id. at § 65302.5)(b)). Similarly, each city and county located in the Sacramento and San Joaquin Drainage District must provide a draft of its safety element or amendment of its safety element to the Central Valley Flood Protection Board before adoption, and the Board may provide recommended changes regarding uses of land, policies, or strategies for reducing flood risk and protecting areas subject to flooding (Id. at § 65302.7).

Statutory Requirements

This section offers a general guide to the contents of the safety element. Note that while the focus is on the minimum requirements for an adequate safety element, an effective general plan will focus more extensively on those issues of greatest relevance to the community. The effects of climate change in particular will influence emergency management issues through varying impacts across local communities statewide. Increases in average temperature, a greater incidence of extreme weather conditions, and sea level rise all will not only exacerbate existing hazards mentioned in this section, but may also create new hazards where none previously existed.

Useful Definitions

Alquist-Priolo Earthquake Fault Zone: A regulatory zone, delineated by the State Geologist, within which site-specific geologic studies are required to identify and avoid fault rupture hazards prior to subdivision of land and/or construction of most structures for human occupancy.

Climate Adaptation: Adjustment or preparation of natural or human systems to a new or changing environment that moderates harm or exploits beneficial opportunities.

Climate Mitigation (Greenhouse Gas Emissions Reductions): A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. Refer to Chapter 7, Climate Change, for more information.

Critical Facility: Facilities that either (1) provide emergency services or (2) house or serve many people who would be injured or killed in case of disaster damage to the facility. Examples include hospitals, fire stations, police and emergency services facilities, utility facilities, and communications facilities.

Extreme Weather Event: In most cases, extreme weather events are defined as lying in the outermost ("most unusual") ten percent of a place's history. Analyses are available at the national and regional levels.

Fault: A fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. A fault zone is a zone of related faults which commonly are braided, but which may be branching. A fault trace is the line formed by the intersection of a fault and the earth's surface.

Active Fault: A fault that has exhibited surface displacement within Holocene time (approximately the past 11,000 years).

Potentially Active Fault: A fault that shows evidence of surface displacement during Quaternary time (the last 2 million years).

Flooding: A rise in the level of a water body or the rapid accumulation of runoff, including related mudslides and land subsidence, that results in the temporary inundation of land that is usually dry. Riverine flooding, coastal flooding, mud flows, lake flooding, alluvial fan flooding, flash flooding, levee failures, tsunamis, and fluvial stream flooding are among the many forms that flooding takes.

Ground Failure: Mudslide, landslide, liquefaction or soil compaction.

Hazardous Building: A building that may be hazardous to life in the event of an earthquake because of partial or complete collapse. Hazardous buildings may include:

(1) Those constructed prior to the adoption and enforcement of local codes requiring earthquake resistant building design.

(2) Those constructed of unreinforced masonry.

(3) Those which exhibit any of the following characteristics:

- exterior parapets or ornamentation which may fall on passersby
- exterior walls that are not anchored to the floors, roof, or foundation
- sheeting on roofs or floors incapable of withstanding lateral loads
- large openings in walls that may cause damage from torsional forces
- lack of an effective system to resist lateral forces
- non-ductile concrete frame construction

Hazardous Material: An injurious substance, including pesticides, herbicides, toxic metals and chemicals, liquefied natural gas, explosives, volatile chemicals, and nuclear fuels.

Hazard Mitigation: Sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects.

Landslide: A general term for a falling, sliding, or flowing mass of soil, rocks, water, and debris. Includes mudslides, debris flows, and debris torrents.

Liquefaction: A process by which water-saturated granular soils transform from a solid to a liquid state during strong ground shaking.

Maladaptation: Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.

Natural Infrastructure: The preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.

Peakload Water Supply: The supply of water available to meet both domestic water and fire fighting needs during the particular season and time of day when domestic water demand on a water system is at its peak.

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Seiche: An earthquake-induced wave in a lake, reservoir, or harbor.

Seismic Hazard Zone: A regulatory zone, delineated by the State Geologist, within which site-specific geologic, soils, and foundation engineering studies are required to identify and avoid earthquake-caused ground-failure hazards, or selected other earthquake hazards, prior to subdivision of land and for construction of most structures for human occupancy.

Storm surge: An abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

Subsidence: The gradual, local settling or sinking of the earth's surface with little or no horizontal motion (subsidence is usually the result of gas, oil, or water extraction, hydrocompaction, or peat oxidation, and not the result of a landslide or slope failure).

Seismically Induced Surface Rupture: A break in the ground's surface and associated deformation resulting from the movement of a fault.

Tsunami: A wave, commonly called a tidal wave, caused by an underwater seismic disturbance, such as sudden faulting, landslide, or volcanic activity.

Wildland Fire: A fire occurring in a suburban or rural area that contains uncultivated lands, timber, range, watershed, brush, or grasslands. This includes areas where there is a mingling of developed and undeveloped lands.

Climate Change Adaptation and Resilience

Requirement Description:

In accordance with the requirements of SB 379, codified at Government Code section 65302(g)(4), climate change adaptation and resilience must be addressed in the safety element of all general plans in California. Specifically, "upon the next revision of a local hazard mitigation plan, adopted in accordance with the federal Disaster Mitigation Act of 2000 (Public Law 106-390), on or after January 1, 2017, or, if a local jurisdiction has not adopted a LHMP, beginning on or before January 1, 2022, the safety element shall be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to the city or county. This review shall consider advice provided in the Office of Planning and Research's General Plan Guidelines..." (Gov. Code § 65302(g)(4)). This section provides advice to support a jurisdiction's compliance with the requirements of Government Code section 65302(g)(4).

Government Code 65302(g):

(4) Upon the next revision of a local hazard mitigation plan, adopted in accordance with the federal Disaster Mitigation Act of 2000 (Public Law 106-390), on or after January 1, 2017, or, if a local jurisdiction has not adopted a local hazard mitigation plan, beginning on or before January 1, 2022, the safety element shall be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to the city or county. This review shall consider advice provided in the Office of Planning and Research's General Plan Guidelines and shall include all of the following:

(A) (i) A vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, including, but not limited to, an assessment of how climate change may affect the risks addressed pursuant to paragraphs (2) and (3).

(ii) Information that may be available from federal, state, regional, and local agencies that will assist in developing the vulnerability assessment and the adaptation policies and strategies required pursuant to subparagraph (B), including, but not limited to, all of the following:

(I) Information from the Internet based Cal-Adapt tool.

(II) Information from the most recent version of the California Adaptation Planning Guide.

(III) Information from local agencies on the types of assets, resources, and populations that will be sensitive to various climate change exposures.

(IV) Information from local agencies on their current ability to deal with the impacts of climate change.

(V) Historical data on natural events and hazards, including locally prepared maps of areas subject to previous risk, areas that are vulnerable, and sites that have been repeatedly damaged.

(VI) Existing and planned development in identified at-risk areas, including structures, roads, utilities, and essential public facilities.

(VII) Federal, state, regional, and local agencies with responsibility for the protection of public health and safety and the environment, including special districts and local offices of emergency services.

(B) A set of adaptation and resilience goals, policies, and objectives based on the information specified in subparagraph (A) for the protection of the community.

(C) A set of feasible implementation measures designed to carry out the goals, policies, and objectives identified pursuant to subparagraph (B) including, but not limited to, all of the following:

(i) Feasible methods to avoid or minimize climate change impacts associated with new uses of land.

(ii) The location, when feasible, of new essential public facilities outside of at-risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in at-risk areas.

(iii) The designation of adequate and feasible infrastructure located in an at-risk area.

(iv) Guidelines for working cooperatively with relevant local, regional, state, and federal agencies.

(v) The identification of natural infrastructure that may be used in adaptation projects, where feasible. Where feasible, the plan shall use existing natural features and ecosystem processes, or the restoration of natural features and ecosystem processes, when developing alternatives for consideration. For the purposes of this clause, “natural infrastructure” means the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.

(D) (i) If a city or county has adopted the local hazard mitigation plan, or other climate adaptation plan or document that fulfills commensurate goals and objectives and contains the information required pursuant to this paragraph, separate from the general plan, an attachment of, or reference to, the local hazard mitigation plan or other climate adaptation plan or document.

(ii) Cities or counties that have an adopted hazard mitigation plan, or other climate adaptation plan or document that substantially complies with this section, or have substantially equivalent provisions to this subdivision in their general plans, may use that information in the safety element to comply with this subdivision, and shall summarize and incorporate by reference into the safety element the other general plan provisions, climate adaptation plan or document, specifically showing how each requirement of this subdivision has been met.

The safety element discussion is not the only section of the GPG that should address climate change adaptation and resilience. Nearly every other chapter of the GPG outlines how climate change applies to each respective section. The safety element is the statutory "home" for the discussion; however, it should not preclude discussion of climate adaptation and resilience in other appropriate sections of a jurisdiction's general plan. Specifically, addressing a changing climate may result in the need to consider the end year of the general plan and the environmental changes that may occur through the life of a general plan's applicability. As the climate changes, future environmental conditions at the horizon year of the general plan may be just as important for consideration of long range policy as the base environment setting. As climatic systems shift away from a historically predictable paradigm, planning policy should adapt to better incorporate the associated impacts of these anticipated environmental shifts. Further, all major policy documents in a jurisdiction should discuss climate adaptation and resilience, as both an input to and implementation of the jurisdiction's general plan. This will lead to consistency within a jurisdiction's policy framework and ensure implementations of policies are occurring in an efficient and appropriate manner. Examples and cases studies of how this incorporation might occur will be hosted on OPR's Adaptation Clearinghouse.

In some cases, jurisdictions have chosen to address climate change in their community through a climate action plan or adaptation plan. Additional guidance on how a jurisdiction might treat these two types of documents in relationship to the general plan is included in Chapter 8, Climate Change. Many jurisdictions have chosen to address greenhouse gas (GHG) emissions reductions and climate change adaptation together in the same document. The guidance here does not require bifurcating the GHG emissions and adaptation discussions, rather the intent of the policy maker should be to look at the whole of the policy framework to both meet statutory requirements while also maximizing co-benefits of policy initiatives. An outline of a climate action plan that could address both GHG emissions and adaptation is included in Chapter 8, Climate Change and in OPR's Adaptation Clearinghouse.

Timing of Updates

For those jurisdictions that have an adopted local hazard mitigation plan (LHMP), the next update of their LHMP triggers an update to the safety element of the general plan to address climate adaptation and resilience. If a jurisdiction does not have an LHMP, the safety element of the general plan must be reviewed and updated on or before January 1, 2022 to address climate adaptation and resilience. Internal consistency and disclosure of impacts to a community may become problematic if the document is not updated regularly. A jurisdiction may choose to review and update the safety element each time the housing element is updated, as is required for flood and fire hazards. The housing element's five to eight year update cycle may be adequate to regularly review and update the safety element climate change discussions. Jurisdictions that have an LHMP may also choose to review and update their climate change analysis in the LHMP concurrently or as preparation for the next LHMP update to create consistency and efficiency in the review and update cycle for both general plans and LHMPs.

Fulfilling the Objectives of This Section

Some jurisdictions have already completed climate change adaptation analysis. In recognition of this, a city or county may use an existing LHMP or climate adaptation plan to satisfy the requirements of this section. The key to using these stand-alone documents is to both satisfy the requirements of this chapter and to adequately incorporate contents of the plan into the general plan. Likewise, a city or county may use a general plan that currently includes adaptation to satisfy the requirements of this section. If a separate plan is used, it must be incorporated by reference into the safety element and summarized to specifically show how each requirement of this subdivision has been met.

To the extent that a county's safety element is sufficiently detailed and contains appropriate policies and programs for adoption by a city, a city may adopt that portion of the county's safety element that pertains to the city's planning area in satisfaction of the requirement imposed by this subdivision.

Process for Analysis

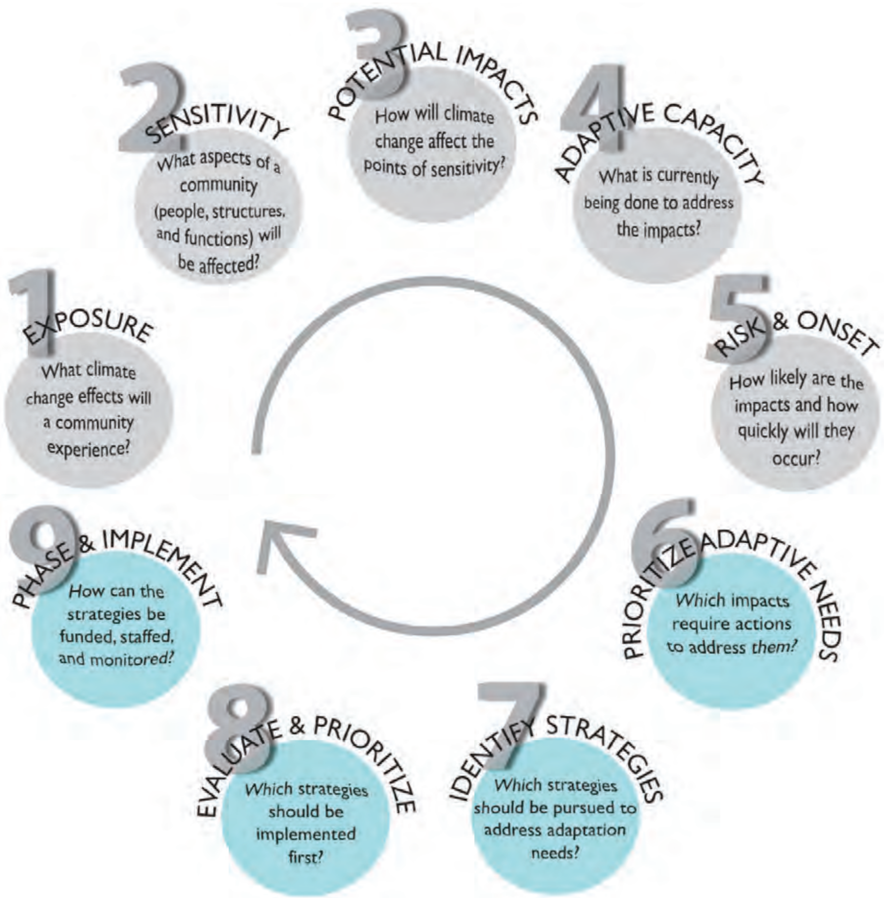
The requirements of SB 379 have five distinct steps (outlined below). The first and last steps focus on the relationship of the analysis and policy efforts of the larger general plan. Steps 2, 3, and 4 focus on how to conduct the recommended analysis, goal setting, and policy development. This process can also be found at the OPR Adaptation Clearinghouse. The five steps require that the jurisdiction:

1. Review the existing LHMP, climate action plan (CAP), adaptation plan and other relevant documents to ensure it meets the requirements of Government Code section 65302(g)(4) as outlined in this chapter. If the LHMP, or plan to address climate adaptation, does not meet the requirements of this chapter, proceed to Step 2. Proceed to step 5 if these requirements have already been satisfied.
2. Conduct a vulnerability assessment.
3. Develop adaptation goals.
4. Create implementation measures.

Complete Adaptation Planning Guide (APG) Process to satisfy these steps

5. Update the safety element with adaptation and resilience considerations consistent with this chapter. This update can be done through incorporation by reference of a plan that meets the requirements of this chapter, through incorporation in entirety of language that meets the requirements, or other appropriate mechanism. When updating the safety element to address climate change, it is important to review other elements of the general plan to ensure consistency.

Steps 2, 3, and 4 respond to the nine step process outlined in the Adaptation Planning Guide (APG).



Source: Adaptation Planning Guide, 2012

The APG is periodically updated in conjunction with updates of the Safeguarding California Plan and State Hazard Mitigation Plan. The next APG update will include updates to address the requirements of Government Code section 65302(g)(4). You can review further detail for each step in the APG in the document.

1. Exposure: What climate change effects will a community experience?
2. Sensitivity: What aspects of a community (people, structures and functions) will be affected?
3. Potential Impacts: How will climate change affect the points of sensitivity?

4. Adaptive Capacity: What is currently being done to address the impacts?

5. Risks and Onset: How likely are the impacts and how quickly will they occur?

6. Prioritize Adaptive Needs: Which impacts require actions to address them?

7. Identify Strategies: Identify the strategies that should be pursued to address adaptation needs?

8. Evaluate and Prioritize: Which strategies should be implemented first?

9. Phase and Implement: How can the strategies be funded, staffed and monitored?

Senate Bill 1000, adopted in 2016, requires local governments to incorporate environmental justice (EJ) policies into their general plans, either in a separate EJ element or by integrating related goals, policies, and objectives throughout the other elements. This update, or revision if the local government already has EJ goals, policies, and objectives, must happen "upon the adoption or next revision of two or more elements concurrently on or after January 1, 2018." Environmental justice should be considered when making decisions about climate change adaptation and resiliency. For additional information on how the new requirement applies to this and other elements in the general plan guidelines, refer to the environmental justice element discussion.

Complete a vulnerability assessment (steps 1-5 of the Adaptation Planning Guide)

As outlined in Government Code section 65302(g)(4) and the APG, the vulnerability analysis should incorporate information from multiple sources. Case studies can also be quite helpful in order to inform a jurisdiction's efforts. Although much of climate adaptation related policy work is an emerging practice, a number of examples are available to provide context. Case studies are available through OPR's Integrated Climate Adaptation Resilience Program (ICARP) "Case Studies" webpage. The results of the Annual Planning Survey and the awareness of efforts occurring in surrounding communities can also be helpful. External resources such as the Climate Resilience Toolkit, Climate Adaptation Knowledge Exchange (CAKEx) and the Georgetown University Adaptation Clearinghouse can also be helpful.

Numerous tools are available to support climate change analysis, such as those referenced in the table in Chapter 8, Climate Change. Specific tools to address climate change adaptation include the following.

TOOLS TO ADDRESS CLIMATE ADAPTATION

Guidelines for CEQA compliance	CEQA Guidelines
Comprehensive framework for addressing adaptation at the local level	APG
Visualization tool for the impacts of climate change and links to resources	Cal-Adapt
Federal resource for visualizing impacts, case studies, decision support	Climate Resilience Toolkit
Guide to developing adaptation policy at the local level in California	Adaptation Planning Guide
Georgetown University Climate Center Adaptation Clearinghouse	Adaptation Clearinghouse
The State's approach to addressing climate impacts	Safeguarding California Plan
The State's framework for climate hazards	State Hazard Mitigation Plan
See also: Chapter 7, Climate Change of the General Plan Guidelines	Chapter 8, Climate
See also: OPR Adaptation Clearinghouse	ICARP

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Including the following information will help a jurisdiction satisfy the minimum requirements of Government Code section 65302(g)(4). A deeper level of analysis is encouraged as data, policy and implementation methods continue to improve over time. In all cases, reviewing the information and process guidance in the California Adaptation Planning Guide (APG) should be the first step, in parallel with reviewing data and information in the Cal-Adapt tool. In some cases, working through a regional collaborative such as those working through the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA), to identify partnering opportunities in analysis and implementation may provide value, and in some cases, resources. Regional guidance may differ from guidance provided in this chapter, and may be appropriate as long as it meets the minimum requirements as shown in the safety element checklist. Staff at the ICARP can also answer questions about the available tools and help jurisdictions choose the appropriate resources. New tools and sources of data will be added to the ICARP Adaptation Clearinghouse as they become available. Other important data sources include:

Assessing vulnerability and risk can help a community plan infrastructure in more resilient areas

Image by Urban Advantage, SANDAG

1. Local agency data on the types of assets, resources, and populations that will be sensitive to various climate change exposures. This can be obtained through overlaying Cal-Adapt outputs with the General Plan Mapping Tool (GPMT) and augmenting with locally relevant data. This service will be provided in updates to both tools.

2. Local agency data on current status of climate change preparedness, including institutional capacity, redundancy limitations, critical assets inventory, exposure risk and vulnerability of disadvantaged communities. Sources include municipal service reviews developed by LAFCOs, Metropolitan Planning Organization (MPO) data, other regionally available data, local hazard mitigation planning documents and data in the General Plan Mapping Tool, Cal-Adapt and MyPlan.

3. Historical data on natural events and hazards, including locally prepared risk and vulnerability maps, and sites that have been repeatedly damaged. This information can be obtained by visiting the General Plan Mapping Tool, MyPlan, Cal-Adapt and the Climate Resilience Toolkit in addition to locally available data that may provide more specificity, detail and context.

4. Existing and planned development in identified at-risk areas, including structures, roads, utilities, and essential public

facilities. Much of this data will only be available at the local level. These can be meshed with downloaded data from the General Plan Mapping Tool, MyPlan and Cal-Adapt.

5. Coordination with federal, state, regional, and local data and information related to protection of public health and safety and the environment, including data from special districts and local offices of emergency services. Through the OPR Adaptation Clearinghouse jurisdictions can access contact information for local, regional, State and federal offices that can assist with this work.

Developing goals and measures for climate change adaptation and resilience (steps 6-9 of the Adaptation Planning Guide)

Jurisdictions must identify a set of adaptation and resilience goals, policies, and objectives, based on the information analyzed in the vulnerability assessment outlined above, for the protection of the community. The "Identifying Adaptation Strategies" chapter of the APG provides a start to this process, and links to other resources. CalAdapt, the OPR Adaptation Clearinghouse and other relevant local, regional, state and federal resources are appropriate to use. In particular, as mentioned in the vulnerability assessment section, regional collaboratives can play a useful role in both identifying policies and coordinating on implementation of those policies. See www.arccacalifornia.org for more information on regional collaboratives and potential partners in your area.

As outlined in the APG, feasible implementation measures must also be developed to ensure the goals, policies, and objectives in the plan are supported through implementing actions. This can be done through the general plan implementation matrix or other mechanism that allows monitoring of progress over time. The structure of the implementation matrix or program may shift depending on whether the climate change discussion is captured in a climate action plan, adaptation plan, or incorporated in the general plan. As with the vulnerability assessment section above, a jurisdiction should start with the APG, then review local or regionally relevant resources, and then review other statewide or national guides as outlined in the table above.

Whenever possible, cities and counties should work with neighboring jurisdictions to develop joint policies and coordinate on joint implementation of policy. Not only does this type of coordination increase policy consistency in a region, but it also may reduce staff and financial cost of implementation. Specific contents required in the climate adaptation discussion include:

1. Feasible methods to avoid or minimize climate change impacts associated with new uses of land. These include, but are not limited to, flooding, fire, extreme heat, sea level rise, runoff, risk, etc.). This should not just capture new risks, but also risks exacerbated by climate change.

2. The location, when feasible, of new essential public facilities outside of at-risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in at-risk areas.

3. The designation of adequate and feasible infrastructure located in an at-risk area. Meaning, any new infrastructure should be built to withstand the identified risk.

4. An approach (guidelines) to working cooperatively with relevant local, regional, state, and federal agencies. The APG includes examples of outreach and coordination measures that can be taken to develop these guidelines.

5. The identification of natural infrastructure that may be used in adaptation projects. Where feasible, the plan shall use existing natural features and ecosystem processes, or the restoration of natural features and ecosystem processes, when

developing alternatives for consideration. Additional guidance on natural infrastructure data and resources can be found at the OPR Adaptation Clearinghouse.

Seismic Hazards

Requirement Description:

The safety element must establish policies to minimize the loss of property and life as a result of earthquakes. The general geology and seismic history of the region and the planning area can be addressed with a map of known seismic and geologic hazards. The element should determine the location of active fault zones designated by the State Geologist under the Alquist-Priolo Earthquake Fault Zoning Act. Next, a geologic evaluation can evaluate the potential for displacement along active and potentially active faults in the planning area. Active and potentially active faults in the region should be identified with historical data on seismic ground shaking within the planning area. A geotechnical evaluation based on the state probabilistic earthquake hazard map can determine the potential for localized ground shaking, landslides, and tsunamis. Hazardous or substandard structures that may be subject to collapse in the event of an earthquake, including, but not limited to, unreinforced masonry buildings could be identified.

The geotechnical evaluation can also identify the potential for earthquake-triggered landslide, mudslide, liquefaction, and soil compaction. It should also determine the location of zones of required investigation for liquefaction. Areas that would be inundated in the event of a dam failure should also be identified. Dam inundation maps are available from the California Office of Emergency Services (OES). The development, facilities, and people potentially at risk in areas subject to potential inundation should be identified as well.

The safety element should include historical data on landslides and mudslides and identify areas that are landslide-prone by using, among other sources, landslide features maps, seismic hazard zone maps, and geology maps produced by Department of Conservation. The local potential for landslides and mudslides should also be identified in a geotechnical evaluation.

Historical data on land subsidence resulting from extraction of groundwater, natural gas, oil, and geothermal resources and from hydrocompaction can be used to identify areas of known risk from liquefaction, subsidence, or ground shaking. The potential risks associated with other known geologic hazards, such as volcanic activity, avalanche, or cliff erosion may also be analyzed.

Flood Protection

Requirement Description:

Flooding is a natural function of every river, alluvial fan, and coastal area. In riverine systems, floodwaters enrich bottomlands and provide spawning habitats for native fish. There are ecological benefits to maintaining connections between the river and its floodplain.

Land use decisions directly influence the function of floodplains and may either reduce or increase potential flood hazards. The functions of floodplains include, but are not limited to, water supply, water quality, flood and erosion control, and fish and wildlife habitat. Development within floodplains may not only expose people and property to floods, but also increase the potential for flooding elsewhere and negatively impact floodplain ecosystems. Land use regulations, such as zoning and subdivision ordinances, are the primary means of implementing general plan policies established to minimize flood hazards. In addition to including floodplain management policies in the general plan, making related changes to zoning and subdivision ordinances is crucial to the success of a floodplain management program.

In the process of preparing a flood management element, the city or county will have to collect a substantial amount of information concerning its floodplains and its watershed. There are a variety of sources for this information. Federal Emergency Management Agency (FEMA) maps are available for most communities. The U.S. Army Corps of Engineers will do floodplain delineation on a cost-sharing basis and has information on floodplains and project levees. The Department of Water Resources (DWR) also has floodplain information and a floodplain management program, as does the Central Valley Flood Protection Board. The OES and DWR have information on past flooding and flood levels based on awareness mapping. Local levee districts and resource conservation districts may also have information to share.

The Central Valley Flood Protection Plan (adopted pursuant to SB 5, the Central Valley Flood Protection Act of 2008) aims to revamp insufficient levee, bypass, and other flood defense mechanisms to create a more integrated and hazard-averse flood management system. Carrying implications for Central Valley land use, conservation, and safety planning in floodplain zones, the 2012 Central Valley Flood Protection Plan (CVFPP) documents the condition of all of the region's state and federal flood management facilities and guides improvements to flood hazard prevention along the Sacramento River and San Joaquin Rivers. All cities and counties within the Sacramento-San Joaquin Valley were required to amend their general plans by July 2015 to contain the data and analysis in the Central Valley Flood Protection Plan and include goals, policies, and objectives based on that plan, as well as relevant implementation measures (Gov. Code § 65302.9).

Key Terms

Flood management is defined as the overarching term that encompasses both floodwater management and floodplain management.

Floodwater Management

Floodwater management includes actions to modify the natural flow of floodwaters to reduce losses to human resources and/or to protect benefits to natural resources associated with flooding. Examples of floodwater management actions include containing flows in reservoirs, dams, and natural basins; conveying flows via levees, channels, and natural corridors; managing flows through reservoir reoperation; and managing watersheds by decreasing rainfall runoff and providing headwater stream protection.

Floodplain Management

Floodplain management includes actions to the floodplain to reduce losses to human resources within the floodplain and/or to protect benefits to natural resources associated with flooding. Examples of floodplain management actions include minimizing impacts of flows (e.g., flood-proofing, insurance); maintaining or restoring natural floodplain processes (e.g., riparian restoration, meander corridors, etc.); removing obstacles within the floodplain voluntarily or with just compensation (e.g., relocating at-risk structures); keeping obstacles out of the floodplain (through subdivision and zoning decisions); education and emergency preparedness planning (e.g., emergency response plans, data collection, outreach, insurance requirements, etc.); and ensuring that operations of floodwater management systems are not compromised by activities in the floodplain.

Fire Hazards

Requirement Description:

There are many opportunities to address fire protection, fire prevention and hazard mitigation in the general plan, most obviously in the safety element which deals with all manner of natural and man-made hazards to life and property. California's increasing population and expansion of development into previously undeveloped areas is creating more "wildland-urban interface" with a corresponding risk of economic loss caused by wildland fire. The changing climate, specifically the rising temperatures and increasing temporal variability of water availability, continues to increase wildfire risk in many areas. Meanwhile, drought episodes with greater frequency and severity effectively lower fuel moisture conditions to create longer fire seasons, and combined with overstocked vegetation vulnerable to insects and diseases, produce an abundance of dead woody matter prime for intense burning.

Mitigating Hazards through Drought Resiliency Plans

The onset of severe droughts in California poses considerable threats to public safety and wellbeing by increasing fire hazard susceptibility and straining already scarce water resources. Drought's toll on crop yields, livestock production, and local community water sources create food and water security concerns, in addition to economic considerations, that showcase the importance of proper preparedness plans. Climate change will likely foster more consecutive disasters – for example, droughts followed by fires, or floods followed by drought – prolonging recovery of natural resources and compounding total recovery costs.

Government Code 65302(g):

(3) Upon the next revision of the housing element on or after January 1, 2014, the safety element shall be reviewed and updated as necessary to address the risk of fire for land classified as state responsibility areas, as defined in Section 4102 of the Public Resources Code, and land classified as very high fire hazard severity zones, as defined in Section 51177. This review shall consider the advice included in the Office of Planning and Research's most recent publication of "Fire Hazard Planning, General Technical Advice Series" and shall also include all of the following:

(A) Information regarding fire hazards, including, but not limited to, all of the following:

(i) Fire hazard severity zone maps available from the Department of Forestry and Fire Protection.

(ii) Any historical data on wildfires available from local agencies or a reference to where the data can be found.

(iii) Information about wildfire hazard areas that may be available from the United States Geological Survey.

(iv) General location and distribution of existing and planned uses of land in very high fire hazard severity zones and in state responsibility areas, including structures, roads, utilities, and essential public facilities. The location and distribution of planned uses of land shall not require defensible space compliance measures required by state law or local ordinance to occur on publicly owned lands or open space designations of homeowner associations

(v) Local, state, and federal agencies with responsibility for fire protection, including special districts and local office of emergency services.

(B) A set of goals, policies, and objectives based on the information identified pursuant to subparagraph (A) for the protection of the community from the unreasonable risk of wildfire.

(C) A set of feasible implementation measures designed to carry out the goals, policies, and objectives based on the information identified pursuant to subparagraph (B) including, but not limited to, all of the following:

(i) Avoiding or minimizing the wildfire hazards associated with new uses of land.

(ii) Locating, when feasible, new essential public facilities outside of high fire risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in a state responsibility area or very high fire hazard severity zone.

(iii) Designing adequate infrastructure if a new development is located in a state responsibility area or in a very high fire hazard severity zone, including safe access for emergency response vehicles, visible street signs, and water supplies for structural fire suppression.

(iv) Working cooperatively with public agencies with responsibility for fire protection.

(D) If a city or county has adopted a fire safety plan or document separate from the general plan, an attachment of, or reference to, a city or county's adopted fire safety plan or document that fulfills commensurate goals and objectives and contains information required pursuant to this paragraph.

In response, many local governments are choosing to strengthen water management and drought prevention efforts by adding a separate water element to their general plan, but drought preparedness strategies could also be incorporated into the safety element as part of fire or flood hazard mitigation tactics. Structural and nonstructural flood management methods that enhance water storage and groundwater recharge work to mitigate drought impacts, and promoting greater water efficiency through land use and development policies can minimize capital damage from droughts as well as fires. As opposed to solely relying on local hazard mitigation plans, existing urban and agricultural water management plans, or expecting state or federal disaster aid after severe drought impacts, local governments can use the general plan as a tool to encourage water conservation policies, drought-tolerant parks and landscaping, water audits, and dual plumbing with recycled water. For more resources on how local governments can plan for droughts, see:

- California's 2010 State Drought Contingency Plan
- OPR's 2014 Local Government Drought Toolkit
- 2011 Climate Change Handbook for Regional Water Planning

- California's 2009 State Water Plan for integrated water management
- Local Government Commission's guidebook for regional water sustainability

Aside from local fire plans and hazard mitigation plans, the general plan's safety element can provide a framework for inserting fire protection and prevention policy requirements in zoning, subdivision, and strategic fire defense ordinances. To safeguard the increasing "wildland-urban interface, " communities with State Responsibility Area (SRA) or Very High Fire Hazard Severity Zone Local Responsibility Area (LRA) must update their safety element following the next revision of the housing element on or after January 1, 2014 to address the risk of wildland fire. In order to develop viable plans for fire protection, wildfire risk reduction, evacuation needs, and consistency between general plan elements and other local plans, the safety element shall incorporate information such as fire hazard maps and assessments, implementation goals and actionable policies, as well as any appropriate references to local fire safety plans.

As a guiding resource, OPR's Fire Hazard Planning Technical Advisory includes a detailed discussion about how to incorporate and comply with the fire hazard requirements in a general plan.

Other Considerations

Additional Requirements

The safety element must also address additional, interrelated considerations in the context of fire and geological hazards. These include evacuation routes, military installations, peakload water supply requirements, and minimum road widths and clearances around structures. The relationships between these considerations interplays throughout the required contents of the safety element, and should be analyzed in the context of safety and disasters, including climate change, drought, fire, flood, or seismic activity, as appropriate.

4

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies for flood risk, fire risk, and climate change can be found in the guidance and technical advisories referenced throughout this chapter.

Sample Policy	Example of Application	Relationship to Other Elements
[City/county] shall promote the strengthening of planned utilities, the retrofit and rehabilitation of existing weak structures and lifeline utilities, and the relocation or strengthening of certain critical facilities to increase public safety and minimize potential damage from seismic and geologic hazards.	City of Rancho Cucamonga	Circulation, climate change, equitable and resilient communities
[City/county] shall site critical public facilities—including hospital and healthcare facilities, emergency shelters, police and fire stations, and emergency communications facilities—outside of the tsunami evacuation zone and 100-year flood plains.	Pacifica	Environmental justice, equitable and resilient communities, healthy communities
[City/county] shall identify and establish specific travel routes for the transport of hazardous materials and wastes, with key considerations being capacity to safely accommodate additional truck traffic, avoidance of residential areas, and use of interstate or state divided highways as preferred routes.	City of Rialto	Circulation, environmental justice, noise, healthy communities
[City/county] shall work to achieve consistency between general plan land use and related policies and the Airport Comprehensive Land Use Plan, as is appropriate for the community. Measures may include restrictions on permitted land uses and development criteria, including height restrictions.	Redwood City	Land use, circulation

Note

The Environmental Justice Element section of the General Plan Guidelines has been updated.

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Return to element quick links

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Air Quality

Introduction

Chronic exposure to air pollutants is a serious health risk to millions of California residents, particularly the young, elderly, and people with heart disease and respiratory problems. Safeguarding public health has been the primary focus of federal and state air quality legislation and activities for many years. Air pollution also impacts local economies by damaging agricultural crops, natural vegetation, buildings, and other exposed materials. In addition, the economic health of an area may be affected adversely if insufficient air quality improvement triggers more stringent federally mandated air pollution controls. Air pollution also can impair visibility and obscure views. Cities and counties should strive to reduce emissions for the benefit of both their own residents and those of other communities in their region and the state as a whole. Air quality can be greatly improved through a multi-prong approach.

Local jurisdictions have responsibility for land use planning and can also significantly affect the design, creation, and management of development and the local circulation system. While air pollution is a regional issue, local governments have an opportunity to address air quality issues through general plans, development ordinances, local circulation systems, transportation services, and other plans and programs. As such, they are uniquely positioned to contribute to the local air district's efforts to achieve and maintain compliance with state and federal air quality standards. Supporting mode shift through improved bicycle and pedestrian facilities and support for transit, building infrastructure for zero emission vehicles, reducing parking, and promoting infill development can help reduce emissions and improve air quality. Cities and counties within the San Joaquin Valley Air Pollution Control District (SJVAPCD) jurisdiction are required by state law to include air quality measures in their general plans. The SJVAPCD developed the *Air Quality Guidelines for General Plans* to assist these cities and counties in meeting these requirements. The document provides additional goals, policies, and programs for adoption in general plans that will reduce vehicle miles traveled and improve air quality. In addition to statutory requirements for air quality measures in the San Joaquin Valley, cities and counties that have identified disadvantaged communities, as defined by SB 1000, must also incorporate air quality into their general plans. For more information on the environmental justice requirements, see the EJ section. Regardless of statutory requirements, the benefits of adopting an air quality element or implementing air quality policies throughout a general plan are universal.

Government Code 65302.1(c):

The adoption of air quality amendments to a general plan to comply with the requirements of subdivision (d) shall include all of the following:

(1) A report describing local air quality conditions including air quality monitoring data, emission inventories, lists of significant source categories, attainment status and designations, and applicable state and federal air quality plans and transportation plans.

4

CORRELATIONS AMONG ELEMENTS

	Land Use	Circulation	Housing	Conservation	OPen Space	Safety	Noise	EJ
Air Quality	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	-	IN STATUTE

■ Identified in statute ■ Closely related to statutory requirements

San Joaquin Valley Completeness Checklist

Statutory Citation	Brief Description of Requirement
§ 65302.1(c)(1)	Background report on local air quality conditions, including: • Air quality monitoring data, • Emission inventories, • Lists of significant source categories, • Attainment status and designations, and • Applicable state and federal air quality plans and transportation plans
§ 65302.1(c)(2)	Summary of government policies, programs, and regulations that may improve air quality, including • Local • District • State • Federal
§ 65302.1(c)(3)	Goals, Policies and Objectives, consistent with the following: • Mitigate project level and cumulative air quality impacts under CEQA • Integrate land use plans, transportation plans, and air quality plans. • Plan land uses in ways that support a multimodal transportation system (i.e., dense and compact). • Local action to support programs that reduce congestion and vehicle trips. • Plan land uses to minimize exposure to toxic air pollutant emissions from industrial and other sources. • Reduce particulate matter emissions from sources under local jurisdiction. • Support district and public utility programs to reduce emissions from energy consumption and area sources.
§ 65302.1(c)(4)	Feasible implementation tools
§ 65302.1(d)	Consider Air District comments on the draft plan

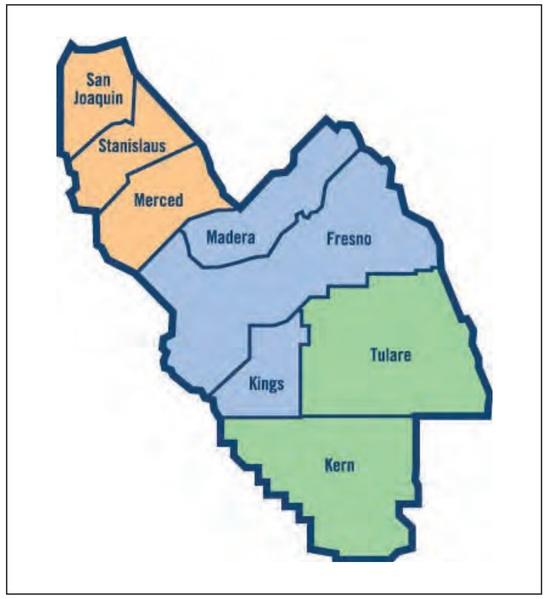
Required Contents in San Joaquin Valley

Pursuant to Government Code section 65302.1, the legislative body of each city and county within the jurisdictional boundaries of the San Joaquin Valley Air Pollution Control District (SJVAPCD) was required to amend the appropriate elements of its general plan, including, but not limited to, the required elements dealing with land use, circulation, housing, conservation, and open space, to include data and analysis, goals, policies, and objectives, and feasible implementation strategies to improve air quality.

The adoption of air quality amendments to a general plan includes all of the following:

- A report describing local air quality conditions including:
  - » Air quality monitoring data
  - » Emission inventories
  - » Lists of significant source categories
  - » Attainment status and designations
  - » Applicable state and federal air quality plans and transportation plans
- A summary of local, district, state, and federal policies, programs, and regulations that may improve air quality in the city or county.
- A comprehensive set of goals, policies, and objectives that may improve air quality.

San Joaquin Valley Air Pollution Control District Boundaries



A set of feasible implementation measures designed to carry out those goals, policies, and objectives.

Federal, State, Regional and Local Air Quality

Federal Air Quality Standards – The Federal Clean Air Act (CAA) requires the U. S. Environmental Protection Agency (U.S. EPA) to set and periodically review national air quality standards (NAAQS) for six air pollutants: carbon monoxide (CO), ozone (O3), particulate matter (currently in two size ranges: less than 10 microns in diameter, PM10; and less than 2.5 microns in diameter, PM2.5, also called fine particles), nitrogen oxides (NOX), sulfur oxides (SOX), and lead (Pb). Primary standards are based only on health considerations, and secondary standards also take into account welfare considerations. When U.S. EPA revises a NAAQS, states are required to attain the NAAQS by target dates specified in the CAA. A state's NAAQS attainment or non-attainment status is determined by U.S. EPA. States that do not attain the NAAQS are required to develop and implement air pollution control plans to achieve the NAAQS (state implementation plans, SIPs) by the target date. U.S. EPA provides guidance interpreting the SIP requirements in the CAA that the states must follow to develop an approvable SIP. If U.S. EPA deems a SIP is not approvable or if a state fails to develop a SIP, U.S. EPA can develop a Federal Implementation Plan that can be imposed on the state.

State Air Quality Standards – The California Air Resources Board (ARB) was established in 1968 to address air quality problems in California. Since formation of U.S. EPA in 1970, ARB has been designated as the State agency responsible for carrying out the State's responsibilities under the CAA. Because California was already regulating air quality before formation of U.S. EPA and passage of the CAA, California was granted several privileges that are not allowed to any other state, including the unique authority to regulate mobile sources.

The California Clean Air Act (CCAA) also directs ARB to set state ambient air quality standards (CAAQS), as well as directing ARB to identify nonattainment areas of the State. In contrast to NAAQS, CAAQS do not have attainment date targets, however, areas that are nonattainment for the CAAQS must make annual progress to reduce air pollution levels. ARB monitors air quality statewide through an extensive monitoring network that is jointly operated with local air pollution control districts (APCDs) and air quality management districts (AQMDs). ARB also promulgates regulations that reduce air pollution emissions from motor vehicles and consumer products that improve air quality throughout the State. ARB has oversight responsibilities related to local air district activities.

Regional Air Quality Management –California is divided into geographic areas which share common airsheds, called air basins. Each part of California falls under the authority of a county air pollution control district (APCD) or a multi-county air quality management district (AQMD). These local districts have the main responsibility of controlling air pollution emissions from stationary sources within their jurisdictions, including sources such as factories, power plants, gas stations, and dry cleaners. The districts adopt and implement rules and regulations related to the stationary sources under their jurisdiction to reach ambient air quality standards in their air basin, and to enforce relevant State and federal laws.

Local Air Quality –Local government air quality responsibility includes four main areas: land use planning, review and mitigation of the environmental impacts of development projects, development and maintenance of transportation infrastructures; including transit systems, and implementation of local air quality programs.

At least 45 days prior to the adoption of air quality amendments to a general plan pursuant to this section, each city and county shall send a copy of its draft document to the SJVAPCD (Gov. Code § 65302.1(d)). The SJVAPCD may review the draft amendments to determine whether they may improve air quality consistent with the strategies. The legislative body of the city or county shall consider the district's comments and advice prior to the final adoption of air quality amendments to the general plan. The SJVAPCD's comments are advisory to the city or county

Statutory Requirements in San Joaquin Valley

The SJVUAPCD prepared the Guide for Assessing and Mitigating Air Quality Impacts (GAMAQI), which can be found on the San Joaquin Valley Air Pollution Control District website. This document, GAMAQI 2015, which has undergone subsequent revisions to ensure its applicability over time, provides guidance for addressing air quality in environmental documents within the District. This includes methods of determining local air quality and suggested policies for improving air quality.

Considerations for Communities Beyond San Joaquin Valley

The general plan, as the foundation for local planning and development, can be an important tool for implementing policies and programs beneficial to air quality. Communities may choose to adopt a separate air quality element or to integrate air quality-beneficial objectives, policies, and strategies in other elements of the plan, such as the land use, circulation, conservation, and community design elements. Whichever method is selected, consistency among elements and policies within the plan is essential for successful implementation.

Required Contents for Disadvantaged Communities

Cities and counties whose general plan must include an environmental justice element, or related goals, policies, and objectives in other elements, must include ways to reduce the unique or compounded health risks in disadvantaged communities by reducing pollution exposure, including the improvement of air quality. For more information on disadvantaged communities and air quality requirements, see the environmental justice element section.

Communities with a Port of Entry

According to the Air Resources Board,

> "The diesel equipment operating in and around freight hubs, such as seaports, railyards, and warehouse and distribution centers, is a significant source of diesel [particulate matter] PM, a toxic air contaminant that can cause cancer and other health problems, including respiratory illnesses, increased risk of heart disease, and premature death. Exposure to diesel PM is a health hazard, particularly to children whose lungs are still developing and the elderly, who may have other serious health problems. The diesel PM emissions from freight operations impact communities located adjacent to those operations, as well as residents living miles away" (Sustainable Freight: Pathways to Zero and Near-Zero Emissions, 2015).

Port of entry communities may experience extensive exposure to air pollutants, and should have a comprehensive set of goals, policies, and objectives that can improve air quality. Sample policies may be found at the end of this chapter, and in greater detail in Appendix A.

Considerations in Land Uses Near High-Volume Roadways[4]

A general plan update is the opportune time to address issues that require thoughtful cross-sector analysis and discussion. Land use decisions near or adjacent to high volume roadways often present conflicts between economic, health, and environmental benefits from the development and the potential health impacts of vehicle emissions on nearby residents, businesses, schools, and other uses. Mitigating existing near-roadway land use conflicts and planning to avoid such conflicts in new projects requires coordination of several general plan elements, including land use, housing, circulation, environmental justice, and health.

Infill development along primary transportation corridors can help to achieve multiple policy objectives (good access to destinations, low VMT, environmental, heath, and economic benefits, fiscal savings for governments and transportation cost savings for citizens),

[4] High volume roadway is defined as: Roadways that, on an average day, have traffic in excess of 50,000 vehicles in a rural area and 100,000 vehicles in an urban area

but may also involve residential and commercial development adjacent to high-volume and other roadways elevated levels of air pollution or air toxics. Studies show that exposure to traffic pollution is associated with health issues including worsening of asthma and other respiratory health impacts. The foremost strategy for reducing pollution exposure near high-volume roadways is to minimize creation of traffic pollution in the first place. There are many efforts to do this:

- Federal and state emissions standards for cars, trucks, and buses
- State regulations for zero emission vehicle adoption
- SB 375, SB 743, regional, and local policies that reduce driving
- California's Sustainable Freight Transport Initiative
- Community- and government-led efforts to increase alternative transportation modes including public transit, biking, and walking

From a land use perspective, other strategies such as removing car lanes, having dedicated transit lanes, adding in separate bike lanes, and widening sidewalks are all practical strategies that can reduce emissions since they minimize traffic. Some areas have started Ciclavias, closing down a road for one day to cars to promote the use of the space by walkers, bikers, and other forms of activity.[xxvi] The land use and circulation sections discuss these options in more depth. Capping – by covering and building atop—or removing freeways is another strategy employed by some areas as appropriate.[xxvii] Eliminating the high frequency road altogether, and providing alternate modes of efficient transportation, as San Francisco did when removing the Embarcadero Freeway, may create co-benefits in the community, including increased health and economic vitality.

Some policies and regulations will go into effect in the next few years and will lead to substantial emissions reductions before development guided by current general plan updates will occur, while others have compliance dates that extend well into the future. Other policies, such as travel demand management, vary at the local level. Fleet turnover and changes in the built environment to increase non-auto travel will also take time. As these policies are realized, there is a need for local governments to consider other mitigation options to protect sensitive populations from near-roadway pollution exposure and to reduce the health impacts associated with living or working near busy roadways.

Deciding where to site a project is not a simple task. The pollutant levels and air quality near a freeway can vary significantly based on air-flow patterns, temperature, time of day, season, presence of sound barriers, vegetation, height of structures and other variables. The variation of near-roadway pollution levels means that development plans must consider reducing both peak and long-term pollution exposures. Cross-sector discussion and analysis are of utmost importance to determine adequate sites for future development and balance multiple policy objectives.

Research has begun to evaluate measures to avoid, minimize, and mitigate air pollution exposure near roadways. Simultaneously, new research shows health benefits from reducing GHGs; improving housing stock; preserving agricultural spaces, habitats, and recreational spaces; and engaging in the active transportation and mass transit made possible through infill development.

A comprehensive discussion around process strategies and mitigation strategies to address near roadway land use has the potential to improve air quality and reduce exposure to toxics. Furthermore, a holistic examination allows for weighing benefits related to equity, health, economics, resource protection, and overall sustainability goals.

The Atlanta, Georgia Summer Olympic games of 1996 provides an example of a holistic approach to improve air quality through temporary mitigation strategies. Recognizing there would be an influx of people, Atlanta implemented a suite of policies to accommodate the additional visitors in a clean and travel efficient manner. These included a 24-hour public transit system, additional buses, modified work place policies such as telecommuting, and even adjustments to delivery schedules. Researchers were able to evaluate the impact of these short-term policies and showed decreased ozone, traffic counts, and acute care asthma visits. Although these were temporary measures, they reflect of what a more comprehensive suite of policy objectives could achieve through mode shift from car dependency to alternative forms of transit.

Just as in the Atlanta games example, the suite of strategies to address near roadway land use must be considered as it applies to the local context. Potential strategies to address near-roadway land use are identified below. Process strategies are listed to consider during the general plan update process. Additionally, mitigation strategies are identified for cases when they are needed. The mitigation measures listed are based on a review of the literature conducted by the Air Resources Board and published in the Strategies to Reduce Air Pollution Exposure Near High-Volume Roadways.

Potential strategies to avoid and mitigate health impacts near roadways

Process Strategies

Aimed at identifying, mitigating, and avoiding—if possible—exposure to air pollution.

- Consult with regional air district during early stages of the general plan update when prioritizing areas for infill development to identify stationary and mobile sources of toxic air contaminants
- Consult with regional air district, community, and other stakeholders during identification of potential infill sites and create an inventory
- Engage with local community members early in the general plan update process to discuss vision, local priorities, and concerns
- Engage with local community groups working on related issues early in the general plan update

Infill development and active transportation create numerous co-benefits

Image by Urban Advantage, Dover Kohl & Partners

- Incorporate air pollution reduction goals and exposure reduction goals into the general plan language
- Prioritize discussion of policy goals that have the potential to reduce emissions overall to be incorporated into the general plan policy language, such as reduction of lanes in roads
- Prioritize discussion of policy goals that support mode shift from single occupancy vehicles to transit and/or active transit to be incorporated into the general plan policy language

Mitigation Strategies

Mitigation strategies are aimed at identifying various potential strategies that cities and counties can incorporate as needed to reduce exposure to near-roadway pollution.

Locating potential infill development sites near a high volume roadway may yield an array of benefits, which should be balanced with drawbacks associated with near roadway pollution. Additionally, many communities already have sensitive land uses near which can not be easily relocated, and thus need mitigation strategies to reduce health impacts. Research over the last decade has identified mitigation strategies that reduce pollution concentrations, emissions, or improve air flow. Site-specific factors should be carefully considered as local jurisdictions, in conjunction with their regional air district, assess and select mitigation strategies that make the most sense for the local context. Also, as illustrated with the 1996 Atlanta games example, a combination of mitigation strategies is likely to have a greater impact than implementing one stand-alone measure.

The research on mitigation measures tends to fall into one of several categories including:

1. Strategies to reduce traffic emissions
2. Strategies to increase dispersion of traffic pollution
3. Strategies to remove pollution from the air breathed by people

A full discussion of mitigation strategies and the background research is available in the Air Resources Board Technical Advisory: Strategies to Reduce Air Pollution Exposure Near High-Volume Roadways. The table below is a high level summary of the description of the strategy, the research findings, and appropriate context and other considerations. Please consult the full publication for a more in-depth discussion.

Strategy	Description of research findings	Appropriate context & other considerations
I. Strategies that reduce traffic emissions		
1. Speed Reduction Mechanisms, including roundabouts	Vehicle speed reduction mechanisms change the design and operating speed of the road by altering the physical characteristics of the road. These features can reduce stop-and-go driving and hard accelerations and thereby reduce emissions rates. Some of these features, like the roundabout intersection, can be used as an alternative to stop-controlled and signalized intersections. Studies show that roundabouts can reduce localized pollutant concentrations compared to intersections with stop and signal control by 20% or more (depending on context and site-specific conditions).	Transportation planners and engineers should carefully consider the potential direct and indirect effects of implementing speed reduction mechanisms to determine if they will reduce vehicle emissions and other impacts to the environment as well as to traveler safety and delay. When guidance is needed to estimate emissions and air quality-related effects, planners and engineers may consult with MPOs or traffic modeling experts.
2. Traffic Signal Management	Traffic signal management systems can reduce stop-and-go driving and vehicle idling, resulting in reduced localized pollutant concentrations of up to 50% compared to corridors that do not implement these systems. Studies show that site-specific conditions dictate the magnitude of reductions.	Many different types of signal management are available, and planners should identify what is best for air quality, vulnerable road user safety, and transit and active mode throughput and comfort.
3. Speed limit reductions on high-speed roadways (>55 mph)	Research studies have identified an optimal average speed range of ~35-55 mph within which per-mile traffic emissions and fuel consumption are minimized. Generally, speed limit reductions on high-speed roadways can reduce tailpipe emission rates up to 30%, depending on the change in speed, the pollutant measured or modeled, and the roadway characteristics.	Speed limit reductions are appropriate on roadways where speed limit and design speeds exceed 55 mph.

Strategy	Description of research findings	Appropriate context & other considerations
II. Strategies that increase dispersion of traffic pollution		
4. Design that promotes ventilation along street corridors	The physical layout of urban streetscapes influences air flow and pollution movement. Research studies show that street corridors characterized by buildings with varying shapes and heights, building articulations (street frontage design elements like edges and corners that help break up building mass), and spaces that encourage air flow (e.g., parks) benefit from better pollutant dispersion and air quality. For example, buildings of varying heights can result in significant increases in turbulence (e.g., up to doubling), and adding bike lanes and sidewalks not only reduces car traffic, but also creates space for more dispersion (up to a 45% reduction in particulate concentrations).	Wider sidewalks, bicycle lanes, and other features benefitting pedestrians can also create space for better air flow and pollutant dispersion along with increasing active transportation and mode shift. This strategy should be considered in the context of the overall need to increase development density.
5. Solid barriers and walls	Measurement and modeling studies consistently find that solid barriers reduce near-road downwind concentrations by increasing vertical dispersion of pollutants emitted by vehicles. The magnitude of the reduction and its spatial extent depend on the height of the barrier, the width of the road, and micrometeorology. As reference, studies have consistently found that pollution concentrations downwind of the barrier, ranging from 10% to 50% reduction compared to concentrations measured on or directly adjacent to high-volume roadways.	Solid barriers should only be considered for installation along freeways, because they have the negative effect of dividing neighborhoods and obscuring sightlines.
6. Vegetation for pollutant dispersion	Studies indicate that vegetation has the potential to alter pollutant transport and dispersion. In some studies, specific locations and conditions translated to air quality benefits (e.g., pollution concentrations of up to 20% on the leeward side of the tree line). It should be noted that most studies were conducted on the East Coast and in Europe where vegetation types and densities differ from what is found in California.	Online tools are available to assist with the selection of appropriate vegetation considering allergen impacts, watering needs, and other factors. Maximum benefits have been shown to occur when vegetation is combined with solid barriers.
III. Strategies that remove pollution from the air breathed by people		
7. Indoor high efficiency filtration	Studies show that particle filtration systems and devices, specifically high-efficiency filtration with mechanical ventilation or portable high efficiency air cleaners, can be highly effective for reducing indoor pollution concentrations. High efficiency filters in ventilation systems can remove from 50-99% of particles in the air. However, research shows that filtration technologies for gaseous pollutants (VOCs) are variable in their effectiveness; some remove certain VOCs well, but not others.	Planners should be aware of current state and local building codes and their respective air filtration requirements, including requirements for amending code standards. Regular operation and maintenance is necessary for highest filter and ventilation efficiency, and is required by regulation in commercial buildings.

Near roadway siting considerations and strategies will continue to evolve. For example, vehicles will continue to become cleaner over the coming years, changing the balance in benefits and drawbacks of near roadway development. A general plan update provides a platform on which to consider multiple policy options simultaneously, and the opportunity to create holistic, internally consistent solutions.

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OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Sample Policy	Example of Application	Relationship to Other Elements
[City, county] shall require that new multi-family residential buildings and other sensitive land uses in areas with high levels of localized air pollution be designed to achieve good indoor air quality through landscaping, ventilation systems, or other measures.	City of Murrieta	Land use, housing, healthy communities
[City, county] shall provide incentives to promote air pollution reductions, including incentives for developers who go above and beyond applicable requirements and mitigate pollution for facilities and operations that are not otherwise regulated.	City of Chula Vista	Land use, healthy communities, environmental justice
[City, county] shall require uses such as smog check stations, automotive painting and repair facilities conduct such activities in enclosed and filtered spaces to prevent odors and emissions from affecting passers-by, nearby residents, and building occupants	National City	Healthy communities, environmental justice
[City, county] shall employ strategies in the Community Design Element that reduce driving rates and improve air quality through land use and urban design will be implemented by the City and other responsible parties. These strategies include transit-oriented development, compact development, an appropriate mix of land uses, a jobs/housing balance, transit oriented development, and walkable streets.	City of Southgate	Circulation, land use, economic development, healthy communities
[City, county] shall minimize exposure to air pollution and hazardous substances	County of Ventura	Climate change, environmental justice, healthy communities
[City, county] shall encourage non-polluting industry and clean green technology companies to locate to the City.	City of Murrietta	Climate change, environmental justice, economic development, healthy communities

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Equitable & Resilient Communities

Designing Healthy, Equitable, Resilient, and Economically Vibrant Places

"The future is not someplace we are going to, but a place we are creating. The paths to it are not found, they are made."

—Jane Garvey

Introduction

Addressing social equity in policy decisions is vital for the economy, the health of the population, community well-being, and climate policies that support all residents. In addition to investments in infrastructure, services, and amenities, policies to support community engagement and to foster human capital in local communities are vital to creating more thriving, healthy, resilient, and equitable places. Additionally, there are significant demographic shifts taking place across California including more aging seniors, increasing ethnic diversity, and changing household structures. [xxviii, xxix]

Cities, counties, regions, and states have increasingly been integrating equity principles into their policies and frameworks to increase opportunities for all to thrive. Disciplines such as transportation, housing, agriculture, energy, economic development, land use, health, and education are utilizing an equity framework to inform policy. [xxx, xxxi, xxxii, xxxiii] In the late 1960s, the urban planning equity movement recognized that through expanding choices and services to those with limited options, local jurisdictions could work towards improved planning outcomes and equity. [xxxiv] Equity is also one of the three key pillars in sustainable development and is recognized by the American Planning Association in its official policy on smart growth. Despite the growth and interest in advancing social equity and the recognition of its importance, one common definition has not emerged. [xxxv]

A few definitions include:

The National Academy of Public Administration defines social equity as:

> "The fair, just, and equitable management of all institutions serving the public directly or by contract; the fair, just and equitable distribution of public services and implementation of public policy; and the commitment to promote fairness, justice, and equity in the formation of public policy."[xxxvi]

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The American Planning Association defines social equity as:

> "The expansion of opportunities for betterment that are available to those communities most in need, creating more choices for those who have few."[xxxvii]

The California Planning Roundtable states that social equity "ensures that all groups enjoy the benefits of a healthy and prosperous community, with access to housing, transportation, jobs and commerce. It enables a variety of businesses to flourish."[xxxviii]

"Health equity" is defined in California law, as "efforts to ensure that all people have full and equal access to opportunities that enable them to lead healthy lives" (Health and Safety Code § 131019.5(a)(2)). "Determinants of equity" are recognized to mean "social, economic, geographic, political, and physical environmental conditions that lead to the creation of a fair and just society" (Health and Safety Code § 131019.5(a)(1)).

Geographic inequity describes a situation in which the burdens of undesirable land uses are concentrated in certain neighborhoods while the benefits are received elsewhere. It also describes a situation in which public amenities are concentrated only in certain areas.

Many communities have used a robust community engagement process to adopt their own working definition of social equity, with agreed upon goals for their equity work in land use and transit planning. This chapter will discuss how social equity is foundational to other planning issues such as environmental justice and healthy communities.

American Planning Association Policy on Smart Growth SOCIAL EQUITY AND COMMUNITY BUILDING

The American Planning Association supports a sustained and focused initiative in federal, state, and local public policy to reverse the general decline of neighborhoods through strategies that promote citizen involvement and reinvestment within core communities.

The American Planning Association supports the application of smart growth principles to expand social equity in rural communities in ways that help preserve and strengthen their character.

The American Planning Association supports increased social, economic, and racial equity in our communities and calls on the federal government to increase community development funds to remedy these inequities and to ensure that planning and land development decisions do not unfairly burden economically disadvantaged groups.

The American Planning Association supports federal, state, and local policies and programs that encourage economically and socially diverse mixed income neighborhoods as the foundation for healthy regions, including encouragement for the provision of workforce housing in all new-growth areas and areas to be redeveloped.

The American Planning Association supports efforts to strengthen public education systems, including pre-K, as essential components of community building in urban, suburban, and rural areas, which help to ensure that children have an opportunity for an excellent education wherever they may live, and which provide a critical element for reinvestment in urban core communities.

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> The American Planning Association supports planning that identifies the transportation, housing, employment, education, recreation and health needs of our changing population, both with respect to the total number of people expected to reside in an area and also with respect to population groups with special needs such as the elderly, school children, or people of diverse cultures.
>
> The American Planning Association supports public-private partnerships as a means to leverage funds to achieve social equity and community redevelopment.
>
> Source: https://www.planning.org/policy/guides/adopted/smartgrowth.htm

CORRELATIONS BETWEEN ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Safety	Noise	EJ
Social Equity	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED

■ Identified in statute ■ Closely related to statutory requirements

Social Equity and other planning issues

Environmental Justice and Equity

Environmental justice (EJ) is defined in state planning law as the "fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies" (Gov. Code § 65040.12(e)). However, in addition to statute, there are several overlapping definitions and frameworks to contextualize EJ with ongoing robust conversation to define how it is related to social equity. In fact, EJ as a field has undergone tremendous expansion beyond the work that traditionally focused on the disproportionate burden of pollution and contaminants suffered by many communities of color to include access to services, healthy food, and affordable housing.[xxxix, xl] Not only does this expanded framework for EJ overlap with social equity, but it also overlaps with work traditionally associated with healthy community policies. This is evident in new EJ legislation, SB 1000, which requires pollution exposure reduction, including air quality, as well as policies to promote food access, safe and sanitary homes, and physical activities for disadvantaged communities. See the EJ section for more details.

EJ is considered an equity issue.[xli] It is an integral component of equity, but social equity also encompasses a larger framework such as access to jobs and economic opportunity, arts and culture, safety from violence, public administration, management of goods and services, access to education, and complete neighborhoods. Social equity is applied across the age range and various disciplines, and has many other nuances. For instance, an elderly population that has limited mobility could live in a neighborhood without safe, walkable streets or accessible public transit. Although it is not necessarily an EJ issue, the lack of mobility options is an important equity consideration. A low-income community that does not have access to parks - since historically they were not funded for development in lower-income areas - could be considered as having both EJ and equity issues. Equity can be used as the larger framework for ensuring opportunities for all in the community.

Healthy Communities and Equity

Healthy community work is also directly related to social equity. For decades, health researchers studied disparities in physical and mental health status among distinct segments of the population, including differences that occur by gender, age, race or ethnicity, sexual orientation, education, income, disability or functional impairment, geographic location, or a combination of any of these factors.[xlii] Decades of research have demonstrated that health outcomes are linked to much more than merely access to health services or underlying genetics. The research uncovered that many social, economic, and environmental factors contribute directly to health outcomes. The increased understanding of these factors has led communities across the nation, with California leading, to work closely with planning departments to improve planning policies and the built environment to better support health. It is important to apply an equity framework to the healthy community work to ensure that efforts do not make health disparities worse. See the Healthy Communities Chapter for more details.

SB 244

SB 244, passed in 2011, specifically recognized that many disadvantaged unincorporated communities lacked adequate investment in infrastructure such as sidewalks, safe drinking water, and adequate waste processing. This lack of adequate investment threatens both health and safety of residents and creates inequity in terms of access to quality services.[xliii] SB 244 created procedural requirements to identify these areas of risk and update general plan policies to improve conditions. See OPR's Technical Advisory on SB244.

General Planning

In the context of creating a general plan, considering distribution of and access to resources within a community may help provide improved services and opportunities to thrive.

Cities and counties can prioritize access to public facilities and services that enhance quality of life, including but not limited to, public transportation options connected to job centers, housing, parks, open space, trails, greenbelts, recreational facilities (including senior and youth centers), community centers, grocery stores, health care facilities, child care centers, libraries, and cultural centers. Considering the number and quality of, and access to facilities is important. Many instances of inequity are not intentional, but manifest themselves in terms of process or results. Therefore, by increasing awareness, jurisdictions can modify processes that lead to inequity. For example, transportation decisions are often informed by commute times. However, commute times are calculated during specified hours. Often, service sector employees engage in "reverse commutes," traveling at later or earlier hours. Regular commuter calculations do not adequately capture service sector needs, so other data should be included.

Common definitions in reference to social equity

In conversations about equity, terms such as underserved, low-income, disadvantaged, or environmental justice community are often interchanged but can potentially have different meanings depending on the context. There are also different statutory definitions and references from various funding sources. It is helpful to clarify terminology. For instance, one could reference a disadvantaged community while referring to an elderly or disabled population that does not have adequate access to transit options. Alternatively, disadvantaged could refer to children who do not have access to safe places to play. Several common terms have statutory definitions and others are used more generally. Additionally, many state and federal programs utilize the statutory definitions to determine funding for programs, and that too can vary. Some of the most applicable terms to local planning are below and apply where there is no other prevailing statutory definition.

Statutory definitions

Definitions pertinent to SB 1000

Disadvantaged Community Government Code Section 65302
"Disadvantaged communities means an area identified by the California Environmental Protection Agency Pursuant to Section 39711 of the Health and Safety Code OR an area that is a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation."

Low-Income Area Government Code Section 65302
"Low-income Area means an area with household incomes at or below 80 percent of the statewide median income OR with household incomes at or below the threshold designated as low income by the Department of Housing and Community Development's list of state income limits adopted pursuant to Section 50093."

Definition in the water code

Disadvantaged Community Public Resources Code Section 75005, Water Code Section 79505.5
A "Disadvantaged Community" is a community with a median household income less than 80 percent of the statewide median household income. "Severely disadvantaged community" means a community with a median household income less than 60 percent of the statewide average.

Definitions pertinent to SB 244

Disadvantaged Unincorporated Community as per SB 244 Government Code Section 65302.10 (a)

"Community" means an inhabited area within a city or county that is comprised of no less than 10 dwellings adjacent or in close proximity to one another.

"Disadvantaged unincorporated community" means a fringe, island, or legacy community in which the median household income is 80 percent or less than the statewide median household income.

"Island community" means any inhabited and unincorporated territory that is surrounded or substantially surrounded by one or more cities or by one or more cities and a county boundary or the Pacific Ocean.

"Fringe community" means any inhabited and unincorporated territory that is within a city's sphere of influence.

"Legacy community" means a geographically isolated community that is inhabited and has existed for at least 50 years.

Environmental Justice Government Code Section 65040.12(e)
EJ is defined in state planning law as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies.

Health Equity Health and Safety Code Section 131019.5

Recognizes "determinants of equity" means social, economic, geographic, political, and physical environmental conditions that lead to the creation of a fair and just society. Furthermore, "Health equity" means efforts to ensure that all people have full and equal access to opportunities that enable them to lead healthy lives.

Incorporating social equity into planning: examples and strategies

There is not one way to incorporate equity into a general plan, but there are unifying approaches to integration. A local jurisdiction should consider using an equity framework as the basis to start its planning process.

Vision, Outreach and Engagement

Robust community engagement to capture all voices within the community from the beginning of the general plan update is vital to creating a shared vision with significant community support, resulting in a plan that is more likely to acknowledge community challenges and accurately account for existing community assets. Engaging multiple groups also leverages community expertise. Partnership and engagement with diverse stakeholders also helps create more support for the plan during the approval process. There are many actions a local agency can take to support engagement from all sectors and groups within the local community. Focused outreach efforts to specific groups that work on equity issues, such as local community-based organizations, can be an effective way to incorporate an equity framework. If consultants manage public outreach, it can also be helpful to have a city or county staff assigned to serve as a liaison or oversee the outreach process for continuity after the project ends. This also provides for consistent and ongoing communication after plan adoption and implementation updates with the community.

As emphasized in the second chapter, A Vision for Long-Range Planning, coordinating with local agencies is important when seeking to implement many of the policies that provide more equitable access to resources. The Community Engagement and Outreach chapter provides more detailed guidance on ways to effectively engage with the community. SB 1000 also has statutory language about civil engagement.

Incorporating Data, Mapping, and Other Tools

An important step in the process of incorporating equity considerations is to integrate it into the analysis of existing conditions. Jurisdictions have to collect at least jurisdiction-wide socioeconomic data during the preparation of the housing element, such as income levels and persons with special housing needs (elderly, farmworkers, single heads of households, etc.). However, a more complete socioeconomic picture of the community can be analyzed using smaller geographic data sets, less than jurisdiction-wide, such as census tracts, which allows a comparison of different areas throughout a community. Data sources are mentioned throughout the General Plan Guidelines.

Some examples of local jurisdictions both within and outside of California that have done mapping projects to incorporate equity into policy decision making processes include:

- Denver
- Portland-Vancouver

- Atlanta
- New York
- Riverside
- Los Angeles

Incorporating Supportive Policies

An analysis of existing conditions combined with robust community input can help bring particular policy issues to the forefront for discussion. As policy priorities are established, formulating strong policy language is a key first step. For example, rather than "consider implementing" use the word "implement." Also, instead of using the phrase "consider the development of," use "develop and implement." Additionally, to create more actionable policy language use "priority on" rather than "emphasis on" to highlight policy areas of particular focus.

Community Resilience

Community resilience refers to the ability of a community to respond, recover, and adapt, and do so dynamically. It is directly related to equity. Incorporating equity considerations from the beginning of the planning process offers the potential to decrease vulnerability in the community in terms of infrastructure and human capital. "Vulnerability is the flip side of resilience: when a social or ecological system loses resilience it becomes vulnerable to change that previously could be absorbed."[xliv] Akin to the circulation of traffic, if power is lost and a traffic light goes out, a bottleneck will occur, slowing traffic down across the entire area, not just the focused area where the light went out. This means the system is vulnerable and not resilient.

When other systems within a community are vulnerable, the effects can ripple throughout the area as well. Incorporating social equity is a key strategy for local governments to create resilient communities.

The Rockefeller Foundation has conducted extensive research on what drivers are important to support resiliency. Using that research, they have implemented lessons learned through practical experience with cities across the globe. Many of the lessons can be modified to apply to land use planning. Adapting their framework to apply to a general plan, local jurisdictions can ask a number of questions during the update and at the end of the process to measure how they are addressing resilience. If resilience was incorporated from the beginning, it is much more likely the series of questions will have affirmative responses and the policies will support resilience community-wide.

Questions informed and adapted from the Rockefeller Foundation Resiliency Framework that could be used by a local jurisdiction as it updates its general plan include: [xlv]

Health and Wellbeing

- How do the policies help community members meet their basic needs?
- How do the policies help create opportunities to support basic needs, such as job training, skills, housing, and job fit?

- How do the policies ensure access to facilities and services, such as emergency services, mental health, and health care services?

Economy and Society

- How do the policies encourage community engagement in the planning process and strengthen social networks?
- How do the policies strengthen crime prevention and safe places?
- How do the policies foster more economic prosperity?

Infrastructure and Environment

- How do these policies conserve our local environmental assets and preserve natural ecosystems?
- How do these policies help maintain our infrastructure and ecosystems?
- How do these policies support multimodal transit and diverse network options?

Leadership and Strategy

- How has data informed the policy development? Were multiple sectors consulted during policy formation?
- Did this general plan update allow for increased organizational capacity, education, and increased awareness between stakeholders and the local government?
- Did data inform the holistic vision that can be integrated across different land use plans, sectors, and users?

Some examples of local jurisdictions both within and outside of California that have incorporated resiliency as a key framework for planning include:

- Boston – Boston has specifically included social cohesion into their framework and has hosted discussions on race and equity to further resilience locally.
- San Francisco – San Francisco, at high-risk for earthquakes and natural disasters, has made resilience around physical infrastructure a priority.
- Atlanta – Atlanta is looking closely at its transit and aging infrastructure.
- Los Angeles – Los Angeles prioritizes addressing poverty as a key to improving resiliency.

The long-range nature of policies in the general plan, as well as the multi-agency and diverse stakeholder involvement, provides an opportunity to incorporate equity. This creates the potential to create a more resilient community.

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OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Sample Policy	Example of Application	Relationship to Other Elements
[City, county] shall develop programs to attract and retain industries that can provide a living wage, provide health insurance benefits, and meet existing levels of workforce education.	City of Murrieta	Land use, housing, healthy communities, economic development
[City, county] shall prioritize projects that significantly address social and economic needs of the economically vulnerable populations. Address and reverse the underlying socioeconomic factors and residential social segregation in the community that contributes to crime and violence in the city.	City of Richmond	Environmental justice, safety, economic development
[City, county] shall encourage activities such as block parties and community–wide social events, that strengthen neighborhood cohesion and the overall identity of the City.	City of El Monte	Safety, healthy communities
[City, county] shall enhance low income independent housing for seniors, continue to develop and expand senior housing services.	Marin County	Land use, housing environmental justice healthy communities

6

Healthy Communities

Designing Healthy, Equitable, Resilient, and Economically Vibrant Places

"I thought about it while riding my bicycle."

—Albert Einstein on the Theory of Relativity

Introduction

The health and well-being of California's residents are fundamental to their quality of life and economic vitality. Protection of the public health, safety, and welfare of residents is the legal basis for land use regulation.[xlvi] Homes, streets, work places, retail and services, schools, and neighborhoods influence community health in fundamental ways. Educational and employment opportunities may influence and improve health by ensuring access to the ingredients for a healthy life, including nourishing food, clean water, affordable places to live, safe places to walk, bike, and be active, and clean air indoors and out. The World Health Organization (WHO) defines health as "a complete state of physical, mental, and social well-being, and not merely the absence of disease."[xlvii] Any reference to health in these guidelines refers broadly to health, including mental health. Health outcomes are not evenly distributed across all segments of the community. Research has shown that certain communities, often low-income and people of color disproportionately suffer from poor health.[xlviii] Many factors contribute to these health disparities, including neighborhood and community conditions. Changing demographics across California create an imperative to address these disparities. Planning, programs, and policy to achieve health equity, through ensuring access to opportunities, will benefit the entire community. The policy priorities established in local general plans have tremendous potential to improve community health and make the healthy option the easier option for everyone.

Research shows that while access to health services is important, social, environmental, and economic factors also have a significant impact on health outcomes. The built environment is a key component of those factors and can affect all chronic conditions. Walkable neighborhoods promote physical activity, improving health outcomes.[xlix] Other links between health and environment continue to emerge; for example, the impact of green space on mental and physical health.[l] Many planning policies, such as Complete Streets, promote healthier outcomes by creating safer places to walk with improved connectivity to destinations. Thinking about health in the planning process can lead to better health outcomes, and using data to inform policy decisions can help to ensure that changes in the built environment improve health disparities, instead of worsening them. Cross-sectoral work throughout the planning process allows communities to prioritize policies and coordinate with other local government agencies and private or non-profit partners to improve the health of the community. Many of the health-related policies identified in this section also promote economic, equity, and climate resiliency goals.

This chapter provides concepts integrated from promising practices that communities may voluntarily incorporate into their general plans and focuses on data analysis and policy development to further healthy planning. Fortunately, many opportunities are already aligned with existing planning practice and state legislation, such as requirements for incorporating complete streets, addressing climate change, and considering environmental justice. This chapter provides ideas for data analysis, policy development, and implementation. Information was gathered from multiple sources, including health organizations across the state, a review of existing published research literature, a survey of promising practices, and extensive stakeholder engagement. As with all of the voluntary sections, this chapter provides suggestions and resources for use by jurisdictions as they see fit. Some of the discussion on topics such as environmental health, nutrition and food systems, housing, and active living and recreation have been moved to Chapter 4 since SB 1000 was signed into law requiring these issues be addressed for disadvantaged communities.

CORRELATIONS BETWEEN ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Safety	Noise	EJ
Healthy Communitites	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	IN STATUTE

■ Identified in statute ■ Closely related to statutory requirements

Strategies and Approaches

Incorporating Health Considerations into General Plans

Local jurisdictions that have incorporated health considerations into their general plans have opted for one of three formats 1) a separate health element; 2) an integrated approach which has health woven throughout all elements; or 3) a hybrid approach that weaves health throughout the General Plan and uses a health element to frame the importance of health issues. The adoption of a health element is consistent with Government Code section 65303. There are benefits to having a separate health element because it can be easier for the public and decision-makers to see health-related policies in one place. At the same time, an integrated approach puts health-related policies into the elements that address those issues. For example, including active transportation policies in a circulation element may potentially make implementation more actionable, by incorporating them in to larger transportation plans. Additionally, some jurisdictions incorporate specific health considerations into the housing element. Since this element is often updated more frequently, it provides an opportunity for more regular evaluation of policy implementation and progress. Regardless of approach, health-related policies must meet internal consistency rule set forth in Government Code Section 65300.5. Ultimately, the best format will depend on the local context, available funding, and community interest, and should complement the overall general plan update and vision.

Jurisdictions will likely prioritize various health considerations differently depending on the local context. For instance, a rural community could prioritize trail connectivity while an urban area might focus on active transportation, while other communities may emphasize clean water access, food systems, or access to health care. Whether the general plan is being adopted by a city or county could also impact which health issues emerge as priority areas. Additionally, policies that work in a rural area might not be as relevant for an urban area and visa versa. The discussion below is not exhaustive, but rather a starting point for further deliberation as to some of the associations between health and planning.

Definitions

Health: A complete state of physical, mental, and social well-being, and not merely the absence of disease.

Health Equity: Means every person, regardless of who they are- the color of their skin, their level of education, their gender or sexual identity, whether or not they have a disability, the job that they have, or the neighborhood that they live in- has an equal opportunity to achieve optimal health.

Health Disparities: Refer to differences in health and mental health status among distinct segments of the population, including differences that occur by gender, age, race or ethnicity, sexual orientation, gender identity, education or income, disability or functional impairment, or geographic location, or the combination of any of these factors.

Sources listed in order:
http://www.who.int/about/mission/en/
HealthEquity: Braveman, PA, et al. (2011) Health Disparities and Health Equity: The issue is Justice. American Journal of Public Health, 101 (S1), S149-S155
Health Disparities: California Health and Safety Code (code sign) 131019.5

Health in All Policies

Health in All Policies (HiAP) is a collaborative, cross-sectoral approach that is being used by jurisdiction across California, the United States, and internationally to address the social and environmental factors that drive health outcomes and health inequities. This includes promoting walking and biking, access to healthy food, healthy housing, violence-free communities, and educational and economic opportunities for all.

There is no one "right" way to implement a HiAP approach, and there is substantial variation in process, structure, scope, and participation in the initiatives. Many HiAP initiatives facilitate health and equity input into general plans. California jurisdictions that use a Health in All Policies approach include:

- The City of Richmond's HiAP Strategy Ordinance
- Ventura County's HiAP Resolution
- Los Angeles Healthy Design Ordinanace and Workgroup
- Salinas HiAP Advisory Council

- Monterey County HiAP Framework
- Healthy Riverside County Initiative
- Healthy Rancho Cucamonga

Resources:
Health in All Policies: A Guide for State and Local Government: http://www.phi.org/uploads/files/Health_in_All_Policies-A_Guide_for_State_and_Local_Governments.pdf

California Health in All Policies Task Force: http://sgc.ca/gov/Initiatives/Health-In-All-Policies.html

Innovative Partnerships and Collaboration

Planning relies on collaborating with different sectors to accomplish the vision set forth in the general plan. Addressing health in the built environment creates an opportunity to form new partnerships. Several organizations can provide unique health expertise and offer a health perspective during the planning process. Additional models of collaboration are referenced in each Chapter.

Both health and planning have distinct professional terminology. In local jurisdictions that have successfully integrated health considerations, cross-sector groups prioritized learning basic planning and health terms, which is important for professional collaboration as well as for community outreach. The long-term nature of the land use plans, e.g., 20 years or more, is new to many groups outside of the planning community. Particularly for large jurisdictions, general plan updates can be costly and are not undertaken frequently. Therefore, it is important to provide clear expectations in the initial phases of engagement, to clarify the timeline, and set expectations about the planning process. In addition, it may be beneficial for jurisdictions that decide to incorporate explicit health considerations into their general plan to start with a city or county resolution prior to the formal update. This may help raise awareness about the connections between the built environment and healthy planning to achieve improved health outcomes. The "Healthy Eating, Active Living Resolution" is an example of such a resolution. To date, 191 cities across California have enacted resolutions to support health and wellness policies.[li]

Sources of Support and Information for Health Considerations

- **Local County and City Departments of Public Health**: Public health experts have in-depth understanding of local health data as well as strong ties with community organizations.
- **Health related non-profits**: Many organizations are working to improve walkability, bikeability, accessibility for the disabled, and overall health in local communities.
- **Equity or Environmental Justice related non-profits**: Many organizations are working to improve conditions in communities unable to access basic resources like safe water, healthy foods, and clean air.
- **Community groups**: Neighborhood or community organizations, local parent groups, youth groups, faith-based organizations, or topically focused interest groups often work on community health issues.

- **Academic institutions**: Academic researchers often analyze health data and provide expertise on data analysis, mapping, health impact analysis, and knowledge of local health conditions.
- **Hospitals and/ or clinics**: Health care reform has increased awareness on the social, environmental, and economic issues that affect health beyond clinic walls; non-profit hospitals conduct community health needs assessments (CHNAs) which are often made available online and provide funding for initiatives to improve health.
- **Local and Regional Governments**: Local agencies such as police, water, flood, utility, and air districts manage programs that impact healthy planning processes.
- **Local School Districts**: School districts partner with Safe Routes to School programs to ensure safe access to get to school; districts also participate in school siting of new facilities, have access to forecasted school growth and/or school closing data.
- **Private Sector Partners**: Local business associations, vendors, and local industries are increasingly designing work wellness programs that often have a transit component.

Innovating in Riverside - A Healthy Community Planner

In 2011, through a grant by The California Endowment (TCE), the Riverside County Department of Public Health became the first health department in California to hire a full-time urban/regional planner. This "Healthy Communities Planner" position is designed to provide leadership in bringing public health concerns into municipal planning. The planner is key to bridging the gap between public health and urban/regional planners to help ensure that health is considered as the cities and the county plan for the built environment, future development and population growth. The planner is helping to implement the County's Health Element of the General Plan, actively participates in TCE's Building Healthy Communities Initiative, and works with the county's 28 cities to adopt "Health City Resolutions."

Health Considerations

The health considerations listed in this section were gathered from multiple sources, including health organizations across the state, a review of existing literature and best and promising practices, and an extensive stakeholder engagement process. It is divided by general health consideration; example policies are listed below to address these topics as well as in the Appendix A.

SB 1000, "The Planning for Healthy Communities Act" requires cities and counties with disadvantaged communities to address certain health considerations within an Environmental Justice element or related goals, policies, and objectives.[lii] Since there is now a statutory requirement to address some of these health considerations including environmental health, food access, access to safe and sanitary homes, and access to physical activity, a full discussion is in Chapter 4 in the Environmental Justice Section.

Economics and Health

Increasingly, health is recognized as a vital component of human capital. Several measures of health and wellbeing are factored into the World Economic Forum Human Capital Report.[liii] Communities that have access to a wide array of resources have more opportunities to experience healthier outcomes and attain their fullest potential. Disinvestment in communities may have the opposite result, worsening health and safety outcomes. Land use planning can influence commute patterns and access to jobs, while development projects may create job opportunities. General plan policies can impact the presence of anchor institutions, such as universities, schools, medical facilities and/or clinics, and have a stabilizing effect on the local economy. Recently, the San Francisco Federal Reserve Bank launched a nation-wide Healthy Communities Cross-sector Initiative to facilitate discussion between community development partners and the health sector, seeking to improve investment in low-income communities and improve health at the community level. New models, with a more integrated approach, continue to emerge and focus on measureable and scalable results. Many of the models for economic development recognize the role of transit-oriented and infill development to leverage resources and increase access to services and amenities to support healthy lifestyles for local community members that work, live, and play in the surrounding areas.

Concurrently, land use patterns that promote healthier lifestyles can generate economic value. A synthesis of peer-reviewed literature showed that open space for recreation and walkable communities create positive economic impacts.[liv] Recognizing the power of healthy planning, the Urban Land Institute created a building healthy places initiative and recently published a series of case studies from developments around the world featuring wellness factors including support of bicycling, built amenities to support physical activity, and design to increase social interaction.[lv]

With changes in health policy, new incentives have emerged for workplace wellness programs, including opportunities to site businesses near multi-modal transportation in a manner that encourages walking, increases activity through design, and improves health in conjunction with workplace programs.[lvi]

A Changing Climate & Resiliency

The natural environment supports human life. Humans, in turn, impact the natural environment. The most prominent example is climate change caused by greenhouse gases (GHGs). Climate change can have devastating consequences on health due to physical or mental harm or displacement from increased frequency or severity of disasters like flooding, drought, fire, and landslides. Climate change may not only increase existing risks but will also pose new threats to human health. The California Department of Public Health provides recommendations and publications dealing with health and climate change. While climate change will be one of the biggest threats to public health for decades to come, land use planning can help communities prepare, adapt, and reduce GHGs that cause climate change. The safety element already requires consideration of natural hazard areas, to avoid or mitigate for potential hazards including fires, flood zones, earthquakes, and landslides. Explicit consideration of health issues provides an opportunity to improve resilience of local communities, especially vulnerable populations.

Some health effects of climate change are already occurring due to increasing temperature. Temperature records continue to be broken with increasing temperatures on record.[lvii] Temperatures in urban areas can exacerbate already warm conditions due to materials, such as asphalt absorbing heat and then releasing it, causing urban heat islands. Increased exposure to heat puts children, elderly, and people with pre-existing health conditions at more serious risk to suffer from heat stroke and heat-related complications. Studies show increased mortality during times of high heat.[lviii] In fact, according to the Center for Disease Control, between 1979 and 2003, more people prematurely died from extreme heat-related illness than the total combined deaths from other natural disasters including tornadoes, floods, earthquakes, hurricanes, and lightning.[lix]

Land use planning to reduce urban heat island effects is essential to creating more resilient communities. Increased urban greening and cool surfaces, which have a high-albedo effect, reflecting higher portions of radiation and thus absorbing less, can decrease temperatures and lessen the effects of extreme heat. Green roofs can also have health benefits by reducing exposure to heat with the added benefit of better air quality. Healthy tree canopies can also provide shade from heat, help with carbon capture, and improve air quality.[lx] Land use planning can also help to ensure the availability of water resources for cooling purposes.

With climate change, there is a growing recognition of the need to preserve limited resources such as water, fertile ground for agriculture, energy, and clean air. All of these actions are vital for human health.

Street design that promotes walking and social interaction

Photo by Elizabeth Baca

Land use policies to promote efficient circulation, conservation, and recapture of water are needed for water conservation and drought mitigation. Additionally, it is important to control for pools of stagnant water. As water pools, without natural systems such as certain fish populations, there is an increased risk for mosquito reproduction. With higher mosquito populations, strong pesticides- that can affect health- are required to spray to contain mosquito populations. Scientists predict that vector borne diseases will change in the future as a result of climate change. More tropical diseases not previously experienced in California, such as dengue and yellow fever, may emerge. In 2013, the particular mosquito that carries dengue was found in California. Land use policies to conserve water and prevent large-scale stagnant pools will be key in combating and containing such health risks.

Climate change also has the potential to harm agricultural yields. Ensuring adequate food supplies to feed the population and avoid famines will require preservation of agricultural land. Land use policies that identify and avoid development on prime agricultural land are important to protect California's food supply.

Energy conservation programs have potential health co-benefits. When developments are planned to use less energy they can reduce energy bills and allow families to use the savings towards other expenses. Additionally, energy efficiency measures may align with opportunities to improve indoor air quality, which can reduce costs of respiratory illness such as asthma.[lxi]

Policies that continue to improve air quality--such as creating more public transportation options, zero emission vehicles, and bike and walk options for commuting-- are all important to maintain air quality and promote public health for all segments of the community and particularly the most vulnerable.

Social Connection & Safety

The physical environment can have a significant impact on health and wellbeing, but the social structures and how community members engage within the physical space can be equally important. Feeling connected to neighbors, feeling safe in one's home, and having a robust supportive social network affects physical and mental health.[lxii] A neighborhood can be well designed and offer amenities, but if the local residents perceive the area to be unsafe, or there is a great amount of community violence or trauma, it will not be utilized to its full capacity. Design principles can be implemented with this in mind. Crime prevention through environmental design (CPTED) examines environmental conditions that have unintended consequences on behavior. This field of research combines evaluations of place and human interaction. CPTED uses design elements to control access, provide more opportunities for passive observation of what is occurring in the area, and encourage civic engagement to maintain properties. An important aspect of implementing CPTED includes a wide, multi-sector-planning approach including law enforcement, for example- community engagement process to define the problems, opportunities, and solutions. Form Based Codes are another planning tool that focuses on design at a scale that incorporates more granular level changes, such as building facades and street level design. This also has potential to design elements to foster more social cohesion. Civic participation and social cohesion can be supported through the design of community spaces that provide engagement, access to learning opportunities, quality interaction of residents, multi-generational connections, public services such as libraries, and cultural and art facilities. Joint use agreements, also known as shared use agreements, with schools allow for another opportunity to collaborate with school districts, maximize resource utilization, and foster more activated spaces that otherwise would be empty during non-work hours.

A safe community with active streets includes protection from criminal activity, as well as from avoidable collisions. Many design elements such as narrower streets; appropriate lighting, improved signage, and slower speed limits can help reduce collisions. Traffic calming measures, complete streets, and improvement of physical infrastructure are important components of injury prevention. In fact, jurisdictions across the US and beyond have adopted Vision Zero efforts to aim for zero collision-related deaths through street design, engineering, and addressing driver related issues. As referenced in the circulation element, the California Complete Streets Act of 2008 (AB 1358) requires local jurisdictions, upon any substantial revision of the circulation element, to plan for a "balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan."[lxiii] The circulation element provides an excellent opportunity to incorporate design for safety and multimodal use. The National Association of City Transportation Officials (NACTO) Street Design guidelines, formally endorsed by Caltrans in 2014, offer examples and a blueprint to guide complete street policy implementation, particularly around priority sites such as schools and daycare centers.[lxiv]

Health & Human Services

Hospitals and clinics are increasingly recognizing that where patients live, learn, work, go to school, and play affects their health and wellbeing. Through new paradigms and innovation, they are considering what community services are necessary to support health for individuals in their community. Non-profit hospitals conduct community health needs assessments as part of their community tax requirements and can reinvest into the community based on the assessment. Additionally, these reports prioritize key health needs for the catchment area and can provide useful information during the planning process. Increased access to health care, opportunities for physical activity, and healthy foods are key priorities that may be addressed in the general plan to improve community health. In addition, general plan policies may improve access to health services through integrated public transportation and provisions for access to broadband, allowing for telemedicine capacity.

General plan policies authorizing or promoting supportive housing can facilitate the integration of healthcare services into multifamily housing developments, especially for the elderly and disabled. A number of housing developments in major metropolitan areas include health clinics, and community spaces, and tenant services for special needs populations. Supportive services have multiple benefits, for both tenants and property management. Integrated service delivery plays a critical role with populations at risk of homelessness or institutionalization. Healthcare providers have started to bring farmer's markets and gardens on clinic and hospital premises to facilitate access to healthy food for their staff and patients.

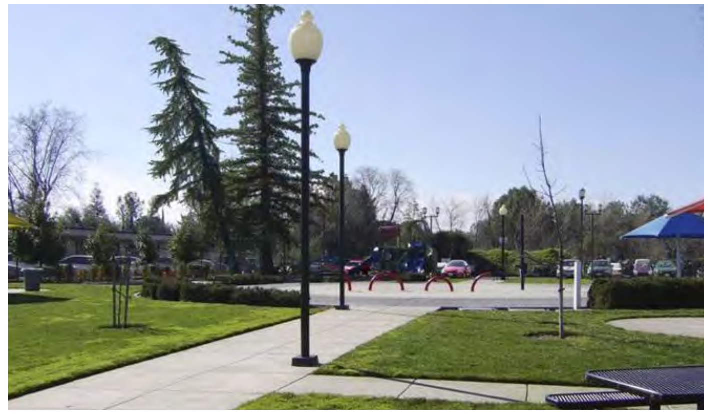
Clinic locations, particularly federally qualified health centers, serve as important meeting points and service centers in case of a disaster. Having established systems in place to ensure access to routine services allow for a more robust and resilient system during times of emergency.

Health Data and Mapping

Data, Mapping, and Tools

Defining existing conditions is part of the general plan update. Incorporating health data creates an opportunity to conduct a more comprehensive existing condition analysis, while also providing baseline data to track progress, particularly for the social, economic, and environmental factors that can impact health. The housing element section includes analysis of community characteristics related to population characteristics, economic conditions and well-being, housing needs, and special populations. These issues all have health implications. As more and more local jurisdictions have started to incorporate explicit health considerations, geospatial data can be used to analyze health outcomes at a geographic level and to inform how health considerations might be incorporated or targeted. Additional tools such as walk audits, charrettes, community-based visual cataloging, and new crowd sourcing platforms can be an effective means of getting communities involved for more local and qualitative data. There are also resources to help find and utilize data for planning purposes, such as "Neighborhoods by Numbers : An Introduction to Finding and Using Small Area Data".[lxix]

Healthy communities provide safe, accessible spaces for all residents.



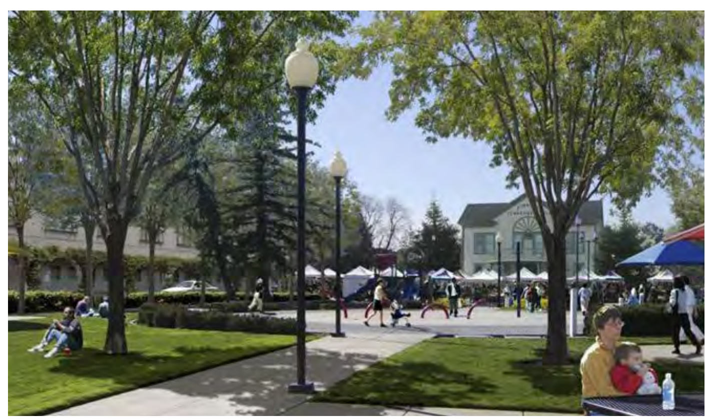


Image by Urban Advantage, SACOG

Data is informing policy in innovative ways. Just as a physician would look at vital signs of a patient, cities and counties have started to look at vital signs or community dashboards that are reflective of the population's health, social, economic, and environmental conditions. An important step in the process of incorporating equity considerations is to assess baseline conditions and acknowledge existing disparities. This type of analytic measurement can be particularly informative when examining areas that are disproportionately burdened by poor health outcomes to help target needed resources towards more vulnerable populations. It can also provide a baseline for analytic discussion on location of services, where to prioritize new or update current infrastructure, and provide a means for tracking outcomes of development and infrastructure investments over time. A more in-depth discussion on supporting and engaging vulnerable populations is located in Chapter 4 and Chapter 5.

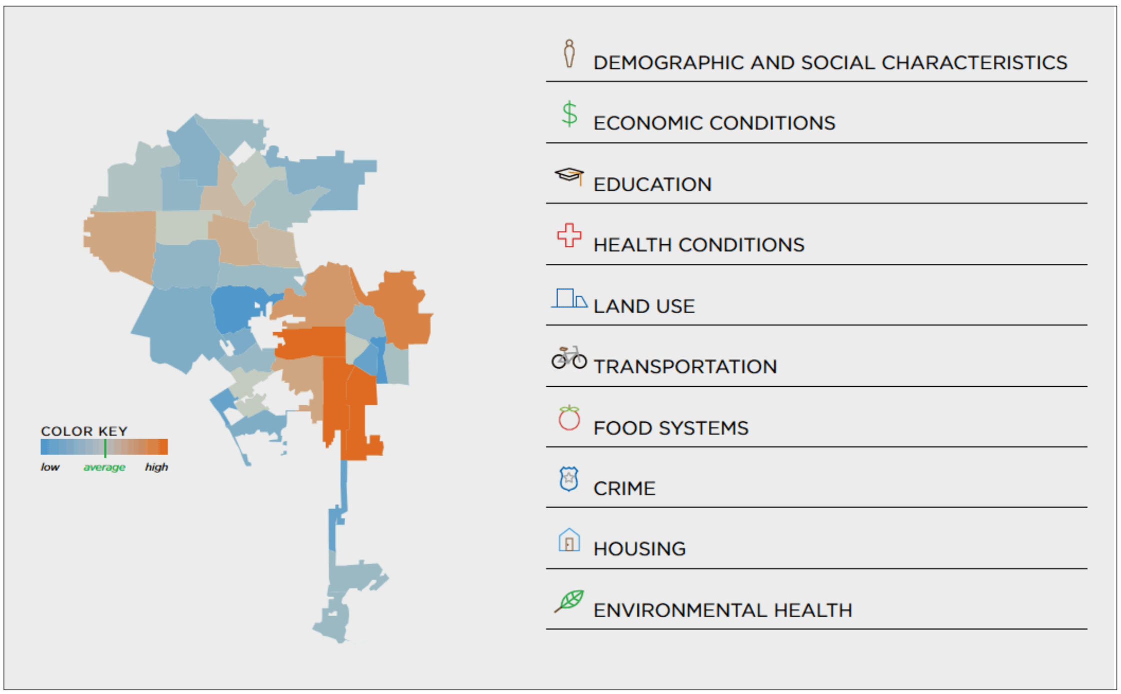
Additional Health-Related Data Resources

Many health, social, environmental, and economic indicators are available at the census tract level. Health departments also have access to local geospatial data on health outcomes and health determinants, occasionally at a more granular scale. Some health departments may already have reports prepared for their accreditation process that can be applicable to creating a baseline analysis for planning. It is helpful to consider variation within the data and to identify and address differences in health outcomes and the underlying reasons. Data needs and analysis will vary based on population characteristics and whether the area is rural or urban. Local outreach and experts involved in the update are able to help determine what data to prioritize in the analysis. Some additional health data resources include:

- **Community Health Needs Assessment**: This free web-based platform was created to assist community hospitals doing their needs assessment and provides census level data for health, economic, social, environmental, and behavioral data.
- **California Environmental Health Tracking Program**: This program is hosted by the CDPH. The data is more focused on environmental health impacts such as air quality, health, climate change related outcomes, water quality, and cancer prevalence.
- **Envirostor**: the Department of Toxic Substances Control hosts this program. It is a database that provides data in a GIS form to identify contaminated sites as well as facilities that deal with hazardous waste. This resource is important for remediation and siting.
- **CalEnviroscreen**: The Office of Environmental Health Hazard Assessment (OEHHA) in the California Environmental Protection Agency created this online mapping tool. It is a tool that can help identify communities that are burdened with high levels of pollution and/or are highly vulnerable to its effects. The tool also contains socioeconomic data.
- **Healthy Communities Data and Indicators Project (HCI)**: the California Department of Public Health (CDPH) hosts HCI. This indicator list provides evidence for links to health outcomes, data sources, and offers the ability to create maps.
- **California Health Interview Survey (CHIS)**: The largest state health survey in the nation, CHIS is a random phone interview administered by the UCLA Center for Health Policy in conjunction with the State Department of Public Health and the Department of Health Care Services. CHIS recently added new functions, available at the neighborhood level in certain jurisdictions, on health behaviors and conditions of relevance to planning for healthy communities.
- **Transportation Injury Mapping System (TIMS)**: TIMS was created and is maintained by University of California, Berkeley. It hosts data on injury and collision data.
- **Travel Surveys**: Both the California Household Travel Survey and the National Household Travel Survey contain important information on travel-related behavior.

- **California Protected Areas Data Portal**: This data base provides a detailed GIS inventory of all parks and open space owned by agencies and nonprofits in California and serves as a resource to assess access and proximity.
- **Cal Brace Data**: The California Department of Public Health provides climate change and health profile data for counties. Data ranges from covering issues such as food insecurity to vector born illnesses and heat impacts.
- **The California Health Disadvantage Index**: This statewide tool is supported by the Public Health Alliance of Southern California and includes data. The data includes many social, economic, and environmental factors that impact health.

The City of Los Angeles created an interactive geospatial map of built environment and health conditions to inform the update of their general plan. A report was produced to inform community outreach, meetings, and policy formation.



Source: http:/healthyplan.la/the-health-profiles/

Sample of OPR Recommended Data for Consideration in Analysis of this Element

The health data resources listed above have some of the recommended data below. Other more granular data might be available through the local department of public health, the local air district, the metropolitan planning organization, water district, or business association.

Intent of Analysis	Recommended Data
Life expectancy can be a good proxy for general health and well-being in the community. Many low-income areas suffer from early mortality and morbidity.	Life Expectancy at Birth
Asthma can be worsened by environmental triggers such as poor air quality, poor housing quality, and climate change, examining baseline conditions can help inform siting decisions.	Asthma (Prevalence, ED visits, hospitalizations)
Obesity is caused by many factors, but lack of access to healthy foods and physical activity are significant contributors. Examining baseline status can help with policy decisions around active transportation, recreation priorities, and food system policies.	Obesity (child and adult) prevalence
These diseases, also caused by many factors, are often associated with obesity. Examining baseline status can help with policy decisions around active transportation, recreation priorities, and food system policies.	Secondary diseases from obesity (high blood pressure, high cholesterol, heart disease, type 2 diabetes prevalence)
Many vehicle crashes involving pedestrians and bicycles could be improved through infrastructure, design, and signage. Examining a baseline can inform policy and planning for transit routes, active transportation, and safety.	Unintentional pedestrian and bicycle injury
Walk trips is a behavior that benefits health and is influenced by the environment. Examining a baseline number can help inform active transportation and for climate change and resiliency policy.	Walk trips per capita
Children walking, biking, or rolling to school is a behavior that can improve health and is influenced by the environmental conditions such as distance to school and safety. Examining the baseline condition can inform policy priorities around active transportation, active design, school siting, and housing siting.	Percent of children who walk, bike, roll to school
Commuting decisions are influenced by connectivity, cost and ease of use. Active transportation can have positive health benefits since people are able to achieve higher physical activity. Examining the baseline can inform policy priorities around active transportation, mixed use developments, job locations, and housing locations.	Percent of commuters who use active transportation
Eating more fruits and vegetables is a behavior that can be supported through more access to healthy, affordable options. Examining a baseline condition can inform policy around food systems and location of services.	Consumption of daily fruits and vegetables
Having access to adequate, affordable, and healthy food is important to health. Examining a baseline condition of those suffering from food insecurity can inform policy around food systems and location of services	Self-reported food insecurity
Understanding the poverty conditions can help focus resources and policy development to areas that need additional support. This is important for various issues such as ability to afford healthy food.	Poverty data for population below 200% of the Federal Poverty Level
Income is an important predictor of health outcomes. Access to job opportunities as well as job/housing/work force fit can inform transit lines, housing location, and where jobs are incentivized to locate.	Employment Density (example: Trade Transportation, utility, leisure, hospitality, goods producing, government, education, real estate, finance, health services)
Mapping baseline food retail and access conditions can identify areas that might not have adequate access and inform policy priorities and decisions for siting.	Food retail, community garden, and farmer market location
Creating an inventory of available vacant public and private lands can help identify lands for conversion into community gardens, urban farming, or small parks.	Number of unused or under-utilized property per tax assessor records
This can help identify vulnerable populations, in conjunction with the poverty data above.	Uninsured population data

Intent of Analysis	Recommended Data
Mapping baseline walk and bike conditions can help create a more connected network for improved use.	Walk and bike maps
Mapping baseline transit conditions can help identify areas that could benefit from improved transportation options	Public transit facilities
Safety in the neighborhood can impact social stress and influence whether people will be active. Establishing a baseline condition can help inform safety policies such as crime prevention through environmental design	Percent of people that feel safe in their neighborhoods
Neighborhood parks contribute important health and community well being benefits, when they are located nearby. Examining the proximity of people to parks can identify areas for future park investment, especially where there is no park within walking distance, or within 1/2 mile.	Inventory of parks and protected open space
This can be assessed to track and analyze risk of displacement	Housing cost burden
Air quality has direct effects on people with respiratory disease. Mapping baseline conditions can help inform policies around transportation, connectivity, siting, and industry.	Air quality (ozone, pm 2.5)
Extreme heat days and heat island effects can cause illness and even death in extreme circumstances. Monitoring heat days and areas with worse heat effects can help inform policies around transit, greening, materials, and programs to mitigate its effects.	Extreme heat days, heat islands effects
Urban tree can have multiple benefits for air quality, shade for easier time spent outdoors for commuting and recreation, and even new research on the benefits of mental health and mood. Establishing a baseline can help inform policy for transit, roadway, recreation, and bike and pedestrian planning.	Urban tree canopy
Health facilities provide daily services and often serve the community in disaster. Establishing a baseline of where services are located can help improve transit decisions, siting, and emergency preparedness planning.	Location of health facilities
Mapping where schools and child facilities are can provide an important baseline. This can inform policies to leverage joint use agreements, ensure they are accessible and free from newly sited environmental hazards.	Location of schools, child care facilities
How much people drive is a proxy to understand how active community members are. New research suggests that the amount of time spent in a vehicle may have potential effects on mental and physical health.	Vehicle Miles Traveled (VMT)
How much the local community is civically engaged can be a measure of how activated the community is	Voting rates

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Policy	Example	Relation to other elements
[City, County] shall promote uses that address daily needs within the [city, county] City and close to neighborhoods, reducing the need for residents to travel long distances to access jobs, goods and services.	City of Arvin	Circulation, land use, housing, economic development, equitable and resilient communities, climate change
[City, County] shall encourage development that reduces VMT, decreases distances between jobs and housing, reduces traffic impacts, and improves housing affordability.	County of Sonoma	Economic development, equitable and resilient communities
[City, County] shall plan for the public health implications of climate change, including disease and temperature effects.	County of Marin	Climate change, EJ, equitable and resilient communities, land use
[City, County] shall encourage the development of complete neighborhoods that provide for the basic needs of daily life and for the health, safety, and mental well-being of residents.	County of Riverside	Circulation, land use, equitable and resilient communities
[City, County] shall implement policies and programs that encourage bicycling and walking as alternatives to driving and as a means of increasing levels of physical activity. Encourage bicycle and pedestrian safety through education and incentive programs.	City of El Monte	Circulation, land use, housing, economic development, climate change, EJ, equitable and resilient communities
[City, County] shall invest in community planning efforts that aim to reverse trends of community deterioration and blight which lead toward the decline of personal and property safety within the [city, county] community districts.	County of Kings	Economic development, equitable and resilient communities, land use
The attraction and retention of high quality grocery stores and other healthy food purveyors should be pursued as an economic development strategy for the [city, county]. Healthy food outlets include full-service grocery stores, regularly-held farmer's markets, fruit and vegetable markets, and convenience stores or corner stores that sell a significant proportion of healthy food.	The City of South Gate	Economic development, EJ, equitable and resilient communities, land use

7

Economic Development and the General Plan

Designing Healthy, Equitable, Resilient, and Economically Vibrant Places

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"World class communities come in all shapes and sizes, they are not determined by geography, and/or natural resources so much as by the mindset of their local leadership."

—Don Allen Holbrook, The Little Black Book of Economic Development

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Introduction

The resilience of an economy both shapes and is shaped by its physical development. It strongly influences how a jurisdiction governs. Cities and counties may include a distinct economic development element, or highlight economic development as a primary theme or goal throughout their general plan. Most communities set forth goals of economic health and sustainable funding for public services for current and future residents, as part of support for a thriving business environment, job growth and retention, and, as appropriate, community revitalization.

CORRELATIONS BETWEEN ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Safety	Noise	EJ
Economic Development	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	-	RELATED

■ Identified in statute ■ Closely related to statutory requirements

Decisions regarding land use and circulation can promote businesses and increase property values.[lxv] Planning effective transportation access to centers of employment, education, and services can help a city or county build and maintain a strong economy. Ensuring an appropriate jobs-housing balance provides residents with nearby employment choices. And fostering public health will have a direct effect on improvements in labor productivity and increased personal income.[lxvi]

Businesses and Employment

Cities and counties can use general plan policies to promote business development and retention, job training and workforce development, partnerships with educational institutions and private and non-profit organizations, incentives for targeted business investments, and marketing and communications programs. Economic development policies should be based on goals identified through community engagement, which should include targeted outreach to the business community. Involving potential employees, developers, and business leaders early in the planning process will help ensure policies grounded in the community vision.

Economic development is strongly related to the circulation element; particularly through the movement of goods, services, and people. Resident and visitor access to employment centers and commercial centers is critical. Assessing and addressing the needs for current and future accessibility through multiple modes, including transit, pedestrians, and bicycles will provide employees and customers access to new and existing businesses and help support economic growth and vitality. Proximity to transit options increases property value as well as economic activity. Promoting connected systems of walkways, bikeways, and transit lines leading to economic centers provides easy, affordable access to retail, employment, and services. Including additional infrastructure around retail centers, such as bikeshare stations, pedestrian rest areas, and covered transit stops, may help economic stimulation.

Revenue Share Agreements

At times, when potential development straddles geographic boundaries between jurisdictions, projects can be delayed or terminated due to conflict over revenue. Shared sales tax agreements, such as the one between the cities of Oakland and Emeryville, can ensure each city or county receives a share of the benefits of economic growth.

Waterford, Wisconsin. Main Street

Image by Urban Advantage, Lakes Area Realtors

Economic Development and Displacement

As cities and counties grow and prosper, consideration must be given to ensuring equitable development and minimizing displacement. While figures vary by geography and demographics, overall, low and middle income housing availability in California is shrinking. For every 100 extremely low income (ELI) renter households, there are just 34 affordable and available units.[lxvii]

Revitalizing communities, building strong economies, embracing sustainable, coordinated development, and improving infrastructure are all positive policies with a wide range of benefits for communities. An efficient economy relies on housing options that are affordable to a range of workers and accessible to jobs. HCD has created recommendations to combat displacement in planning and implementation in their Statewide Housing Assessment. Additionally, numerous organizations and academics are working to identify potential tools for planners, advocates, and local governments. Some of these tools include:

- Community benefits funds
- Value Capture
- Inclusionary zone

Healthy Communities and the Economy

Public health outcomes correlate directly to economic vitality. Increased investment in communities can lead to improved public health outcomes, through greater opportunities for active transportation and outdoor activity, increased access to nutritious food, and improved economic opportunities. Planning for employment and business centers that are accessible through transit and active transportation can be especially beneficial to public health outcomes, and improve equity in communities.

Ensuring all residents of a city or county are included in economic development planning - through distribution of infrastructure, retail, employment, transit and active transportation networks, housing, and other considerations - can ensure improved health outcomes for the full community.

Economic Development and Climate Change

The impacts of climate change present an increasing threat to local economies throughout California. Planning for climate resiliency and adaptation can help support and maintain a strong local economy. By incorporating climate impacts into long term planning, cities and counties can help local businesses, and their economy, recover more rapidly from climate events, increasing community resiliency. Additionally, promoting adaptation and resilience creates more secure fiscal environments for investment, promoting development and job growth.

Cities and counties can explore the Cal-Adapt tool to examine potential climate impacts in their community. By implementing policies to promote adaptation and resiliency, local communities can help reduce the likelihood of economic disruption from natural disasters and extreme weather events. Planning and policies for climate change can also improve economic recovery after climate events, increasing business resiliency and fiscal stability.

Community Assets and Fiscal Stability

Community assets such as schools, parks, open space, universities, and cultural amenities, as well as infrastructure such as sidewalks, transit systems, and utilities, help create cities and counties that attract residents and businesses. The creation, maintenance, and promotion of

Revenue Share Agreements

At times, when potential development straddles geographic boundaries between jurisdictions, projects can be delayed or terminated due to conflict over revenue.

The neighboring cities of Oakland and Emeryville recognized this issue warly on, and developed a revenue share agreement in 1994 to address it. In 2011, when a large Target opened on the border of both cities, the existing agreement helped them share the additional $550,000 in sales tax revenue.

Shared sales tax agreements, such as the one between the cities of Oakland and Emeryville, can ensure each city or county receives a share of the benefits of economic growth.

assets and infrastructure should be addressed throughout the general plan. Infrastructure and community assets must align with economic development goals, as they attract, retain, and support the workforce and commercial base that new and existing businesses require.

Ultimately, businesses will invest in and support communities that offer a strong workforce, a stable fiscal climate, and policies to support their growth. General plans create an opportunity for cities and counties to implement policies that can spur economic development, revenue generation, and shared benefits for all community members. Additionally, equity should be considered in all economic development decisions, to ensure all community members benefit from policies and investments.

Engagement with the Business Community

A strong general plan will benefit from outreach and input from all community members. It is important to engage business community members in any economic development plan, as their input and support is vital to its success. Direct outreach, including visiting existing businesses, surveys, and small, targeted meetings, will help ensure engagement with the business community. Additionally, working with business organizations such as chambers of commerce, Business Improvement Districts, and Economic Development Corporations; partnering with service clubs such as Rotary or Kiwanis; and connecting with colleges and universities and Workforce Investment Boards will create a robust pool of information from community members invested in economic development. Such outreach could even lead to public private partnerships, shared benefit programs, or increased investment in the community.

SAMPLE OF OPR-RECOMMENDED DATA FOR CONSIDERATION IN ANALYSIS OF THIS ELEMENT

Intent of Analysis	Recommended Data
Inventory of current business establishments	Local lists, local chambers of commerce, or commercial sources such as InfoUSA.
Inventory of current jobs by industry and business	See above
Estimated wages by industry and occupation	Bureau of Labor Statistics Metropolitan Area Occupational Employment and Wage Estimates
Cost of living data	City-data.com and other sources
Population Characteristics	U.S. Census and City-data.com
Workforce Characteristics	U.S. Census and City-data.com

OPR Recommended Policies

These policies are an example of recommended policies adopted by varying jurisdictions, to be modified and used as appropriate. A full list of recommended policies can be found here.

Policy	Example	Relation to other elements
Encourage a balance between job type, the workforce, and housing development to reduce the negative impacts of long commutes and provide a range of employment opportunities for all (city/county) residents.	Sacramento	Circulation, healthy communities, equitable and resilient communities, economic development, climate change
[City, county] shall require the provision of bicycle parking and related facilities in new employment-generating development to facilitate multi-modal commute choices.	San Pablo	Land use, circulation, healthy communities, equitable and resilient communities, climate change
[City, county] shall establish a list of "ready-to-go" or "shovel-ready" sites in consultation with property owners, and provide the list to interested developers and businesses seeking sites in the city.	Fresno	Land use, circulation

8

Climate Change

Designing Healthy, Equitable, Resilient, and Economically Vibrant Places

"California, as it does in many areas, must show the way. We must demonstrate that reducing carbon is compatible with an abundant economy and human well-being. So far, we have been able to do that."

—Governor Jerry Brown

Introduction

The impacts of climate change pose an immediate and growing threat to California's economy, environment, and to public health. Cities and counties will continue to experience effects of climate change in various ways, including increased likelihood of droughts, flooding, wildfires, heat waves and severe weather. California communities need to respond to climate change both through policies that promote adaptation and resilience and by significantly reducing greenhouse gas (GHG) emissions. For requirements related to climate adaptation please see the Safety Element.

While climate change is global, the effects and responses occur substantially at the local level, and impacts and policies will affect the ways cities and counties function in almost every aspect. Cities and counties have the authority to reduce (GHG) emissions, particularly those associated with land use and development, and to incorporate resilience and adaptation strategies into planning. For example, the interplay of general plans and CEQA requirements is particularly critical in evaluation of GHG emissions and mitigation. For this reason, specific guidance is provided on how to create a plan to reduce GHG emissions that meets the goals of both CEQA and general plans. To this end, this chapter summarizes how a general plan or climate action plan can be consistent with CEQA Guidelines section 15183.5 (b), entitled Plans for the Reduction of Greenhouse Gas Emissions. This chapter can also be used to update older plans so they comply with the criteria in Section 15183.5 (b) and associated CEQA streamlining opportunities.

This guidance, however detailed, should not be considered the only approach to addressing GHG emissions at the local level. Local governments have substantial discretion in choice of methodology and may identify appropriate methods to address this important issue. This chapter also provides recommended approaches to consistency with other documents that may be related to the general plan such as climate action plans (CAPs), climate adaptation plans, and plans to reduce GHG emissions. Other chapters have more specific guidance for addressing climate change in the context of that element/chapter.

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Throughout this chapter, greenhouse gas emissions is referred to as "GHG emissions" and taking measures to address the impacts of climate change is referred to "adaptation." For more in depth definitions of GHG emissions and resilience refer respectively to the California Air Resources Board Climate Change Scoping Plan and the California Natural Resources Agency Safeguarding California Plan. For requirements related to climate adaptation please see the Safety Element.

CORRELATIONS BETWEEN ELEMENTS

	Land Use	Circulation	Housing	Conservation	Open Space	Safety	Noise	EJ
Climate Change	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED	RELATED

■ Identified in statute ■ Closely related to statutory requirements

Reducing Greenhouse Gas Emissions

Local governments play a critical role in reducing GHG emissions. In California, local governments regulate many activities that contribute to GHG emissions and air pollutants, including industrial permitting, land use and transportation planning, zoning and urban growth decisions, implementation of building codes and other standards, and control of municipal operations.

Since the Legislature expressly recognized climate change as a consideration in CEQA in 2007, local governments have typically addressed climate change either in policies in the general plan itself, or through adoption of a CAP. Doing so, among other things, allows for consistency with GHG discussions and related mitigation measures in the General Plan EIR and mitigation monitoring and reporting program.

The CEQA Guidelines recognize the important role of Climate Action Plans in the CEQA process (CEQA Guidelines § 15183.5, Tiering and Streamlining the Analysis of Greenhouse Gas Emissions). The Guidelines set forth a basic framework for developing a plan to reduce GHG emissions and acknowledges the role CEQA plays in ensuring the impacts of climate change are addressed (CEQA Guidelines § 15183.5(b), Plans for the Reduction of Greenhouse Gas Emissions).

The SEEC ClearPath California tool, supported by the state and available without charge, provides a "five milestone" process for GHG inventory, planning, implementation, and monitoring. While ClearPath is not the only approach, it includes support from state agencies and can be used as a starting point for local governments addressing GHG emissions. The Governor's Office of Planning and Research (OPR) and the California Air Resources Board (ARB) serve on the advisory committee for management of the ClearPath California tool to ensure its ongoing improvement and consistency with California climate policy. ClearPath and most proprietary tools also correspond to the Community Protocol for Addressing Community Scale Emissions and the Local Government Operations Protocol, which also have state support.

Plans to Reduce Greenhouse Gas Emissions

The GHG emissions reduction plan can be either a stand-alone CAP or directly part of the general plan. The CEQA Guidelines recognize either approach. Regardless of approach, local governments should inventory and mitigate GHG emissions "within a defined geographical area"—typically the city or unincorporated county over which they have land use authority.

Additionally, regardless of approach, it is preferable to create the plan to reduce GHG emissions concurrently with or closely following a general plan update. There are a number of benefits of aligning a GHG reduction strategy, such as a CAP, with a general plan update including:

1. Allowing local governments to include a wider range of mitigation measures in the GHG reduction strategy, especially those that are related to land use and transportation;
2. Allowing projects to take advantage of a wider range of CEQA streamlining measures;
3. Streamlining environmental review for the GHG reduction strategy itself; and
4. Ensuring that the CAP and general plan use a consistent set of baseline conditions and growth assumptions, which can save effort for planners.

SEEC ClearPath California "Five Milestone" Process for Addressing Community GHG Emissions

Source: www.californiaseec.org

The Role of CEQA Guidelines in Supporting GHG Emissions Reductions in General Plans

The CEQA Guidelines acknowledge the role of long-range plans, such as general plans, in addressing cumulative impacts (CEQA Guidelines § 15183.5(a)-(b)). This approach applies to greenhouse gas emissions (GHGs). Because GHGs can be evaluated in different types of plans, such as general plans, facilities plans, and CAPs, CEQA Guidelines section 15183.5(b) sets forth minimum criteria that a plan should satisfy to allow streamlining a cumulative impacts analysis under CEQA. For additional background, see pages 90 and 91 in the Natural Resources Agency's Final Statement of Reasons. For Regulatory Action: Amendments to the State CEQA Guidelines Addressing Analysis and Mitigation of Greenhouse Gas Emissions pursuant to SB97 (Dec. 2009).

Under CEQA, lead agencies should analyze the GHG emissions of proposed projects, and should reach a conclusion regarding the significance of those emissions (CEQA Guidelines § 15064.4, Determining the Significance of Impacts from Greenhouse Gas Emissions).

Lead agencies should also undertake an analysis of a proposed project's potential energy use (including transportation-related energy), sources of energy supply, and ways to reduce energy demand, including through the use of efficient transportation alternatives (Pub. Resources Code § 21100(b)(3); CEQA Guidelines, Appendix F). As with other environmental impacts, when a project's GHG emissions may be significant, lead agencies should consider a range of potential mitigation measures to reduce those emissions. (CEQA Guidelines § 15126.4(c)). Lead agencies should analyze potentially significant direct, indirect, and cumulative environmental impacts that a project may cause by placing projects in hazardous locations, including locations potentially affected by hazards that result from climate change. Agencies should also analyze impacts to the project where the project risks exacerbating those hazards. (California Building Industry Association v. Bay Area Air Quality Management District (2015) 62 Cal. 4th 369; CEQA Guidelines § 15126.2(a)).

As explained below, lead agencies may significantly streamline the analysis of GHG on a project level by using a programmatic greenhouse GHG emissions reduction plan meeting certain criteria (CEQA Guidelines § 15183.5(b)). As a result, the CAP and EIR, or general plan and EIR, with a robust discussion of climate impacts and mitigation, can be used to streamline project-level evaluation of climate impacts under CEQA.

CEQA Streamlining

CEQA requires analysis of a project's GHG emissions, a determination of whether those emissions are significant, and if so, mitigation of those emissions. On a project-by-project basis, such analysis can be complicated and costly. CEQA provides several ways for a project-level evaluation to rely on programmatic environmental review of climate impacts, including "tiering" (see CEQA Guidelines § 15385, tiering), use of master EIRs, and incorporation by reference (CEQA Guidelines § 15183.5(a)). While there are specific rules for using such tools, this chapter uses the term "streamlining" as a blanket term for relying on a certified plan-level environmental document, such as a general plan EIR, in analyzing the impacts of a specific project. Streamlining is a way for lead agencies to reduce project-level environmental review by ensuring robust evaluation at the programmatic level. Projects that are consistent with the CAP, for example, may be found to cause a less than significant impact under CEQA. (CEQA Guidelines § 15064(h)(3)).

1. Cumulative Impacts (Section 15064(h)(3))

CEQA Guidelines Section 15064(h)(3) provides that "[a] lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project will comply with the requirements in a previously approved plan or mitigation program," that meets certain criteria. However, providing substantial evidence showing how the cumulative effect (in this case of GHG emissions) is addressed is essential to a well-functioning plan or mitigation program that is addressing climate change. A general plan or CAP can lay the foundation for this substantial evidence.

2. Developing a General Plan or Climate Action Plan for CEQA Streamlining related to GHG Emissions (CEQA Guidelines § 15183.5(b))

When a project is consistent with a general plan or CAP that satisfies the criteria in subdivision (b) of Section 15183.5, a lead agency may also presume that the project's GHG emissions are less than significant. Section 15183.5(b) does not require public agencies develop plans for the reduction of GHG emissions, nor does it prohibit public agencies from developing individual ordinances and regulations to address individual sources of GHG emissions. However, a plan satisfying the criteria in that section can be used to streamline the CEQA analysis of future projects and can make it easier to manage both implementation and consistency discussions as required in general plans and general plan EIRs.

As technology improves to support the development of spatial accounting for GHG reduction strategies, CAPs should also be modified to reflect this more integrated approach. Tools such as Urban Footprint, General Plan Mapping Tool and the California GeoPortal can help support decision making by local officials through a data rich, geospatially-referenced environment while also retaining the substantial evidence to support a CEQA analysis.

CEQA Guidelines Section 15183.5, *Tiering and Streamlining the Analysis of Greenhouse Gas Emissions* outlines six "Plan Elements" that should be included in a plan to reduce GHG emissions. This general plan guidelines chapter provides additional guidance on how to implement this section in a general plan, or a CAP that is incorporated by reference into a general plan.

Further Guidance on the Six "Plan Elements" and Other Considerations

STEP 1: Section 15183.5(b)(1)(A) Inventory *("Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area")*

An essential component of a community scale CAP is the GHG emissions inventory. The Local Government Operations Protocol provides an approach for GHG inventories for municipal operations. The United States Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions provides an approach for community scale GHG emissions inventories in California and nationwide. OPR recommends use of these protocols in local government planning efforts. The Community Protocol does a good job of providing standards for quantifying emissions from different sources; however, individual jurisdictions may choose to do more detailed or different types of analysis depending on community needs.

OPR continues to work with the Statewide Energy Efficiency Collaborative (SEEC), ICLEI, Local Governments for Sustainability, the California Air Resources Board and the Association of Environmental Professionals to ensure the Protocol responds to the needs of California and is effectively integrated into tools, both currently available and under development, for local government use in calculating community scale greenhouse gas emissions. OPR recommends the use of the SEEC tools and templates for development of a general plan or CAP. However, there may be locally appropriate reasons to use other tools and resources such as when additional granularity is desired in specific sectors or when add-on tools achieve better results than the settings in ClearPath. For additional information on available tools and additional resources to complete GHG analysis, please refer to the Cool California website.

Consumption-Based Greenhouse Gas Emissions Inventories

Consumption-based emissions inventories (CBEI's) combines emissions from transportation and heating fuels used by households with emissions embodied in the life cycle of energy, food, goods and services they consume, regardless of where those emissions were produced in global supply chains. In contrast, production-based inventories traditionally used in CEQA and general plan discussions count emissions where they physically enter the atmosphere.

The CBEI for cities and counties in California is calculated by U.C Berkeley's CoolClimate Network and CoolCalifornia. Online carbon footprint calculators, maps and downloadable datasets are designed to inform households on their GHG emissions and actions that can be taken to reduce consumer drive GHG emissions.

STEP 2: Section 15183.5(b)(1)(B) Reduction Target *("Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable")*

A summary report published by the State Energy Efficiency Collaborative, "State of Local Climate Action: California 2016", found that almost all jurisdictions with a greenhouse gas emissions reduction target include 2020. Many jurisdictions also include a general plan buildout year target. Some are, and increasingly so, including goals for 2050. With a few exceptions, local targets are typically consistent with long-term targets the State has established for 2020 and 2050. Some jurisdictions are preparing updates to include 2030 targets. Nearly all jurisdictions include a "mass emissions" calculation. Some also include "per capita" and "service population" estimates where those metrics may be useful for additional context. Examples are also included in the SEEC document and case studies are available through the Integrated Climate

Adaptation and Resiliency Program (ICARP) Clearinghouse. Analyzing mass emissions at the community, state, per capita emissions, and service population emeissions may be appropriate to support a full understanding of community emissions.

Reducing GHG emissions on a trajectory consistent with long term State emissions reduction targets, as outlined in Executive Orders S-03-05 and B-30-15, and supported by the International Panel on Climate Change (IPCC), can demonstrate that a plan's emissions will be less than significant for CEQA purposes. Additional recommendations from the California Air Resources Board Scoping Plan for local action should also be considered.

Communities may also consider selecting multiple target years. Selecting a single reduction target year does not typically allow an agency to accurately assess the trajectory of the plan over time. Given the long-term nature of the effects of climate change, understanding the effects of the plan on long-term emissions reductions is necessary to determine whether the plan will reduce emissions to a less than significant level. Examining the long-term trajectory also allows a lead agency to determine whether the emissions reductions in the plan are sustainable, or will be overtaken by population growth, increased driving, or other shifts in emissions.

Community spaces can serve multiple functions, creating places to gather, recreate and generate economic activity

Image by Urban Advantage, Opticos

Take for example, a plan that sets only a near-term target. Such a plan might rely on increasing building energy efficiency to achieve near-term goals. Looking further out, however, might demonstrate that steady increases in vehicle miles traveled will counteract those reductions, and result in an emissions trajectory that increases rather than decreases. Setting targets out to the general plan horizon year or beyond allows a lead agency to consider the full suite of measures that might be necessary to achieve long-term reduction goals.

What Target Years Should the Plan Include?

Once a lead agency commits to looking at a long-term trajectory, the precise points along that trajectory that it chooses to measure may be influenced by practical considerations. The mechanism selected to measure progress towards a target should ensure that it allows the lead agency to meaningfully assess the impacts of a plan. Choosing to measure 2020, 2035 and 2050 emissions may allow a lead agency to compare its progress to projected statewide and region-wide emissions reductions based on work being done under SB 375, AB 32, SB 32, and other State programs. Choosing the year 2030 will align the jurisdiction's efforts with the State's interim target year and link to other air quality regulations. In order to maintain a trajectory towards the statewide 2050 reduction target, local governments should be aiming for more robust reductions in later years. This is due to the phase-in of more significant land use policies and the associated emissions benefits that will achieved by more efficient circulation patterns and resource use. Generally, the target year may reflect horizon years of local planning documents, such as general plans, while also ensuring that long term monitoring can be satisfied through the choices made in target years. If a CAP is developed to mitigate the impacts of a general plan, the CAP should also include a target for the horizon year of the general plan.

What Baseline Year is Appropriate?

Typically, a GHG emissions reduction plan baseline year includes the most recent year for which information is available. In the 2006 AB 32 Scoping Plan, the recommended target for local government action was 15% below "current" levels by 2020, generally construed as the baseline years between 2005 – 2008. Newer baseline GHG inventories use years after 2008, which may require some additional calculation to determine consistency with the State's 1990 baseline year. As long as the appropriate narrative and substantial evidence is provided to support a particular baseline year, the specific year chosen is less important than the targets.

STEP 3: Section 15183.5(b)(1)(C) Forecast Projected Emissions for Activities Covered by the Plan *("Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area")*

This step is the long-term forecast and includes trends reflecting existing programs and policies. In the case of a city's general plan, it might address development or infrastructure added by the general plan policies. The forecast might also include implementation of state regulations addressing climate change, such as adopted building codes. In sum, the forecast includes emissions from all activities expected to occur absent any policies in the CAP.

When discussing State programs in a forecast, timing of the baseline year and the start of implementation of State programs are important. Reductions measured towards a reduction target should not include the benefits of State programs already in force; rather these reductions should be reflected in the forecast. Regardless of the role State programs play in local emissions reductions, the focus of local CAPs should be on measures to reduce emissions beyond what the State programs will achieve. The ultimate goal is a plan that identifies strategies to realistically meet longer term State targets as discussed previously.

The same principle applies with respect to existing local reduction measures. For example, a local green building ordinance adopted in 2004 would not be counted as a GHG reduction measure if the plan's inventory base year is 2005. Emission reductions attributed to that ordinance should be reflected in the GHG inventory and forecast – that is, the total amount of GHG emissions from building energy use in the inventory would be lower because the effects of the green building ordinance would already be taking place. Lastly, when accounting for the impacts of existing state or local programs in a local GHG reduction plan, it is important to ensure there is no double-counting of emission reductions.

Mandatory Measures - Nuance

Although mandatory measures are preferred to establish the substantial evidence that a particular emissions reduction measure will have the stated benefit, there are some examples of incentive based measures that could be considered mitigation. One example is proposed to expand an energy efficiency program that has been in place several years and have a proven emissions reduction track record. These types of measures can be included in reductions towards a target, as long as assumptions reflect the proven ability for that program to reduce emissions. In other words, there should be substantial evidence to support the calculations for the measure.

STEP 4: Section 15183.5(b)(1)(D) Reduction Measures *("Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level")*

The heart of a CAP is the suite of reduction measures that will ensure that the plan achieves the selected reduction targets in a transparent and replicable manner. To do so, the lead agency should compare the emissions projected in Step 3 (Forecast) with the targets set in Step 2 (Targets). If forecasted emissions from activities covered by the plan in Step 3 are projected to exceed the reduction targets established in Step 2, additional reduction measures will be needed. See CEQA Guidelines Section 15126.4(c), Mitigation Measures Related to Greenhouse Gas Emissions, for additional information on the appropriate form measures should take. Only GHG emission reduction measures implemented after the baseline year should be counted towards the plan's GHG emissions reduction target.

Feasibility and Enforceability

CEQA Guidelines sections 15168(b)(4) and 15168(c)(3) recognize that programmatic documents like a general plan or CAP provide an opportunity to develop mitigation plans that will apply on a project-specific basis. As a result, a CAP needs to include measures that will achieve the reduction target. How the plan achieves those targets, whether through mandatory or a mix of voluntary and mandatory measures, is up to the lead agency, so long as substantial evidence supports the conclusion.

When addressing greenhouse gas emissions, like all other technical analysis, the methodology and calculations should be transparent and replicable with the goal of providing substantial evidence supporting the assumptions, analysis and conclusions. Measures should also be real and verifiable, through either full enforceability or through substantial evidence in the record supporting an agency's conclusion that mitigation will be effective.

A number of published court cases address the need for feasible and enforceable emission reduction measures. The decision in Communities for a Better Environment v. City of Richmond (2010) 184 Cal. App. 4th 70, provides guidance on the level of detail that is needed. In that case, the city proposed to mitigate the effects of a refinery project by developing an emissions reduction plan after project approval. Specifically, the city pledged to implement measures that would ensure no net increase in emissions from the refinery. The EIR for the refinery suggested several possible measures, including energy efficiency upgrades and carbon sequestration. On appeal, the court held that the city's mitigation plan was inadequate. Specifically, the court found:

> "...The final EIR merely proposes a generalized goal of no net increase in greenhouse gas emissions and then sets out a handful of cursorily described mitigation measures for future consideration that might serve to mitigate the 898,000 metric tons of emissions resulting from the Project. No effort is made to calculate what, if any, reductions in the Project's anticipated greenhouse gas emissions would result from each of these vaguely described future mitigation measures. Indeed, the perfunctory listing of possible mitigation measures ... are nonexclusive, undefined, untested and of unknown efficacy." (Communities for a Better Environment, supra, 184 Cal.App. 4th at 93).

The court observed that to be adequate, a plan should include measures that are "known to be feasible", "coupled with specific and mandatory performance standards to ensure that the measures, as implemented, will be effective" (Id. at p. 94).

Finally, when discussing emissions reduction measures in a general plan or CAP, co-benefits from reduction strategies should be considered that may result in better health outcomes, lower energy costs, improved access to transportation options, recreational opportunities, and general resource efficiency.

Existing Local and Regional Plans

Relying on emissions reductions that are achieved at the local level to the detriment of regional emissions is not an appropriate approach to achieving local targets. In the context of GHG emissions, some projects may cause adverse environmental impacts but still provide an overall benefit of reducing GHG emissions on a statewide or regional level. For example, a city may make a policy choice to allow increased housing density within a jobs-rich region in order to reduce region-wide GHG emissions from vehicles and transportation (See, e.g., 2007 Integrated Energy Policy Report (IEPR), at p. 210). Though the introduction of new housing within the jurisdiction may result in near-term or local GHG emissions, doing so may assist the region as a whole in meeting region-wide reduction targets. CEQA Guidelines Section 15093(a) expressly allows a lead agency to consider this type of environmental benefit of a project in a statement of overriding considerations in the environmental document. This ensures that lead agencies may consider regional and statewide benefits along with a project's adverse impacts. Consistent with CEQA Guidelines Section 15021(d), the lead agency may consider environmental benefits to balance a project's significant adverse environmental effects that remain even after the adoption of all available feasible mitigation measures.

Regional transportation plans may contain information regarding transportation-related greenhouse gas emissions that is useful in a cumulative impacts analysis. Sustainable community strategies in regional transportation plans include projections of a region's GHG emissions and related cumulative effects.

Planning inclusive communities creates space for all residents

Image by Urban Advantage, Moule & Polyzoides

Offsets and sequestration

Offsets and sequestration are emerging as a mechanism to achieve longer term targets that using traditional emission reduction measures will not achieve. CEQA recognizes offsets and sequestration as potential mitigation for GHG emissions. Lead agencies have discretion to choose what is considered feasible and what they are capable of monitoring. Onsite or local offsets and sequestration measures may be more easily monitored and supported with substantial evidence.

In identifying sequestration projects, offsets/offsite mitigation as possible strategies for GHG reductions, cities and counties should keep in mind that achieving long term targets may be challenging and that innovative approaches to addressing emissions locally may be necessary. CAPs should include strategies that address the natural sequestration capabilities within a community, and community-wide efforts that may benefit from project-based funding. Offsets/offsite mitigation should be employed after other measures are generally exhausted, and the proposed measure(s) should be tied to impacts resulting from the project. For example, if a retrofit program is proposed to support GHG reductions within the community covered by the plan, then reductions resulting from the measure are appropriate to count towards achievement of a specific target, assuming the retrofit program is additional to legal requirements (see discussion below).

The lead agency should find, based on substantial evidence, that any measure, including offsets or sequestration measures, is capable of being accomplished successfully within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors (CEQA Guidelines § 15364).

Must be additional

Actions identified as reduction measures in a CAP should not be otherwise required by law or regulation. This is important for measures that apply to new development as well as measures that require funding of offsets/offsite mitigation.

STEP 5: Section 15183.5(b)(1)(e) **Monitoring** *("Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels")*

CAPs may be updated every three to five years in order to make adjustments based on the trajectory of emissions under adopted policies. Accordingly, "many plans are on a five year update cycle with tracking of inventories occurring more frequently" (State of Local Climate Action: California 2016). Each update should provide context with regional planning efforts, such as those included in a regional transportation plan (RTP) or sustainable community strategy (SCS).

When incorporated into a general plan, a CAP's policies should also be reflected in the general plan implementation program. This allows for regular monitoring along with other general plan policies in the annual status report submitted to OPR.

Establishing a mechanism to monitor the plan's progress toward achieving the stated target and to require amendment if the plan is not achieving specified levels is an important part of any CAP or general plan. Because GHG reduction strategies tend to be long-term, strategies may become stale, particularly as methods used to quantify GHG emissions evolve and economic growth projections change. Resources are available that allow for efficient monitoring, including through the SEEC ClearPath California tool. Ongoing monitoring of the success of mitigation measures will ensure they are successfully implemented according to the timeline specified within the strategy and that the plan remains eligible for CEQA streamlining. This is also an ideal opportunity to update the decision making body on progress made to date on emissions reductions and implementation of programs in a CAP.

STEP 6: Section 15183.5(b)(1)(F) Environmental Review *(Plan must "be adopted in a public process following environmental review")*

Local governments adopting CAPs and general plans that incorporate GHG emissions reduction policies are required to analyze the impacts of the policies on the environment. CEQA requires analysis and mitigation of a project's significant adverse environmental impacts. While the overall effect of a CAP may be beneficial, a robust CAP may entail environmental tradeoffs. For example, a CAP that calls for increased solar development may require analysis of impacts to species or habitat. Increases in density may require analysis of land use impacts. Such impacts should be analyzed and, if necessary, mitigated through an environmental document. Note that the CEQA Guidelines define "environmental documents" to include "Initial Studies, Negative Declarations, draft and final EIRs, documents prepared as substitutes for EIRs and Negative Declarations under a program certified pursuant to Public Resources Code Section 21080.5, and documents prepared under NEPA and used by a state or local agency in the place of an Initial Study, Negative Declaration, or an EIR" (CEQA Guidelines § 15361).

Subsequent Projects

A lead agency may rely on the analysis in the CAP or general plan to forego further CEQA analysis of greenhouse gas emissions if a project is consistent with the analysis in the plan.

CEQA Guidelines section 15064.4 together with section 15064(h)(3) provides a lead agency the ability to demonstrate consistency with an existing GHG reduction plan, but it should show that the plan actually addresses the emissions that would result from the project. One way to establish clear compliance with a CAP is a project checklist whereby applicants for new projects identify which CAP measures apply to the project, and include those measures in the application for project review. This is similar in nature to a general plan consistency analysis or zoning code compliance review.

A plan that includes a compliance checklist, discussed in Step 5 above, can simplify this evaluation for later projects. In the absence of such a checklist, a lead agency should demonstrate that the project is consistent with the development assumptions that underlie the plan and verify that relevant measures in the plan are incorporated into the later project. Thus, instead of performing a full GHG analysis (including quantification of emissions and development of mitigation) for the individual project, the initial study or EIR for the later project may just include the evaluation described above.

Climate Adaptation Planning

Emergency managers, planning agencies, private companies, and communities affected by climate change need to plan for the increase in the type, extent, and intensity of natural hazards. As outlined in more detail in the safety element, a jurisdiction can start the process of understanding these hazards by using the resources in Cal-Adapt, the State's visualization tool for climate impacts. Cal-Adapt can be used in conjunction with California's climate change adaptation decision support tool called the Adaptation Planning Guide. Together they can guide creation of an adaptation plan or a general plan that meets minimum requirements for addressing climate adaptation, as required in the safety element. The safety element may be the "home" for adaptation discussions in the general plan, but climate change adaptation should be integrated throughout the elements of a general plan to create internal consistency and support holistic consideration of this important issue. A general plan should also provide context for changes in the environmental setting that will occur over time. For additional information on requirements and recommendations for addressing climate risk, including policy recommendations, please visit the safety element discussion.

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Many local governments find it difficult to address climate change risk and adaptation policy alone. Increasingly, they are choosing to create or join collaborative partnerships that address climate adaptation at a multijurisdictional level. Regional collaboratives can be a coordination point for policy and program development and implementation. The Alliance of Regional Collaboratives for Climate Adaptation (ARRCA) (see www.arccacalifornia.org) is one example. ARCCA was established in 2012 to help various regions of the state prepare for climate change related extreme events such as flooding, heat waves, fires, and others.

Tools and Resources for Addressing Climate Change at the Local Level

Some of the more useful climate change tools and resources referenced throughout this section and in other parts of the GPG are included in the table below. This, and additional resources, such as case studies, executive orders, legislation, and regulatory underpinnings of this discussion are located on the OPR Integrated Climate Adaptation and Resiliency Program website.

Process Guidance and Vulnerability/Impact Tools	Comprehensive free resource supported by the State of California to reduce GHG emissions at the community scale	California State Energy Efficiency Collaborative (SEEC) ClearPath California
	Guidelines for California Environmental Quality Act compliance	CEQA Guidelines
	Decision making framework supported by the State of California for addressing adaptation at the local level	Adaptation Planning Guide
	Tool supported by the State of California for visualizing the impacts of climate change and links to resourcese	Cal-Adapt
	Federal resource for visualizing impacts, historical trends, case studies, decision support.	Climate Resilience Toolkit
Greenhouse Gas Emissions Tools	State of California supported online resource that hosts links to various tools and case studies	Cool California
	Outlines the steps to reduce GHG emissions and includes templates supported by the State of California	California State Energy Efficiency Collaborative
	Outlines examples of policies and programs to reduce GHG emissions	California Air Pollution Control Officers Association (CAPCOA)
	Provides state priorities, targets and the narrative regarding the importance of local planning on climate change. Also included recommended local targets and measures to reduce GHG emissions	California Air Resources Board Scoping Plan
	California Energy Commission Planning Guide	Energy Aware Planning Guide
Climate Adaptation and Resilience	The state supported decision support framework and guide to developing adaptation policy at the local level in California	Adaptation Planning Guide
	The State's approach to addressing climate impacts, including context to how the State should work in coordination with regional and local efforts.	Safeguarding California Plan
	The State's framework for hazard mitigation, including climate risk in the context of emergency services.	State Hazard Mitigation Plan

OPR Recommended Policies

Numerous element specific climate change policy recommendations are included throughout the general plan guidelines. Further policy guidance is included in the resources outlined in the table above. Addittional recommended policies can be found in the Air Resource Board Scoping Plan. A partial list of recommended policies can be found in the general plan guidelines Appendix A.

9

Implementation

Preparing, Integrating, and Implementing the General Plan

"I have been impressed with the urgency of doing. Knowing is not enough; we must apply. Being willing is not enough; we must do"

—Leonardo da Vinci

Introduction

All statutory references are to the California Government Code unless otherwise noted

The implementation of a general plan is particularly important to consider even before the general plan update process is started. Determining how goals, policies, and actions may work in practice can help define how best to approach the general plan update and content. Additionally, with the proliferation of regional planning initiatives, grant programs promoting particular policies, and focused and related companion documents such as climate action plans, the general plan serves the function of integrating and synthesizing the various interrelated documents and programs that make a community function affectively.

A general plan is ineffective if not well implemented. Implementation relies on specific plans, zoning ordinances, subdivision ordinances, and public project consistency requirements, among other mechanisms. State law requires cities and counties to have subdivision and building regulations and open-space zoning, while many of the other measures described in this chapter are adopted at the discretion of the city or county. To effectively implement the objectives, policies, and proposals of the general plan, implementing measures must be carefully chosen, reflective of local needs, and carried out as an integrated program of complementary and mutually reinforcing actions. Measures should be specific enough to implement the goals of the general plan, while maintaining enough adaptability to allow flexibility in implementation throughout the timeline of the general plan.

It is important to remember that implementation measures identified in the general plan (and the mitigation measures identified in its EIR) must be fiscally and technically feasible to be valid. Cities and counties should consider collaborating with regional public and private sector partners to develop multi-party fair share impact fee programs for financing infrastructure improvements. For transportation components, jurisdictions should consider impact fee programs focusing on multi-modal system improvements that reduce the VMT generated by new development.

Some cities and counties have implemented metrics to track their progress towards reaching the outcomes highlighted in their general plans. The City of Sunnyvale incorporated implementation strategies and a system of trackers available annually to the community. The City of Sacramento uses metrics to create reports on the implementation of its general plan annually, and completes a thorough review every five years, looping the information back into regular general plan updates. Implementing metrics to track progress and inform reviews can improve transparency and ease the update process.

Zoning

Zoning is one of the primary means of implementing a general plan. In contrast to the long-term outlook of the general plan, zoning classifies the specific, immediate uses of land. The success of a general plan, and in particular the land use element, rests in part upon the effectiveness of a consistent zoning ordinance in translating the long-term objectives and policies contained in the plan into everyday decisions.

The typical zoning ordinance regulates land use by dividing the community into districts or "zones" and specifying the uses that are to be permitted, conditionally permitted, and prohibited within each zone. Text and map(s) describe the distribution and intensity of land uses in such categories as residential, commercial, industrial, and open space. Trade-offs and considerations related to sustainable development, infill, climate risk, environmental justice, and equity, among other issues, should be considered when designating zoning maps. Written regulations establish procedures for considering projects, standards for minimum lot size, building height and setback limits, fence heights, parking, and other development parameters within each land use zone.

Form based codes (FBC) have also emerged as a resource for planning the "feel" of a community. FBCs are typically accomplished through overlays on a base zoning designation but can also be stand alone. More information on FBCs can be found here.

In counties, general law cities, and charter cities with a population of more than two million, zoning provisions must be consistent with the general plan (Gov. Code § 65860). Charter cities with a population of under two million are exempt from the zoning consistency requirement unless their charters provide otherwise; however, these charter cities should see consistency between the general plan and zoning as a common-sense approach to planning and transparency. An in-depth discussion of zoning consistency can be found later in this chapter under the heading "Consistency in Implementation."

Zoning Tools

Zoning must be consistent with the general plan. The following are some common examples of zoning provisions that can be used to further general plan objectives and policies.

- **Cluster zoning**: A district that allows the clustering of structures upon a given site in the interest of preserving open space. Cluster zones typically have a low standard for gross residential density and a high minimum open-space requirement to encourage the clustering of structures.

- **Conditional use permit (CUP)**: A discretionary permit that enables a city or county to consider, on an individual basis, specific land uses that might otherwise have undesirable effects upon an area and to approve such uses when conditions can be placed on them that would avoid those effects.

- **Design review**: Required review of project design and/or architectural features for the purpose of ensuring compatibility with established standards. It is often used in historic districts or areas that have a distinct character worthy of protection. Design review is a means of enforcing aesthetic standards.
- **Floating zone**: A district described in the zoning ordinance but not given a specific location on the zoning maps until a property owner or developer applies for it. Planned Unit Development (PUD) zoning is a common example of a floating zone. Floating zones can implement development standards established in the general plan.
- **Floodplain zone**: A district that restricts development within delineated floodplains in order to avoid placing people and structures in harm's way and obstructing flood flows. The zone may allow for agricultural, open-space or similar low-intensity uses that account for current and future flood risk.
- **Hillside development ordinance**: Provisions regulating development on steep slopes, often by establishing a direct relationship between the degree of slope and minimum lot size. This can implement specific policies and standards that may be found in the land use, open-space, and safety elements.
- **Mixed-use zoning**: An ordinance provision that authorizes several land uses to be combined in a single structure, area, or project. It is being widely used in a variety of communities from urban to rural in nature. It is often used for office/commercial/high-density residential and for urban projects that combine ground floor retail/commercial with residential units above.
- **Open-space zoning**: Government Code section 65910 specifically requires the adoption of open-space zoning to implement the open-space element. Similarly, the Timberland Productivity Act requires local governments with qualifying timberlands to adopt Timberland Productivity Zoning (TPZ) for qualifying timberlands (Id. at §§ 51100, et seq.).

Creating walkable, transit friendly communities can revitalize an economic district

Image by Urban Advantage, SANDAG

- **Overlay zone**: Additional regulations superimposed upon existing zoning in specified areas. Subsequent development must comply with the requirements of both the overlay zone and the base district. Overlay zones commonly establish historic districts, airport height restrictions, and floodplain regulations.
- **Planned unit development (PUD) zoning**: A type of floating zone designed to provide flexibility in project design and standards. It is usually characterized by comprehensive site planning, clustering of structures, and a mixture of land uses. A PUD can implement specific density, open-space, community design, and hazard mitigation standards contained in the general plan.
- **Specific plan zone**: A district that mandates the preparation of a specific plan prior to development. The specific plan establishes zoning regulations tailored to that site, consistent with the general plan.
- **Transfer of development rights (TDR)**: A device by which the development potential of a site is severed from its title and made available for transfer to another location. The owner of a site within a transfer area retains property ownership but not approval to develop. The owner of a site within a receiving area may purchase transferable development credits, allowing a receptor site to be developed at a greater density. The California Coastal Commission has used this technique to "retire" antiquated subdivision lots in environmentally sensitive areas.

Zoning-Related Statutes

Although local governments have broad discretion in zoning matters, there are a number of state-mandated zoning requirements that directly relate to the general plan. The following summarizes most of the requirements that apply to general law cities, charter cities with a population above two million, and counties:

- **Surplus school sites**: School districts may request the rezoning of certain surplus school sites (Gov. Code § 65852.9). The city or county must then zone the site consistently with the general plan. The local government may not rezone surplus school sites to open-space, recreational, or park uses unless surrounding lands are similarly zoned or the school district agrees to the rezoning. If a surplus school site is located on the periphery of a community, rezoning should be compatible with the nature of the development on surrounding parcels.
- **Prezoning**: Government Code section 65859 allows a city to prezone adjacent unincorporated territory. The prezoning action is subject to the requirements applicable to zoning in the city, including the requirement for consistency with the general plan. Prezoning has no regulatory effect until the property is annexed to the city. Local agency formation commission (LAFCO) law requires prezoning as part of the annexation process. Prezoning properties should be considered in context to growth occurring in the city and whether infill development may address similar growth accommodating needs without requiring annexation of undeveloped property.
- **Interim ordinance**: Cities and counties may enact interim ordinances prohibiting uses that may conflict with a contemplated general plan, specific plan, or zoning proposal if they find that the use would result in a threat to public health, safety or welfare (Gov. Code § 65858). Interim zoning may be imposed for an initial period of 45 days and extended for up to two years. It can be used effectively when a general plan revision or major rezoning is underway in order to achieve general plan consistency. Local governments should exercise caution when imposing land use controls or moratoriums, even if they are only temporary. Excessive restrictions may give rise

to a claim of regulatory taking that entitles affected landowners to just compensation. City and county officials should consult with their legal counsel to determine what degree of interim development control is reasonable.

- **Regional housing needs**: Local governments must consider the effects of proposed ordinances on regional housing needs and balance them against the availability of public services, fiscal resources, and environmentally suitable sites. A zoning ordinance limiting the number of new housing units must contain findings regarding the public health, safety, and welfare that justify reducing regional housing opportunities (Gov. Code § 65863.6). Pursuant to Government Code section 65913.1, the local government must zone a sufficient amount of vacant land for residential use to maintain a balance with land zoned for nonresidential use and to meet the community's housing needs as projected in the housing element. In addition, Government Code section 65863 restricts the ability of a city or county to reduce, through administrative, quasi-judicial, or legislative action, the residential density of any parcel to a density lower than that used by the Department of Housing and Community Development (HCD) in determining compliance with housing element law. Allocation of housing and determination of suitable sites should also consider how new housing may be impacted by a changing climate.
- **Housing development projects**: Government Code Section 65589.5 restricts cities and counties from disapproving a housing development project affordable to very low-, low- or moderate-income households except under certain circumstances. These circumstances include inconsistency with both the applicable zoning and the general plan land use designation, and specific unavoidable adverse impacts on the public health and safety, among others. This code section further restricts the ability of cities and counties to lower the density of a housing development project that is consistent with general plan and zoning standards unless there is a specific, adverse impact on public health and safety that cannot otherwise be mitigated.
- **Density bonus**: Local governments must provide incentives to developers of specified housing developments. A density bonus and at least one other regulatory incentive must be provided when a developer pledges to set aside specific percentages of the total amount of housing for low- or very low-income residents, seniors, or—for condominium projects only—moderate-income residents (Gov. Code § 65915). In return, the developer must reserve these units for this purpose for a certain number of years. Incentives may include a reduction in site development standards or approval of mixed-use zoning. A density bonus must exceed the maximum allowable general plan or zoning density by at least 25 percent.
- **Accessory Dwelling Units**: Local governments may, by ordinance, provide for the creation of accessory dwelling units, also known as "second units", in single family and multifamily zoning districts (Gov. Code § 65852.2). The ordinance may designate areas where accessory dwelling units are permitted, subject to certain zoning and design conditions as set forth in the statute. Second unit applications must be considered ministerially; without discretionary review a local government cannot adopt an ordinance totally precluding second units. In the absence of any local ordinance, state law provides for the approval of accessory dwelling units that meet certain statutory standards. Government Code Section 65583 allows a city or county to identify sites for second units based on the number of second units developed in the prior housing element planning period whether or not the units are permitted by right, the need for these units in the community, the resources or incentives available for their development, and any other relevant factors, as determined by the department.

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Specific Plans

A specific plan is a helpful tool for systematically implementing the general plan within all or a portion of the planning area (Gov. Code §§ 65450, et seq.). Any interested party may request the adoption, amendment, or repeal of a specific plan. Either the public or private sector may prepare a plan. However, responsibility for its adoption, amendment, and repeal lies with the city council or county board of supervisors. As a legislative act, a specific plan can also be adopted by voter initiative and is subject to referendum.

At a minimum, a specific plan must include a statement of its relationship to the general plan (Gov. Code § 65451(b)) and text and diagram(s) specifying all of the following in detail:

- The distribution, location, and extent of the uses of land, including open space, within the area covered by the plan (Id. at § 65451(a)).
- The proposed distribution, location, extent, and intensity of major components of public and private transportation, sewage, water, drainage, solid waste disposal, energy, and other essential facilities proposed to be located within the area covered by the plan and needed to support the land uses described in the plan (Ibid.).
- Standards and criteria by which development will proceed and standards for the conservation, development, and utilization of natural resources, where applicable (Ibid.).
- A program of implementation measures, including regulations, programs, public works projects, and financing measures necessary to carry out the provisions of the preceding three paragraphs (Ibid.).
- Any other subjects that, in the judgment of the planning agency, are necessary or desirable for general plan implementation (Gov. Code § 65452).

A specific plan is especially useful for large projects, as well as for sites with environmental and fiscal constraints. A specific plan may be adopted by resolution (like a general plan) or ordinance (like a zoning ordinance). Some jurisdictions have chosen to adopt the policy portions of their specific plans by resolution and the regulatory portions by ordinance. This enables a city or county to assemble, in one package, a set of land use specifications and implementation programs tailored to the unique characteristics of a particular site.

A regulatory specific plan often has advantages over zoning. A community's control of development phasing provides a good example. The regulatory effects of zoning are immediate, while the provisions of a general plan are long term. If a general plan's implementation is limited to zoning, phasing a long-term development so that it meets the general plan's objectives can be difficult. The one-time adoption of a specific plan that stipulates development timing or schedules infrastructure installation can solve the problem.

Statutory provisions allow streamlined permitting once a specific plan is in place. For example, residential development projects are exempt from CEQA if they implement and are consistent with a specific plan for which an EIR or supplemental EIR has been prepared (Gov. Code § 65457).

A specific plan can reduce development costs. For example, the specific plan's land use specifications, in combination with its capital improvements program, can eliminate uncertainties as to future utility capacities and help avoid costly oversizing. CEQA exempts certain transit oriented development projects that are consistent with a Specific Plan (Pub. Resources Code §21155.4). The exemption applies if a project meets all of the following criteria:

1. It is a residential, employment center, or mixed use project;
2. It is located within a transit priority area;
3. The project is consistent with a specific plan for which an environmental impact report was certified; and
4. It is consistent with an adopted sustainable communities strategy or alternative planning strategy.

The exemption can be used if the project would cause no new or worse significant impacts compared to what was analyzed in the environmental impact report for the specific plan. If new or worse impacts would result, supplemental environmental review would need to be prepared.

A specific plan must be consistent with the jurisdiction's general plan (Gov. Code § 65454). In turn, zoning ordinances, subdivisions (including tentative tract and parcel maps), public works projects, development agreements, and land projects (as defined in Business and Professions Code section 11004.5) must be consistent with any applicable specific plan (Gov. Code §§ 65455, 66473.5, 66474(a), and 65867.5). Furthermore, a special district, school district, or joint powers authority may not carry out its capital improvements program (prepared pursuant to Government Code section 65403) if the affected city or county's planning agency finds the program or any part inconsistent with a specific plan, unless the district or local agency explicitly overrules the city or county's finding (Id. at § 65403(c)).

A specific plan is prepared, adopted, and amended in the same manner as a general plan, except that it may be adopted by resolution or ordinance and it may be amended as often as the local legislature deems necessary (Gov. Code § 65453(a)). A specific plan is repealed in the same manner as it is amended (Id. at § 65453(b)). To defray the cost of specific plan preparation, a city or county may impose a fee upon persons whose projects must be consistent with the plan. The fee must be prorated according to the benefit a person receives from the specific plan (Id. at § 65456).

For more information about specific plans, see OPR's publication The Planner's Guide to Specific Plans.

Subdivision Regulations

Land cannot be subdivided for sale, lease, or financing in California without local government approval. The Subdivision Map Act establishes statewide uniformity in local subdivision procedures while giving cities and counties the authority to regulate the design and improvement of subdivisions, require dedications of public improvements or related impact fees, and require compliance with the objectives and policies of the general plan (Gov. Code §§ 66410, et seq.). This includes the authority to approve and design street alignments, street grades and widths, drainage and sanitary facilities, lot size and configuration, traffic access, and other measures that are "necessary to ensure consistency with, or implementation of, the general plan or any applicable specific plan" (Id. at § 66418, 66419).

These regulatory powers can promote the usual array of land use, circulation, open-space, and safety element objectives, policies, and plan proposals. Good subdivision design can encourage pedestrian access, residential street calming, urban forestry, tree preservation, floodplain management, wildland fire safety, and other principles or policies that may be articulated in the general plan.

Subdivisions provide infrastructure that will serve the new lots being created. Local governments can require dedications of public improvements or the payment of in-lieu fees for:

- Streets, alleys, drainage, public utility easements, and public easements (Gov. Code § 66475)
- Local transit facilities, such as bus turnouts, benches, shelters, and landing pads (Gov. Code § 66475.2)
- Bicycle paths (Gov. Code § 66475.1)
- Parks and recreational facilities, if the city's general plan or specific plan contains policies and standards for such facilities (Quimby Act, Gov. Code § 66477)
- Elementary "school sites (Gov. Code § 66478)
- Access to waterways, rivers, and streams (Gov. Code § 66478.4)
- Access to coastline or shoreline (Gov. Code § 66478.11)
- Access to public lakes and reservoirs (Gov. Code § 66478.12)
- Drainage and sanitary sewer facilities (Gov. Code § 66483)
- Bridges and major thoroughfares (Gov. Code § 66484)

No tentative subdivision map or parcel map can be approved unless the city or county finds that the subdivision, together with design and improvement provisions, is consistent with all aspects of the general plan or any applicable specific plan (Gov. Code §§ 66473.5, 66474, and 66474.61). Lot line adjustments must also be consistent with the general plan (Id. at § 66412). The local government must deny a proposed subdivision if it finds that the proposed subdivision map is inconsistent with the general plan or any applicable specific plan; the design or improvement of the subdivision is inconsistent with the general plan or any applicable specific plan; the site is physically ill-suited for either the type or proposed density of development; or the subdivision's design or types of improvements are likely to cause substantial environmental damage, substantially and avoidably injure fish or wildlife or their habitat, or cause public health problems (Id. at § 66474). Local governments should also carefully consider climate risk and environmental justice in approving subdivision and parcel maps in order to be consistent with general plan requirements for the same. Cities and counties must make written findings of fact supported by substantial evidence for each of these matters when deciding upon a subdivision.

The special rules applicable to vesting tentative maps are worth noting, as detailed in Government Code section 66498.1, et seq. When subdividers receive city or county approval of a vesting tentative map, they also obtain a limited right to develop the subdivision in substantial compliance with those ordinances, policies, and standards in effect at the time the application was deemed complete (Id. at § 66498.1(b); Kaufman and Broad v. City of Modesto (1994) 25 Cal.App.4th 1577). If, however, a local agency has initiated formal proceedings to amend applicable plans or regulations prior to the application being deemed complete, the amendments, if adopted, will apply to the vesting map (Gov. Code §§ 66498.1(b), 66474.2). The local agency may condition or deny building permits for parcels created under a vesting tentative map if the agency determines that a failure to do so would threaten community health or safety or the condition or denial is required by state or federal law (Id. at § 66498.1(c)). The vesting tentative map law applies to all subdivisions, including commercial and industrial tracts.

Changes in land use and circulation can stimulate economic activity

Image by Urban Advantage, Calthorpe Associates

Capital Facilities

Capital facilities must be consistent with the general plan (Gov. Code § 66473.5; Friends of B Street v. City of Hayward (1980) 106 Cal.App.3d 988). The network of publicly owned facilities, such as streets, water and sewer facilities, public buildings, and parks, forms the framework of a community. Although capital facilities are built to accommodate present and anticipated needs, some (most notably water and sewer facilities and roads) play a major role in determining the location, intensity, and timing of development. For instance, the availability of sewer and water connections can have a profound impact upon the feasibility of preserving agricultural or open-space lands.

The general plan should identify existing capital facilities and the need for additional improvements. The circulation element is the most obvious place to address infrastructure issues, but it is not the only element where capital improvements come into play. For example:

- The housing element must identify adequate sites for various housing types based in part on public services and facilities. Water and sewer providers are required to adopt a procedure to grant priority to development with units affordable to lower income households.
- The safety element must "address evacuation routes, peakload water supply requirements, and minimum road widths...as those items relate to fire and geologic hazards". Climate risk in siting capital facilities should also be considered to ensure long term needs and viability of the investment (Gov. Code § 65302(g)(4)(c)(ii)).
- The land use element must include education-related land uses such as school sites, open-space for recreation, public buildings and grounds (the placement of public buildings may play an important role in urban design), and solid and liquid waste disposal facilities.
- The open-space element may consider "[o]pen-space for outdoor recreation... areas particularly suited for park and recreation purposes" (Gov. Code § 65560(b)(3)). It may also address open-space areas for protecting water quality and for water reservoirs.
- The conservation element can address flood control measures and must be developed "in coordination with any countywide water agency and with all district and city agencies that have developed, served, controlled or conserved water for any purpose in the county or city for which the plan is prepared" (Gov. Code § 65302(b)).

What about timing of improvements for implementation?

Local governments can underscore their interest in public services and facilities by adopting an optional public facilities element.

Each year, the local planning agency is required to "review the capital improvement program of the city or county and the local public works projects of other local agencies for consistency with the general plan" (Gov. Code § 65103(c)). To fulfill this requirement, all departments within the city or county and all other local governmental agencies (including cities, counties, school districts, and special districts) that construct capital facilities must submit a list of proposed projects to the planning agency (Gov. Code § 65401).

In lieu of considering individual projects or only those projects to be undertaken in a single year, many cities and counties prepare and annually revise a 5- to 7-year capital improvement program (CIP). The CIP projects annual expenditures for acquisition, construction, maintenance, rehabilitation, and replacement of public buildings and facilities, including sewer, water, and street improvements; street lights; traffic signals; parks; and police and fire facilities. In rapidly developing areas, a CIP coordinated with a general plan can help shape and time growth according to adopted policies. In an older city with a declining tax base and deteriorating capital facilities, a CIP can help stimulate private investment or stabilize and rehabilitate older neighborhoods by demonstrating a public commitment to the provision of key public facilities on a predetermined schedule.

Many federal grant programs, including those under the Clean Air Act and the Moving Ahead for Progress in the 21st Century Act (MAP-21) require or promote consistency between federally assisted capital projects and local, regional, and state plans. For example, the Clean Air Act requires that the population projections used in planning capital facilities conform to the assumptions contained in the regional air quality management plan adopted as part of the State Implementation Plan (SIP) when federal funding or approval is sought. The federal government gives priority to implementing those programs that conform to the SIP and will not fund those that do not. The Code of Federal Regulations Title 40, Chapter I, Part 52, Subpart F, Section 52.220 lists all of the items which are included in the California SIP.

Capital improvements also have regional implications. The growing interrelatedness of planning issues among local governments applies directly to local capital improvement projects. The location of major roads, sewer facilities, water trunk lines, and emergency service buildings within the city or county can affect surrounding communities by encouraging or deflecting the direction of growth. Although the LAFCO exists to encourage the orderly provision of services within cities and special districts, it is seldom an effective substitute for every city and the county consulting and cooperating with its neighbors.

Development Agreements

A development agreement is a contractual agreement between a city or county and a developer that identifies vested rights that apply to a specific development project. By its nature, it offers opportunities for a city or county to assure that general plan objectives, policies, and plan proposals will be implemented as development occurs within an area.

A development agreement provides that, for a specified time period, the rules, regulations, and policies that are applicable to a particular development will not change. This gives developers who have otherwise yet to attain a vested right to develop a degree of assurance that their project preparations will not be nullified by some future local policy or regulation change (e.g., the rezoning of a commercial project site to residential), with limited exceptions. In exchange for the privilege of a regulation "freeze," the city or county usually will obtain certain concessions from the developer. For example, the developer might provide extra affordable housing, open space, or public facilities.

Development agreements must specify the duration of the agreement, the permitted uses of property, the density or intensity of use, the maximum height and size of proposed buildings, and the provisions for reservation or dedication of land for public purposes (Gov. Code § 65865.2). In addition, development agreements may include the conditions, terms, restrictions, and requirements for subsequent discretionary actions; provide that such stipulations shall not prevent development of the land with regard to the uses, densities, and intensities set forth in the agreement; specify the timing of project construction or completion; and set forth the terms and conditions relating to applicant financing of necessary public facilities and subsequent reimbursement over time (Ibid.).

One advantage of development agreements is that the developer may be asked to obligate the project to improvements that exceed the usual legal limits on exactions. The limits do not apply when the developer has voluntarily entered into a contract with the city or county. A disadvantage of development agreements is that a city or county may be unable to respond to a changing market or apply new regulations to a project that is controlled by a long-term development agreement.

A city can enter into a development agreement covering unincorporated territory that is within its sphere of influence (Gov. Code § 65865(b)). This allows for planning in advance of an annexation. Such an agreement is not operative unless annexation proceedings are completed within the period of time specified by the agreement (Ibid.). If territory covered by a county development agreement becomes part of a newly incorporated city or is annexed to a city, the agreement is valid for its original duration or eight years from the date of incorporation, whichever is earlier (Id. at § 65865.3).

Unless otherwise provided in the development agreement, the existing rules, regulations, and policies in effect when the agreement is executed will apply to development of the property (Gov. Code § 65866). This avoids unanticipated consequences for both a developer and a city or county. A detailed specific plan prepared and adopted prior to a development agreement is one way to specify development details for a site, including the regulations and policies that would apply under the development agreement. Specific plan preparation can also facilitate further participation in planning a development.

Building and Housing Codes

State Housing Law delegates the enforcement of state building standards and housing codes to the local building department. Codes and standards are intended to encourage uniformity and establish minimum standards to protect the health, safety and general welfare of the public and occupants of residential buildings statewide. Local land use, housing elements, and additional health or safety elements are established by local ordinances. Building and housing codes have their greatest effect on new construction and rehabilitation, but certain parts of the codes apply to the use, maintenance, change in occupancy, and public health and safety hazards of existing buildings.

State Housing Law (Health & Saf. Code §§ 17910, et seq.) requires cities and counties to enforce state building standards and other regulations adopted by the Department of Housing and Community Development. Local ordinances may modify state building standards to impose substantially the same requirements as those contained in the various industry codes: the Uniform Housing Code, the International Building Code, The International Residential Code, The International Existing Building Code, the Uniform Plumbing Code, the National Electrical Code, and the Uniform Mechanical Code. The State Housing Law applies to buildings such as apartments, hotels, motels, lodging houses, manufactured housing, and dwellings but not to mobile homes (Id. at § 17911). In addition to meeting the requirements of state housing law, local codes must also comply with other state requirements related fire safety, noise insulation, soils reports, earthquake protection, energy insulation, and access for the disabled.

State law allows a city or county, when adopting the California Building Standards Code, to make such changes "as it determines ... are reasonably necessary because of local climatic, geological or topographical conditions" (Health & Saf. Code § 17958.5). Further, the local building department can authorize the use of materials and construction methods other than those specified in the California Building Standards Code where the department finds the proposed design satisfactory and the materials or methods at least equivalent to those prescribed by the California Building Standards Code with regard to performance, safety, and the protection of life and health (Id. at § 17951(e)(2)). These provisions can be used to promote the construction of affordable housing and the rehabilitation of substandard housing.

Other provisions are particularly useful where a community intends to encourage historic preservation. Health and Safety Code section 17958.8 allows the use of original materials and construction methods in existing buildings. Health and Safety Code section 17980(c)(2) requires local enforcement agencies to consider needs expressed in the housing element when deciding whether to require abandonment or repair of a substandard dwelling. In the reconstruction of existing buildings that would be hazardous in the event of an earthquake, the law allows cities and counties to use building standards that provide for the protection of the occupants but that are less rigorous in other respects than current building standards (Id. at §§ 19160, et seq.).

Code enforcement and abatement procedures are another means of implementing the general plan, particularly the housing and safety elements. Various state laws and regulations spell out abatement procedures that local government may enforce upon buildings that, because they are substandard or unsafe, constitute a public nuisance. The most common procedures involve citation and misdemeanor action on the part of the city or county to mandate abatement by repair, abandonment, or demolition.

Acquisition

City and county acquisition of real property rights can help to implement the policies of the land use, circulation and open-space elements. In implementing the land use element, cities and counties may acquire land designated for government offices, police and fire stations, parks, access easements, etc., or for public purposes such as urban redevelopment. With regard to the circulation element, local governments may acquire land for public rights-of-way (e.g., streets, sidewalks, bicycle paths, etc.), transit terminals, airports, etc. Cities and counties may advance open-space element policies and proposals through the acquisition of open-space and conservation easements.

Open-space acquisition has some advantages over purely regulatory approaches to implementation, such as zoning. Ownership ensures that the land will be controlled by either the city or county or another public agency. Another option is acquiring an open-space or conservation easement, rather than full ownership. This ensures that development will be limited, while the private landowner who continues to hold the underlying rights is compensated for lost development opportunities. This avoids the question of whether regulatory limitations have unconstitutionally "taken" private property without just compensation.

The primary disadvantage to acquisition is its cost. Land often is expensive, particularly when urbanization is imminent or where the supply of potentially developable land is limited. Funding sources, such as taxes and assessments, are limited in this post-Proposition 13 and post-Proposition 218 environment. A successful acquisition program often involves the resourceful blending of several funding sources.

Acquisition can take various forms. An overall program can be tied to general plan consistency or a capital improvements program. A city or county, in consultation with its legal counsel, may wish to consider the following:

- **Fee simple absolute interests**: A fee simple absolute estate in land consists of all the real property interests associated with the land, including the rights to sell, lease, and develop the property. Consequently, fee simple absolute ownership entitles a city or county to develop or not develop the land as it chooses.
- **Easement interests**: An easement consists of a portion of the rights to real property, such as the right to travel over the property or the right to build structures. The seller retains all property rights not stipulated in the easement. Travelways, utilities and open space are some common uses of easements.
- **Leasing**: The lessee possesses and occupies leased real property for a determinable time period, although the landlord retains full ownership. A city or county may lease land from a property owner for access purposes, open-space preservation, etc.
- **Lease-purchase agreements**: A city or county may lease real property and rental payments may be put toward purchasing the property. If a local jurisdiction does not have enough capital to buy the land outright, the lease-purchase method can spread payments over time.
- **Purchase and resale or lease**: Once a city or county has purchased a parcel of land or the parcel's development rights, the jurisdiction may assist in the development of housing affordable to lower income households and preserve open space (or otherwise control land use) by selling the land or the development rights with deed restrictions specifying permitted land uses. A local jurisdiction may also lease property subject to a rental contract specifying permitted uses. These techniques enable the jurisdiction to recover at least a portion of its purchasing expenses.
- **Joint acquisition**: Two or more local governments may combine their funding resources to acquire joint ownership of real property rights. Joint acquisition allows local governments to share the financial burden of purchasing land.
- **Land swapping:** Local governments may exchange some of their land for parcels owned by private landowners or other jurisdictions in order to obtain desirable open space, park sites, etc.
- **Eminent domain**: Eminent domain involves the compensated taking of property for a public use or purpose, such as the acquisition of open space for a city greenbelt. This may include fee simple interest and less-than-fee interests such as easements. An owner whose property is taken is entitled to receive just compensation through the payment of fair market value for the loss (Cal. Const., art. I, § 19). Cities and counties are authorized to exercise the power of eminent domain (Gov. Code §§ 37350.5, 25350.5) in accordance with the Eminent Domain Law (Code Civ. Proc. §§ 1230.010, 1230.020).

Preferential Property Tax Assessments

Preferential assessment programs provide landowners an economic incentive to keep their land in agricultural, timber, open-space, or recreational use. This can help implement the land use, open-space, and conservation elements by protecting areas designated for such uses from premature development. State law provides local governments with several preferential assessment programs, the most common of which are discussed below.

Williamson Act

The Legislature enacted the California Land Conservation Act, also known as the Williamson Act (Gov. Code §§ 51200, et seq.) in response to the rapid loss of agricultural land in areas of increasing land values. Typically, as development approaches an agricultural area, the price of land is driven upward by owners and buyers speculating on the future development potential of the land. The increase in prices leads to a corresponding increase in the assessed value of the land and to the owner's property taxes. At some point, the increased tax burden makes it uneconomical to continue farming and encourages the sale of the land for development.

The Williamson Act allows counties and cities to establish agricultural preserves and to assess agricultural and open-space land on the basis of its agricultural, rather than market, value (Gov. Code § 51252). Owners of qualified land located in an agricultural preserve contract with the county or city to continue agricultural or compatible activities for a period of at least ten years (or in some circumstances nine years) (Id. at § 51244). Until 2010, the state annually reimbursed local agencies for a portion of the resultant tax losses pursuant to the Open Space Subvention Act (Id. at §§ 16140 et seq.). However, funding for these payments has not been included in the state budget since 2010. As a result, some counties have stopped entering new Williamson Act contracts; some have also declined to renew existing contracts, generally due to small parcel size or incompatible use.

A Williamson Act contract automatically renews itself each year (Gov. Code § 51244). Termination of the contract may be accomplished by one of three methods. The landowner or local government can file a notice of "nonrenewal" (Id. at § 51245). The notice halts the yearly contract renewal, resulting in its expiration at the end of the ten years (Id. at § 51246). Alternatively, at request of the landowner, a local government may immediately cancel a contract after making certain strict findings. (Id. at § 51282). Such a cancellation requires the owner to pay penalty fees. (Id. at § 51283). A contract may be rescinded without penalty when the city or county has entered into an agreement with the landowner to simultaneously place an equal or greater amount of equally suitable agricultural land into an agricultural conservation easement (Id. at § 51256). The value of the proposed conservation easement must be at least 12.5 percent of the cancellation value of the land subject to the contract being rescinded and other restrictions apply (Ibid.). Nonrenewal is intended to be the normal route for ending a Williamson Act contract. Cancellation is meant to be reserved for special circumstances (Lewis v. City of Hayward (1986) 177 Cal.App.3d 103) and rescission is intended to provide more flexibility.

Williamson Act contracts are voluntary, which is both their greatest strength and weakness. On the positive side, voluntary contracts lessen the potential for litigation over the uncompensated taking of land that is sometimes alleged when land uses are restricted. Also, because the owner is directly involved in entering the program, responsibility is imparted to the landowner for ensuring that the program works. On the other hand, the potential profits anticipated from future development on the urban fringe may outweigh the tax advantages of the contract. Thus, in the very areas where it could be most effective in preventing the premature conversion of farmland, there are strong economic incentives not to join the program.

In 1998, in response to the perceived weaknesses of the Williamson Act program, the Legislature added additional non-regulatory protection in the form of farmland security zones for specific classifications of farmland, including prime farmland, farmland of statewide importance, unique farmland, and farmland of local importance. Land can be entered into a farmland security zone contract for a 20-year term rather than the 10-year term of Williamson Act contracts (Gov. Code § 51296.1). During this time, the land is assessed at 65 percent of either its Williamson Act valuation or its Proposition 13 valuation, whichever is lower, rather than on the actual use of the land for agricultural purposes as is required under the Williamson Act (Rev. & Tax Code § 423.4). Cities and special districts that provide non-agricultural services are generally prohibited from annexing land enrolled under a farmland security zone contract, with certain exceptions (Gov. Code §§ 51296.3, 51296.4). Additionally, farmland Security Zone statutes prohibit a school district from using contracted land for school facilities, rendering inapplicable a local zoning ordinance, or even acquiring land, in a farmland security zone (Id. at §§ 51296.5, 51296.6, 51296.7). Farmland security zone contracts also provide that any voter-approved special taxes levied after January 1, 1999, for urban-related services be levied upon the contracted land or the trees, vines, or crops on the land at a reduced rate, unless the urban service directly benefits the land or living improvements (Id. § 51296.2).

For more information on the Williamson Act and farmland security zone contracts, contact the Department of Conservation's Division of Land Resource Protection.

Timberland Productivity Act

The Timberland Productivity Act of 1982 requires all counties and cities with productive private timberland to establish timberland production zones (TPZs) to discourage the premature conversion of timberland to other uses (Gov. Code §§ 51100, et seq.). The land use element must reflect the distribution of existing TPZs and have a land use category that provides for timber production (Id. at 65302(a)(1)). A city or county also may use TPZs to implement the conservation element's timber resource provisions.

Patterned after the Williamson Act, TPZs are subject to rolling 10-year restrictions on use of the land and taxation of the land is based on such restrictions in use (Gov. Code §§ 51110 et seq.). Under this program, assessments on timber are based on the value of harvested timber, rather than on the market value of standing timber, pursuant to the Forest Taxation Reform Act of 1976 (Rev. & Tax Code §§ 434 et seq.) and the Timber Yield Tax Law (Id. at §§ 38101 et seq.).

During the first two years of the Act, local governments could adopt TPZs on qualified parcels without approval of the property owner, provided that statutory procedures were followed (Gov. Code §§ 51110, 51112). Currently, additions to local programs are limited to requests from property owners (Id. at §§ 51113, 51113.5). Subject to approval by the local legislative body, land may be removed from a TPZ by rezoning (Id. at §§ 51120, 51121). The effective date of the new zone generally must be deferred until expiration of the 10-year restriction (Id. at § 51120). However, the local legislative body may, under special circumstances, approve immediate rezonings and a tax recoupment fee will be imposed (Id. at §§ 51133, 51134, 51142).

The Timberland Productivity Act did not rely on voluntary inclusion during its beginning stages. This was advantageous because restrictions could be applied in a more comprehensive manner than Williamson Act contracts and could provide coherent preserves of timberland. The primary disadvantage is that there is greater potential for conflict between property owners and local governments over the designation of lands.

Conservation, Open-Space, and Scenic Easements

State law provides several means of conserving open space through easements. Easements are attractive because they are less expensive than full-fee rights, can be more effective than zoning, do not displace property owners, and may yield property or inheritance tax advantages to the grantor. Recording the easement in the office of the County Recorder places future owners on notice of the easement's provisions.

The Conservation Easement Act enables a local government or a non-profit organization to acquire perpetual easements for the conservation of agricultural and open-space lands and for historic preservation (Civ. Code §§ 815, et seq.). Granting of a conservation easement may qualify as a charitable contribution for tax purposes. The easement may also qualify as an enforceable restriction for purposes of preferential assessment.

The Open-Space Easement Act of 1974 authorizes local governments to accept easements granted to them or to non-profit organizations for the purpose of conserving agricultural and open-space lands (Gov. Code §§ 51070 - 51097). These easements are established for a term of not less than ten years and renew annually (Id. at § 51081). They must be consistent with the general plan and are considered enforceable restrictions on land that provides for reduced taxation based on value of the land subject to the restrictions, rather than market value (Cal. Const., art. XIII, § 8). The local government is prohibited from granting building permits for any structures that would violate the easement (Gov. Code § 51086). Procedures for termination by nonrenewal and by abandonment are outlined in Government Code sections 51090 through 51094.

The California Farmland Conservancy Program Act (CFCP) (Pub. Resources Code §§ 10200 - 10277) authorizes the Department of Conservation to provide grants to local governments and qualified non-profit land trusts to assist in the voluntary acquisition of agricultural conservation easements. To be eligible, a parcel be large enough for, and be located in an area that is conducive to, sustained commercial agricultural production (Id. at § 10251(a)). In addition, the local government within whose jurisdiction the parcel is located must have a general plan that demonstrates a long-term commitment to agricultural land conservation, reflected in plan provisions that relate to the area where the easement acquisition is located (Id. at § 10251(b)). Finally, there must be evidence that without protection, the parcel is likely to be converted to a nonagricultural use in the foreseeable future (Id. at § 10251(c)).

There are other noteworthy open-space provisions in the Government Code. The Scenic Easement Deed Act (Gov. Code §§ 6950 - 6954) authorizes a local government to purchase fee rights or scenic easements but does not promote a specific mechanism for obtaining them. Government Code sections 65870 through 65875 enable local governments to adopt an ordinance for the purpose of establishing open-space covenants with property owners. These are deed restrictions regulating land uses.

Land Trusts

A land trust is a private non-profit organization established for the purpose of preserving or conserving natural resource and agricultural lands through acquisition. A city or county may establish cooperative policies with a local land trust or one of the national trusts, such as the Nature Conservancy, the Trust for Public Land, or the American Farmland Trust, to promote the objectives and policies of the land use, open-space, conservation, and safety elements of its general plan.

Land trusts, whether local, statewide, or national, are often funded through membership dues and donations from individuals, businesses, and foundations. Working in cooperation with landowners and governmental agencies but outside of the structure of government, a land trust can quickly, flexibly, and confidentially obtain land or development rights that would otherwise enter the open market. In many cases, particularly where natural lands are being preserved, after obtaining the land or development rights the trust transfers its rights to a governmental agency at below-market rate for the agency to manage.

Transportation System Management

Transportation system management (TSM) is a means of improving the efficiency of the existing transportation system through more effective utilization of facilities and selective reduction of user demand. TSM strategies, both individually or as a package of supportive programs, attempt to reduce existing traffic congestion and vehicle miles traveled and increase the person-carrying capacity of the transportation system. Other benefits of TSM include improved air quality, conservation of energy resources, reduction of new transportation and parking facility needs, and prolonged life of existing transportation facilities.

Generally, TSM strategies cost less than traditional capacity-increasing capital projects. To achieve the highest degree of success, transportation and planning agencies, transit providers, developers, and employers should all coordinate in the planning and implementation of TSM.

TSM policies can be used to help correlate the land use and circulation elements by assuring that planned street and highway capacities will adequately accommodate traffic generated by planned land uses. TSM programs that discourage single-passenger car commutes and that promote flexible hours at places of employment may improve the levels of service of area streets and highways by reducing peak-hour flows. If a jurisdiction's conservation element includes clean air or energy conservation policies, such provisions may be implemented through TSM programs that reduce motor vehicle trips and thereby air pollution and energy use.

EXAMPLES OF TRANSPORTATION SYSTEM MANAGEMENT TECHNIQUES

Listed below are various transportation system management (TSM) techniques aimed at improving the efficiency of circulation on highway and transit systems by improving flow, reducing congestion, and increasing the carrying capacity of existing facilities. Caltrans has divided these techniques into seven categories, each containing particular measures that may be applied to specific TSM cases.

Programs to Improve Traffic Flow

Signalization

Traffic signal synchronization

One way streets

Changeable message signs

Computerized traffic systems

Integrated single-system traffic operations systems

Reversible lanes

Ramp meters

Preferential Treatment for Transit and Other High-Occupancy Vehicle (HOV) Strategies

Exclusive highway bus or bus/carpool lanes

Contra flow HOV lanes

Reserved lanes or dedicated streets for buses and HOVs

Bus turnouts

Bus-actuated signals

Ramp meter bypass lanes for HOVs

Infrastructure Funding Mechanisms

The timing, type, and quality of development are often directly related to the availability of infrastructure and public services. The principal funding sources for local government infrastructure are taxes, benefit assessments, bonds, and exactions (including impact fees). The following discussion briefly describes each of these.

It is important to remember that implementation measures identified in the General Plan (and the mitigation measures identified in its EIR) must be feasible to implement to be legally defensible. Cities and counties are advised to collaborate proactively with their regional public and private sector partners in order to develop and adopt multi-party fair share impact fee programs needed to finance planned transportation infrastructure improvements. In light of the legislative trends outlined in Appendix C, cities and counties are advised to base such impact fee programs on multi-modal system improvements with a demonstrated ability to reduce the VMT generated by new development.

Taxes

Taxes are either general or special. A general tax, such as the ad valorem property tax (which is capped at one percent of assessed valuation by Proposition 13), a utility tax, or a hotel tax, is collected and placed in the city's or county's general fund. General taxes are not dedicated to any specific purpose and are usually imposed to pay for capital improvements or services that will used by the entire community.

A special tax is a non-ad valorem tax that is either levied by a city or county and dedicated to a particular use or levied by a special district (e.g., a school district a transit district, etc.) to finance its activities. Special taxes often finance specific projects or services, such as flood control or ambulance service.

The Mello-Roos Community Facilities Act of 1982 authorizes a special tax that is primarily intended and commonly used to finance the infrastructure needs of new development (Gov. Code §§ 53311 - 53368.3). Under the Mello-Roos Act, cities, counties, and special districts create "community facilities districts" and levy special taxes within those districts to finance new public improvements, police and fire protection, and school construction (Id. at §§ 53313, 53313.5). The Mello-Roos Act also authorizes the issuance of bonds (Id. at §§ 53345 et seq.).

The Property Assessed Clean Energy Program (PACE) is an innovative mechanism for financing energy efficiency, water efficiency and renewable energy improvements in multifamily housing and other facilities throughout the state. For more information on PACE, see here.

Proposition 218, approved by voters in November 1996, requires a popular election in order to levy a local general tax (with a simple majority needed for approval) or a special tax (with a two-thirds majority needed for approval) (Cal. Const., art. XIII C; id., art. XIII D). It also requires a simple majority election in order to levy certain service fees, although generally not development impact fees. The effect of Proposition 218 on local financing has been profound. Prior to its passage, an election usually was not required in order to impose or increase taxes, so a jurisdiction could more easily raise needed revenue.

Benefit Assessments

Benefit assessments (also known as special assessments) are among the oldest techniques for financing the construction and maintenance of such physical improvements as sidewalks, sewers, streets, storm drains, lighting, and flood control that benefit distinct areas. Most of the numerous assessment acts authorize the use of bonds, paid for by an assessment.

Unlike general taxes, benefit assessments are not subject to a two-thirds vote requirement. Instead, as a result of Proposition 218 of 1996, a proposed assessment is subject to a ballot procedure that enables property owners to reject the proposal by majority protest among those returning ballots (Cal. Const., art. XIII D, § 4). Property owners' ballots are weighted: those who would pay a larger assessment have a greater vote (Ibid.).

A benefit assessment cannot be levied on a parcel that does not receive a direct benefit from the improvement or service being financed (Cal. Const., art. XIII D, § 2; id., art. XIII D, §4). The amount assessed to a parcel is strictly limited to the pro-rata share of benefit being received (Cal. Const., art. XIII D, § 4). The improvement must provide a special benefit to each assessed parcel, above and beyond any general benefit that might accrue (Ibid.).

Proposition 218 created important limitations on the use of benefit assessments. Prior to levying any such assessment, OPR recommends reviewing Proposition 218 and any implementing statutes. For more information, see the following sources: Proposition 218 Implementation Guide (League of California Cities, 2007), Understanding Proposition 218 (Office of the Legislative Analyst, 1996), and A Planner's Guide to Financing Public Improvements (OPR, 1997).

Bonds

Cities, counties, school districts, and other districts may issue general obligation (G.O.) bonds for the acquisition or improvement of real property, such as buildings, streets, sewers, water systems, and other infrastructure, upon approval by two-thirds of the voters casting ballots. G.O. bonds are secured by local governments' ability to levy property taxes but may also be repaid from other revenue sources as available. School district (K-12) and community college district bonds may be passed by a 55% vote rather than a two-thirds vote pursuant to Proposition 39 of 2000 (Cal. Const., art. XIII A, § 1; id., art. XVI, § 18).

Revenue bonds are secured by the future revenues of the facility or enterprise they are financing. Wastewater treatment facilities and parking facilities are examples of the types of revenue-producing facilities that are commonly financed by revenue bonds. The Revenue Bond Law of 1941 provides for a source of funds for the construction of hospitals, water facilities, sewer plants, parking facilities, and other such public facilities (Gov. Code §§ 54300, et seq.). Because revenue bonds are secured by the proceeds from the enterprise they fund, they generally carry higher interest rates than general obligation bonds.

Lease revenue bonds are a similar tool. Instead of being issued by the city or county, lease revenue bonds are issued by a non-profit corporation or a special authority that constructs a facility and leases it to the city or county. Lease payments provide the revenue to pay off the bond. When the bond is retired, the facility is turned over to the city or county. Some local agencies have used this method to finance administrative centers and schools.

Exactions

Exactions are dedications of land, improvements, or impact fees imposed on new development to fund the construction of capital facilities. They cannot be used for operations and maintenance. The authority to impose exactions on development derives from the police power and statute. An exaction is levied to finance a specific activity, facility, or service and can only be levied once, at the time of project approval.

Exactions may only be imposed where they will advance a legitimate state interest (e.g., health, safety, and welfare issues, such as smooth traffic flow, availability of recreational facilities, sewer and water service, etc.) and are necessary to mitigate the adverse impact to that interest that would otherwise result from the project (Nollan v. California Coastal Commission (1987) 107 S.Ct. 3141). This principle is reflected in the Mitigation Fee Act, which lays out the ground rules for imposing development impact fees and other exactions (Gov. Code §§ 66000, et seq.).

While the general plan may form a policy basis for exactions, keep in mind that it does not preempt constitutional limits on regulatory "takings" or enable any exaction that would conflict with state law. The Nollan decision established that there must be a nexus between the exaction and the state interest being advanced. The U.S. Supreme Court, in Dolan v. City of Tigard (1994) 114 S.Ct. 2309, added a second step to the analysis: there must be a "rough proportionality" between the exaction being imposed and the relative need created by the project. Reducing Dolan to its simplest terms, the court overturned the city's requirements for bicycle path and floodway dedications because they were out of proportion to the impact on flooding and the contribution to bicycle traffic that would have resulted from the proposed expansion of a plumbing supply store, even though Tigard's comprehensive plan contained definitive policies relating to such dedications.

In Koontz v. St. Johns River Water Management District (2013) 133 S. Ct. 2586, 2599, the U.S. Supreme Court held that the "nexus" and "rough proportionality" requirements also apply to mitigation fees (i.e., exactions of money, rather than exactions of property) imposed to obtain a land use approval (accord, Ehrlich v. City of Culver City (1996) 12 Cal.4th 854). In Ehrlich, the California Supreme Court held that while the Mitigation Fee Act is the method for bringing constitutional challenges to a monetary exaction imposed as a condition of development approval in the state, the Court interprets the standards of the Mitigation Fee Act (Gov. Code § 66001) as embodying the requirements established in the Nollan and Dolan opinions (Ehrlich, supra, at pp. 867-868).

In a case decided after Koontz, the California Supreme Court held that the increased scrutiny required by Nollan and Dolan does not apply to allegations that application of an ordinance regulating land use constitutes a taking, if the ordinance does not require the landowner to convey or dedicate a property interest (CA Building Industry Assn. v. City of San Jose (2015) 61 Cal.4th 435).

In some jurisdictions, where development may adversely affect the availability of low- and moderate-income housing, exactions are levied upon developers to finance the construction of sufficient housing to alleviate that impact. San Francisco, for example, has an inclusionary housing program that mandates the construction of affordable housing or payment of in-lieu fees in accordance with a prescribed formula, which links projected employment to the number of housing units, as a condition of new downtown office development. *Public Needs and Private Dollars*, by William Abbott, Marian E. Moe, and Marilee Hansen discusses the legal basis for development exactions and offers practical, California-specific advice about calculating and imposing them.[lxviii]

Privatization

Recent years have seen a growth in the popularity of privatization--the use of private contractors or private ownership--to provide local services, such as garbage collection or street maintenance. Although not strictly a financing measure, privatization is a strategy that can help stretch limited public funds. Privatization has certain advantages: local governments need not purchase and maintain specialized machinery, personnel for specialized or seasonal tasks need not be maintained on salary, and the costs to local governments of providing services may be reduced. It also has disadvantages: special skills are needed to establish and manage the contract with the private-service provider, quality is beyond the direct control of the local government and elected officials, and, if it is necessary to replace the contractor, residents may face a period of interrupted service.

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Transportation Financing Methods

Caltrans' Division of Transportation Planning has provided the following descriptions of general categories and examples of measures to generate additional funds for transportation projects:

- Business license taxes, which are often based upon gross receipts or number of employees, since business activity and employment concentration affect traffic congestion. San Francisco has used this method to provide funds for the operation of its municipal railway.
- Parking regulations, such as neighborhood parking stickers, parking meters, and daily tickets, which can bring in substantial funds in urban areas. These revenues can be used for a variety of local transportation programs.
- Transportation impact fees (also called traffic impact mitigation fees, system development charges, and adequate public facilities fees) based upon the traffic projected to be generated and/or the cost estimates of public transportation facilities necessitated by development. In the Westchester area of Los Angeles, a one-time fee is collected for each p.m. peak-hour trip generated by new commercial and office development to cover needed areawide improvements. In Thousand Oaks, the city requires traffic mitigation fees to pay for signals, the cost of paving adjacent arterials, and off-site improvements, all of which are made necessary by the traffic resulting from new development. To offset development impacts on the local transit system, San Francisco charges a transit impact fee based on building square footage.
- Airspace leasing, which taps the value of public rights-of-way in urban areas. A governmental agency may capitalize on that value by leasing to the private sector unoccupied space over, under, or within the right-of-way. This has been used for a variety of purposes, including parks, parking lots, cellular communications, office buildings, restaurants, and public facilities.
- Public/private partnerships, development agreements, and cost-sharing, which involve developing agreements between the private and public sectors that split responsibilities for the cost of infrastructure provision, operation, and maintenance. This technique tends to be more flexible and less bound by legal constraints than other measures.
- Privatization, which may reduce or eliminate the need for public funds for transportation infrastructure if the prospect of profit exists. California's first modern toll roads were built in Orange County by private funds. Private provision of transit services is becoming more common as it is connected to specific developments. Individual developers and employers have designed and initiated traffic mitigation programs, such as traffic flow improvements, flexible work hours, and bicycle facilities. In addition, recent trends show groups of developers, employers, and businesses banding together in transportation management associations to address mutual traffic concerns in a specific area and developing programs such as those mentioned above. Such measures have been established in the cities of El Segundo, Pleasanton, and Berkeley (in cooperation with the University of California).

Consistency in Implementation

The general plan is largely implemented through zoning and subdivision decisions. In 1971, the Legislature made consistency with the general plan a determinative factor for subdivision approvals. Since then, lawmakers have continued to add consistency requirements to California's planning and land use laws. Other statutes, while not mandating consistency, require findings or a report on whether various local actions conform to the general plan. Consistency statutes and legal precedents are detailed below.

In order for zoning and other measures to comply with consistency requirements, the general plan itself must first be complete and adequate (i.e., it must address all required issues and be internally consistent). In 1984, the Court of Appeal ruled that a conditional use permit issued pursuant to existing zoning may be challenged if a city or county general plan does not comply with the statutory requirements that are relevant to the permit in question (Neighborhood Action Group v. County of Calaveras (1984) 156 Cal.App.3d 1176, 1184). More recently, the appeals court ruled that a general plan amendment can only be challenged on the basis of an internal general plan inconsistency when there is a nexus between the particular amendment and the claimed inconsistency in the general plan (Garat v. Riverside (1991) 2 Cal.App.4th 259, 289-90).

The California Attorney General has opined that "the term 'consistent with' is used interchangeably with 'conformity with'" (58 Ops. Cal.Atty.Gen. 21, 25 (1975)). A general rule for consistency determinations can be stated as follows: An action, program, or project is consistent with the general plan if, considering all its aspects, it will further the objectives and policies of the general plan and will not inhibit or obstruct their attainment (see Ibid.).

The city or county is responsible for determining whether an activity is consistent with the general plan. A city council's finding of a project's consistency with the plan would be reversed by a court if, based on the evidence before the council, a reasonable person could not have reached the same conclusion (No Oil, Inc. v. City of Los Angeles (1987) 196 Cal.App.3d 223).

Any given project need not be in perfect conformity with each and every policy of the general plan if those policies are not relevant or leave the city or county room for interpretation (Sequoayah Hills Homeowners Association v. City of Oakland, (1998) 23 Cal.App 4th 704, 719 (1993)). In Families Unafraid to Uphold Rural El Dorado County v. El Dorado County Board of Supervisors (1998) 62 Cal.App.4th 1332, 1341, the court held that "[t] he nature of the policy and the nature of the inconsistency are critical factors to consider." A project is clearly inconsistent when it conflicts with one or more specific, fundamental, and mandatory policies of the general plan (Id. at p. 1342).

Placer County's Online General Plan employs one method to help ensure consistency. Upon receiving a development proposal or other entitlement request, county staff enters distinguishing project features into a computer program. The program analyzes the proposal by checking for general plan and community plan consistency, identifying goals and policies by topic, and preparing a report of its results. The software can compare project characteristics to the goals and policies of the general plan and each of its elements, providing an unbiased consistency analysis.

Zoning Consistency

Counties, general law cities, and charter cities with populations of more than two million are required to maintain consistency between their zoning ordinance and their adopted general plan (Gov. Code § 65860). Charter cities with populations under two million are not subject to this mandate but may choose to enact their own code requirements for consistency (Id. at §§ 65803, 65860(d)).

Where the consistency requirement applies, every zoning action, such as the adoption of new zoning ordinance text or the amendment of a zoning ordinance map, must be consistent with the general plan. A zoning ordinance that conflicts with the general plan at the time it is enacted is "invalid at the time it is passed" (Lesher Communications v. City of Walnut Creek (1990) 52 Cal.3d 531; accord, Sierra Club v. Board of Supervisors (1981) 126 Cal.App.3d 698).

By the same token, when a general plan amendment makes the zoning inconsistent, the zoning must be changed to re-establish consistency "within a reasonable time" (Gov. Code § 65860(c)). According to the California Supreme Court, "[t] he Planning and Zoning Law does not contemplate that general plans will be amended to conform to zoning ordinances. The tail does not wag the dog." (Lesher Communications v. City of Walnut Creek, supra, at p. 541).

State law does not prescribe what constitutes "a reasonable time" for reconciling the zoning ordinance with the general plan. OPR suggests that when possible, general plan amendments and necessary related zoning changes be heard concurrently (Gov. Code § 65862). When concurrent hearings are not feasible, OPR suggests the following time periods:

- For minor general plan amendments (those involving a relatively small area), six months.
- For extensive amendments to the general plan (such as a revision that results in the inconsistency of large areas), two years.

Zoning-related initiatives and referenda must also maintain general plan consistency. An initiative seeking to impose growth management regulations was invalidated when it was found to be inconsistent with the general plan (Lesher Communications v. City of Walnut Creek, supra). A referendum that sought to overturn a rezoning approval was invalidated because the rezoning was necessary to maintain or achieve consistency with the general plan (deBottari v. City of Norco (1985) 171 Cal.App.3d 1204; City of Irvine v. Irvine Citizens Against Overdevelopment (1994) 25 Cal.App.4th 868).

Zoning can be a useful tool in creating vibrant spaces

Image by Urban Advantage, SANDAG

Assessing and Achieving Zoning Consistency

Zoning consistency can be broken down into three parts: uses and standards, spatial patterns, and timing. These are described below.

The local agency's general plan and zoning ordinance contain text and maps that specify development standards and the proposed location of uses for the community. The development standards and uses specified for all land use categories in the zoning ordinance—density, lot size, height, and the like—must be consistent with the development standards and uses specified in the general plan's text and diagram of proposed land use. This has several implications.

The zoning scheme, with its range of zoning districts and their associated development standards or regulations, must be broad enough to implement the general plan. For example, if a general plan contains three residential land use designations, each with its own residential intensity and density standard, then the zoning ordinance should typically have at least as many zoning districts with appropriate standards. Similarly, if the general plan identifies seismic hazard areas and calls for zoning measures to implement safety policies, the zoning ordinance must contain appropriate provisions, such as a hazard overlay zone, or specific development standards.

When a new element or major revision to a general plan is adopted, the zoning scheme should be thoroughly reviewed for consistency. It must be amended if necessary to ensure that it is adequate to carry out the new element or revisions.

When rezoning occurs, the newly adopted zoning must be appropriate and consistent with all elements of the general plan. This includes not only the land uses and development standards, but also the transportation, safety, open-space, and other objectives and policies contained in the plan.

Both the general plan diagram of proposed land use and the zoning map should set forth similar patterns of land use distribution. However, the maps need not be identical if the general plan text provides for flexibility of interpretation or for future development (*Las Virgenes Homeowners v. County of Los Angeles* (1986) 177 Cal.App.3d 312). For example, a land use diagram may designate an area for residential development while the zoning map may show the same area as predominantly residential with a few pockets of commercial use. Despite the residential designation, the commercial zoning could be consistent with the general plan if the plan's policies and standards allow for neighborhood commercial development within residential areas. Likewise, more than one zoning classification may be consistent with any one of the general plan's land use categories. For example, both R-1 (residential) and PUD (planned unit development) may be consistent zoning for a low-density residential category in the plan.

The timing of development is closely linked to the question of consistency of spatial patterns. A general plan is long term in nature, while zoning responds to shorter-term needs and conditions. In many cases, zoning will only gradually fulfill the prescriptions of the general plan. Timing may be particularly important in rural areas designated for future urbanization. If the general plan contains policies regarding orderly development, adequate public services, and compact urban growth, rezoning a large area from a low-intensity use (e.g., agriculture) to a more intensive one (e.g., residential) before urban services are available would be inconsistent with the general plan. Conversely, an inconsistency may be created when general plan policies promote high-intensity development in an area but the jurisdiction instead permits low-intensity uses.

Since timing can be a problem, general plans should provide clear guidance for the pace of future development, perhaps by using five-year increments or by establishing a set of conditions to be met before consistent zoning would be considered timely.

Local governments have devised a number of ways to evaluate and achieve zoning consistency. A fairly common approach is to employ a matrix comparing the general plan's land use categories and associated development standards with the zoning districts and their corresponding zoning ordinance development standards. To indicate the degree of zoning consistency with the plan, many matrices feature categories ranging from "highly compatible" to "clearly incompatible." An intermediate category, "conditionally compatible," could reflect zoning that by itself is not compatible but could become compatible if measures such as a PUD overlay were imposed to reduce or eliminate potential conflicts.

The matrix approach has its limitations. By itself, a matrix cannot answer questions about the zoning's compatibility with the objectives, policies, and programs of the general plan, nor can it answer questions about timing. A number of local governments use a checklist to evaluate the consistency of individual zoning proposals. The checklist repeats the major goals and policies of the general plan and rates the degree to which the proposed zoning conforms to each of them (e.g., "furthers," "deters," "no effect"). A point system that rates development projects by their level of consistency with the goals, objectives, and policies of the general plan is a similar approach.

Subdivision Consistency

Before a city or county may approve a subdivision map (including parcel maps) and its provisions for design and improvement, the city or county must find that the proposed subdivision map is consistent with the general plan and any applicable specific plans (Gov. Code § 66473.5). These findings can only be made when the local agency has officially adopted a general plan and the proposed subdivision is "compatible with the objectives, policies, general land uses and programs specified in such a plan" (Ibid.).

Government Code sections 66474 and 66474.61 require a city or county to deny approval of a tentative map if it makes either of the following findings: the proposed map is not consistent with applicable general and specific plans or the design or improvement of the proposed subdivision is not consistent with applicable general and specific plans.

Enforcement and Remedies

Any resident or property owner may sue to enforce the requirements for the adoption of an adequate general plan (58 Ops.Cal.Atty. Gen. 21 (1975)). The same is true for enforcing the requirements that zoning and subdivisions must be consistent with the general plan (Gov. Code §§ 65860(b), 66499.33). As the state's chief law enforcement officer, the Attorney General may do the same (58 Ops. Cal.Atty.Gen. 21; Cal. Const., art. V, § 13). Additionally, persons living outside a city have standing to sue if the city's zoning practices exclude them from residing in the city or raise their housing costs by adversely affecting the regional housing market (Stocks v. City of Irvine (1981) 114 Cal.App.3d 520).

The courts may impose various remedies for failure to have a complete and adequate general plan (Gov. Code §§ 65750, et seq.). One is a writ of mandate to compel a local government to adopt a legally adequate general plan. The courts also have general authority to issue an injunction to limit approvals of additional subdivision maps, parcel maps, rezonings, and public works projects or (under limited circumstances) the issuance of building permits pending adoption of a complete and adequate general plan (Id., 58 Ops.Cal.Atty.Gen. 21 (1975), Friends of "B" Street v. City of Hayward (1980) 106 Cal.App.3d 988, *Camp v. Mendocino* (1981) 123 Cal.App.3d 334). Where a court finds that specific zoning or subdivision actions or public works projects are inconsistent with the general plan, it may set aside such actions or projects. Under certain circumstances, the court may impose any of these forms of relief prior to a final judicial determination of a general plan's inadequacy (Gov. Code § 65757).

Annual Progress Reports

After the general plan has been adopted, Government Code section 65400(a)(2)(A) requires the planning agency to provide an annual report to their legislative body, OPR, and HCD on the status of the plan and progress in its implementation. The report must detail progress in meeting the jurisdiction's share of regional housing needs determined pursuant to Government Code section 65584 and local efforts to remove governmental constraints to the maintenance, improvement, and development of housing pursuant to Government Code section 65583(c)(3) (Id. at § 65400(a)(2)(B)).

The annual progress report must be provided to the legislative body, OPR, and HCD on or before April 1 of each year. Jurisdictions must report on a calendar-year basis (January 1 through December 31). Jurisdictions are able to complete the housing element portion of the annual progress report online through the Department of Housing and Community Development's online portal. While there is a standard format for the housing element portion of the annual report, there is no standardized format for the preparation of the annual progress report for the rest of the general plan. The form and content of the report may vary based on the circumstances, resources, and constraints of each jurisdiction. This section is meant to provide general guidance to cities and counties in the preparation of their annual progress reports.

Purpose of the Report

- To provide enough information to allow local legislative bodies to assess how the general plan is being implemented in accordance with adopted goals, policies, and implementation measures.
- To provide enough information to identify necessary course adjustments or modifications to the general plan as a means to improve local implementation.
- To provide a clear correlation between land use decisions that have been made during the 12-month reporting period and the goals, policies, and implementation measures contained in the general plan.
- To provide information regarding local agency progress in meeting its share of regional housing needs and removing governmental constraints to the development of housing pursuant to Government Code section 65583(c)(3).

Format of the Report (General)

The following describes ways in which various cities and counties have organized and formatted their annual progress reports:

- **Focus on individual policies and implementation measures**: Provide a comprehensive listing of all general plan policies, including those which have been incorporated by reference, categorized by element, with a commentary on how each policy was implemented during the reporting period (i.e., a description of the activities underway or completed for implementation of each policy). This listing can most easily be accomplished by using a table format.
- **Focus on development activities and projects approved**: Provide comprehensive listing of all development applications that the planning agency received and processed with commentary on how the agency's actions on these development applications further the goals, policies, and/or implementation measures of the general plan. Link the major projects, including public projects, to the general plan using policy numbers or by element.
- **Focus on general plan elements**: Provide a general summary of each of the mandatory and optional elements of the general plan with a brief description of various actions taken by the agency (e.g., development application approvals, adoption of ordinances or plans, agency-initiated planning studies, etc.) that advanced specific goals and policies of each element.
- **Broad annual report format**: Incorporate the annual progress report into a broadly focused annual report on all of the

activities and programs of the jurisdiction, drawing upon data and sources such as an annual performance report on budgeting, processing of land use entitlements, redevelopment activities, housing construction, or other programs or "state of the city/ county" reports.

CONSISTENCY PROVISIONS IN STATE LAW AND LEGAL PRECEDENTS

All statutory references are to the California Government Code unless otherwise noted.

Agricultural Preserves

- § 51234 requires that agricultural preserves established under the Williamson Act be consistent with the general plan.
- § 51282 requires a city or county, when approving a Williamson Act contract cancellation, to make a finding that the proposed alternate use is consistent with the general plan.

Capital Improvements

- §§ 65401 and 65402 require planning agencies to review and report on the consistency with the applicable general plan of proposed city, county, and special district capital projects, including land acquisition and disposal.
- § 65103(c) requires planning agencies to review annually their city or county capital improvement programs and other local agencies' public works projects for consistency with the general plan.
- Friends of B Street v. City of Hayward (1980) 106 Cal.App.3d 988 held that a city's capital facilities projects must be consistent with the city's general plan.
- § 53090, et seq., require that most public works projects undertaken by special districts, including school districts, must be consistent with local zoning, which in turn must be consistent with the general plan. A school district board may render a zoning ordinance inapplicable with respect to school classroom facilities (§ 53094). A special district governing board may render the zoning ordinance inapplicable if it makes a finding after a public hearing that there is no feasible alternative to the project (§ 53096). State entities are an exception to this consistency requirement (Rapid Transit Advocates, Inc. v. Southern California Rapid Transit District (1986) 185 Cal.App.3d 996).

Condominium Conversion

- § 66427.2 requires that when the general plan contains objectives and policies addressing the conversion of rental units to condominiums, any conversion must be consistent with those objectives and policies.

Development Agreements

- § 65867.5 requires development agreements to be consistent with the general plan.

Consistency Provisions in State Law and Legal Precedents, Continued

Housing Authority Projects

- Health and Safety Code § 34326 declares that all housing projects undertaken by housing authorities are subject to local planning and zoning laws.

Integrated Waste Management

- Public Resources Code section 41701 states that if a county determines that the existing capacity of a solid waste facility will be exhausted within 15 years or if the county desires additional capacity, then the countywide siting element of the county's hazardous waste management plan must identify an area or areas, consistent with the applicable general plan, for the location of new solid waste transformation or disposal facilities or for the expansion of existing facilities.
- Public Resources Code section 41702 states that an area is consistent with the city or county general plan if:
  1. The city or county has adopted a general plan.
  2. The area reserved for the new or expanded facility is located in, or coextensive with, a land use area designated or authorized by the applicable general plan for solid waste facilities.
  3. The adjacent or nearby land use authorized by the applicable general plan is compatible with the establishment or expansion of the solid waste facility.

On-Site Wastewater Disposal Zones

- Health and Safety Code section 6965 requires a finding that the operation of an on-site wastewater disposal zone created under Health and Safety Code section 6950, et seq., will not result in land uses that are inconsistent with the applicable general plan.

Park Dedications

- § 66477 enables local governments to require as a condition of subdivision and parcel map approval the dedication of land or the payment of in lieu fees for parks and recreational purposes if the parks and recreational facilities are consistent with adopted general or specific plan policies and standards.

Parking Authority Projects

- Streets and Highway Code section 32503 specifies that parking authorities, in planning and locating any parking facility, are subject to the relationship of the facility to any officially adopted master plan or sections of such master plan for the development of the area in which the authority functions to the same extent as if it were a private entity.

Planning Commission Recommendations

- § 65855 requires that the planning commission's written recommendation to the legislative body on the adoption or amendment of a zoning ordinance include a report on the relationship of the proposed adoption or amendment to the general plan.

Consistency Provisions in State Law and Legal Precedents, Continued

Reservations of Land Within Subdivisions

- § 66479 specifies that reservations of land for parks, recreational facilities, fire stations, libraries, and other public uses within a subdivision must conform to the general plan.

Special Housing Programs

- Health and Safety Code section 50689.5 specifies that housing and housing programs developed under Health and Safety Code section 50680, et seq., for the developmentally disabled, mentally disordered, and physically disabled must be consistent with the housing element of the general plan.

Specific Plans

- § 65359 requires that a specific plan covering an area affected by a general plan amendment shall be reviewed and amended as necessary to make it consistent with the applicable general plan.
- § 65454 specifies that a specific plan may not be adopted or amended unless the proposed plan is consistent with the general plan.

Format of the Report (Housing Element)

In 2010, the State Department of Housing and Community Development adopted regulations on the preparation of the annual housing element progress report (Cal. Code Regs., tit. 25, §§ 6200, et seq.). All housing element progress reports must conform to these regulations. Forms, instructions, and a copy of the regulations can be found at the HCD's website at http://www.hcd.ca.gov/community-development/housing-element/index.shtml. In general, the following information is required for housing element reporting:

- Listing of building permits issued for the calendar year by income category.
- Demonstration of the progress towards meeting the regional housing need.
- A description of the progress in implementation of the policies and programs in the housing element.
- A city or county that is the successor to a former redevelopment agency shall include financial and housing information specified at Health and Safety Code section 34176.1(f) in its annual report.

The report must be considered at an annual public meeting before the legislative body where members of the public may provide oral testimony and written comments.

Contents of the Report

Each jurisdiction should determine which locally relevant issues are important to include in the annual report. The following items may be useful in the annual progress report:

- Introduction.
- Table of contents.
- Date of presentation to and acceptance by the local legislative body.
- List of major agency-initiated planning activities that were initiated, in progress, or completed during the reporting period (i.e., master plans, specific plans, master environmental assessments, annexation studies, and other studies or plans carried out in support of specific general plan implementation measures). Include a brief comment on how each of these activities advances the goals, policies, and/or implementation measures contained in the general plan. Provide specific reference to individual elements where applicable.
- List each of the general plan amendments that have been processed, along with a brief description and the action taken (e.g., approval, denial, etc.). This listing should include agency-initiated as well as applicant-driven amendments.
- List each of the development applications that have been processed, along with a brief description, the action taken (e.g., approval, denial, etc.), and a brief comment on how each action furthers the goals, policies, and/or implementation measures of the general plan. Provide specific reference to individual elements where applicable.
- Identify significant projects built within jurisdiction but not approved by jurisdiction, such as large school facilities not approved by city or county, but affecting general plan.
- Identify priorities for land use decision-making that have been established by the local legislative body (e.g., passage of moratoria, emergency ordinances, development of community or specific plans, etc.).
- The annual progress report should identify goals, policies, objectives, standards, or other plan proposals that need to be added, deleted, amended, or otherwise adjusted.

Submitting the Report to OPR and HCD

Annual progress reports can be submitted to OPR in either electronic or paper format. Preference is for electronic reporting. If you wish to submit your annual report to OPR electronically, e-mail it to state.clearinghouse@opr.ca.gov. Word, Excel, PowerPoint or PDF are the only acceptable file formats. Printed copies of the annual report should be sent to Governor's Office of Planning and Research, State Clearinghouse and Planning Unit, P.O. Box 3044, Sacramento, CA 95812-3044.

A copy of the report must also be sent to the Department of Housing and Community Development via their online system, or printed copies to Division of Housing Policy Development, P.O. Box 952053, Sacramento, CA 94252-2053

Coastal Act Compliance for those Jurisdictions Located in the Coastal Zone

CALIFORNIA COASTAL ACT

The California Coastal Act of 1976 (Public Resources Code section 30000 et seq.) was enacted to "[p]rotect, maintain, and, where feasible, enhance and restore the overall quality of the coastal zone environment and its natural and artificial resources" (Id. at § 30001.5). The Coastal Act applies to the coastal zone, defined in section 30103(a) as a strip along the California coast generally "extending seaward to the state's outer limit of jurisdiction, including all offshore islands, and extending inland generally 1,000 yards from the mean high tide line of the sea." In significant coastal estuarine habitat and recreation areas, the zone may extend further inland by as much as five miles, and in developed urban areas the zone may extend inland less than 1000 yards (Ibid.). The legal coastal zone boundary is delineated on a set of maps adopted by the Legislature and located at the Coastal Commission's San

Francisco office. The coastal zone excludes the area of San Francisco Bay, which is under the jurisdiction of the San Francisco Bay Conservation and Development Commission. The Coastal Act otherwise applies to all those portions of cities (charter and general law) and counties that lie within the coastal zone (70 Ops.Cal.Atty.Gen. 220 (1987)).

The Coastal Commission, in partnership with coastal cities and counties, plans and regulates the use of land and water in the coastal zone. Under the Coastal Act, Local Coastal Program (LCP) planning requirements create a unique partnership between state and local government. The development of an LCP by a local government is the primary mechanism to implement the state's coastal management policies at the local level. The Coastal Act declares that "[t]o achieve maximum responsiveness to local conditions, accountability, and public accessibility, it is necessary to rely heavily on local government and local land use planning procedures and enforcement" in carrying out the state's coastal management objectives and policies (Pub. Resources Code § 30004). To this end, the Act requires each of the 76 local governments (15 counties and 61 cities) lying wholly or partly within the coastal zone to prepare, with maximum public participation, an LCP to guide future development in the coastal zone. While local government develops LCPs, the Coastal Commission must certify that the LCP is consistent with the state Coastal Act before an LCP may be implemented. Once certified, local government assumes responsibility to issue most local coastal development permits pursuant to the certified LCP, with the Commission retaining limited permit and appeal authority.

As defined in the Coastal Act, an LCP means "a local government's (a) land use plans, (b) zoning ordinances, (c) zoning district maps, and (d) within sensitive coastal resources areas, other implementing actions, which, when taken together, meet the requirements of, and implement the provisions and policies of the Coastal Act at the local level" (Pub. Resources Code § 30108.6).

An LCP must include a Land Use Plan (LUP) which, by definition, means "the relevant portions of a local government's general plan or local coastal element which are sufficiently detailed to indicate the kinds, location, and intensity of land uses, the applicable resource protection and development policies, and where necessary, a listing of implementing actions" (Pub. Resources Code § 30108.5). Each LCP must include "a specific public access component to assure that maximum public access to the coast and public recreation areas is provided" (Id. at. § 30500(a)).

The implementation plan (IP) portion of an LCP, including zoning, must conform with and be adequate to carry out the LUP (Pub. Resources Code § 30513). This is a distinctive provision of the Coastal Act. The Act does not just merely state that the zoning must be consistent with the land use plan as is the case for general plans; rather, the Act states that zoning must conform with and be adequate to carry out the LUP.

It is possible that a zoning ordinance would be "consistent with" a general plan designation but not conform with and be adequate to carry out the general plan. For example, zoning code requirements establishing height limits and setback requirements may be consistent with LUP policies regarding protection of public views and community character, but may not by themselves be adequate to carry out those policies. Similarly, zoning code provisions establishing maximum density may be consistent with LUP density limits but be inadequate to address other LUP policies regarding the protection of habitat or the adequacy of public services to support new development. Finally, the adequacy to carry out a certified LUP may hinge on the use of mandatory "shall" or "must" language, rather than "should," where required. The development of zoning ordinances to satisfy the Coastal Act, therefore, must begin with precisely drawn policies in the Land Use Plan, which in turn reflect the specific policies of the Coastal Act. The clearer the land use plan designations and policy statements are, the easier it will be to develop zoning ordinances that provide clarity for decision makers, property owners, and the public.

The Commission's methodology for preparing LCPs can be found at Title 14, Division 5.5 of the California Code of Regulations, sections 13506 through 13514. Amendments to certified LCPs must be submitted to the Commission for review and, in the case of major amendments, certification (Pub. Resources Code § 30514). LCP amendments that are minor in nature or that require rapid or expeditious action are reviewed by the Commission's Executive Director and become valid if the Commission concurs with the Executive Director's determination (Id. at § 30514; Cal. Code Regs., tit. 14, §§ 13554, 13555).

The Coastal Act has special requirements for the coastal zone portions of the ports of Port Hueneme, Long Beach, Los Angeles, and the San Diego Unified Port District. Rather than preparing LCPs, these ports must prepare master plans and have them certified by the Coastal Commission (Pub. Resources Code §§ 30711, 30714). With certain exceptions, each development within a port requires a development permit and must conform to the port's master plan (Id. at §§ 30715(a), 30715.5). The cities and counties that have these ports within their jurisdictions must, for informational purposes, incorporate the master plan into their LCPs (Id. at § 30711(a)).

The four ports identified above and in Chapter 8 of the Coastal Act all have certified Port Master Plans and intergovernmental coordination was part of the original certification. How LCPs address these Port Master Plans for informational purposes all differ and reflect local conditions. However, recognizing Port Master Plans in LCPs for informational purposes offers an important benefit in that it can make clear the different jurisdictions and standards of review of proposed coastal developments. On occasion, when appropriate and the conditions warrant, the Commission can review both an LCP Amendment and a Port Master Plan Amendment at the same hearing when the development affects both jurisdictions.

With certain exceptions, development within the coastal zone is subject to a coastal development permit issued either by a local government pursuant to a certified LCP or, where no certified LCP exists, by the Coastal Commission (Pub. Resources Code §§ 30519(a), 30600(d)). A city or county that lacks a certified LCP surrenders a good deal of planning authority within the coastal zone.

Some decisions made under an LCP may be appealed to the Commission (PRC, § 30603). Additionally, the Commission retains permanent jurisdiction over development on coastal zone tidelands, submerged lands, and public trust lands (Pub. Resources Code § 30519(b)).

RELATION BETWEEN THE COASTAL ACT AND THE GENERAL PLAN

Coastal cities and counties are subject to both planning and zoning laws and the California Coastal Act. The Coastal Act has specific requirements that in the coastal zone are different than the Government Code provisions that the local government may be more familiar with in developing general plans. Therefore it is important to keep in mind that in the coastal zone, a local government's general plan may have to be modified if it is to be certified as part of an LCP that must meet Coastal Act requirements. The Coastal Act specifies that coastal Land Use Plan (LUP) provisions be "sufficiently detailed to indicate the kind, location, and intensity of land uses . . ." (Pub. Resources Code § 30108.5).

The contents of coastal LUPs overlap some of the required provisions of general plans but not all are duplicative. For instance, the Coastal Act requires policies concerning diking, dredging, filling, and shoreline structures (Pub. Resources Code §§ 30233, 30235), while planning and zoning law usually does not.

To govern effectively in the coastal zone, a general plan should be consistent with the local government's Local Coastal Program (LCP). Therefore, when developing or amending a general plan, local governments should coordinate closely with the California Coastal Commission to assure that general plan provisions intended to apply in the coastal zone are consistent with the governing LCP and California Coastal Act as relevant.

While there are requirements under the Coastal Act and regulations for the content of LCPs, there is no set format. Some communities have adopted separate coastal elements within their General Plans. Others have incorporated coastal plan policies, plan proposals, and standards directly into the general plan's land use, open-space, and conservation elements and submitted those general plan elements as the LCP for certification. A third option is to adopt a specific plan within the coastal zone. Given the diversity of local coastal jurisdictions there is no "one size fits all" approach, but the requirements of the Coastal Act must be met in completing the LCP. In the Commission's experience, with a few exceptions for local jurisdictions that are wholly within the coastal zone, maintaining the LCP as a separate element of the general plan results in a more clear understanding of the LCP requirements and fewer issues on appeals. In order to encourage general plan amendments necessary to preparing a certified LCP, such actions do not count toward the limit of four general plan amendments per year (Gov. Code § 65358(b), (d)(3)).

Some communities have adopted separate coastal elements. (See for example the LCP for the City of Malibu.) Others have incorporated coastal plan policies, plan proposals, and standards directly into the general plan's land use, open-space, and conservation elements and submitted those general plan elements as the LCP for certification. (For example see the LCP for the Santa Monica Mountains segment of Los Angeles County.) This LUP is a discrete part of the County's general plan that applies just to the Santa Monica Mountains geographic LCP segment within the coastal zone. The subsections of the LUP are organized into elements, matching the applicable general plan elements. The certified Implementation Plan (IP) of the LCP for this segment is similarly a discrete segment of the County's planning and zoning ordinance. The IP contains all of the applicable standards for the geographic area of the LCP segment, without reference to the general zoning ordinance standards.

A third option is to adopt a specific plan within the coastal zone for the Implementation Portion of an LCP. Examples of this are found in the City of Carlsbad LCP (for Carlsbad Ranch), the City of Huntington Beach LCP (for the Downtown Specific Plan) and others.

There is a special situation where a community has a certified coastal LUP but has not prepared the necessary implementing measures to obtain full LCP certification. The Coastal Act requires that the Commission delegate authority to issue permits within 120 days after the effective date of certification of an LUP, and that the local government shall adopt ordinances that set procedures for issuing coastal development permits (Pub. Resources Code § 30600.5(b), (f)). If the local government does not adopt ordinances establishing permitting procedures, permitting authority remains with the Commission. Further, if such communities adopt general plan amendments without updating the LUP (through amendments that must be certified by the Coastal Commission), discrepancies may arise between land uses and densities authorized under the general plan and those authorized in the coastal LUP. If the general plan and coastal LUP diverge significantly, problems may arise when a project applicant applies to the Commission for a coastal development permit. Communities may avoid these problems by reviewing all general plan amendments affecting the coastal zone for consistency with their coastal LUP. Communities may more efficiently control their planning process and obtain the authority to issue coastal development permits locally by completing their LCPs and seeking full certification from the Coastal Commission.

HOUSING REQUIREMENTS IN THE COASTAL ZONE

LCPs are not required to include housing policies or programs (Pub. Resources Code § 30500.1). The Government Code, however, contains special requirements for the protection and provision of low- and moderate-income housing within the coastal zone (Gov. Code § 65590). Local governments are responsible for implementing those requirements.

Government Code section 65588, subdivisions (c) and (d), state that when coastal jurisdictions update a housing element, they must document the number of low- and moderate-income housing units converted or demolished and the number of replacement units provided, including specific numbers in the coastal zone. This helps the locality determine whether affordable housing stock in the coastal zone is being protected and provided as required by Government Code Section 65590. This analysis should also reflect whether any housing in the coastal zone was converted or demolished for a nonresidential use that is not “coastal dependent” as defined in Public Resources Code section 30101 (Gov. Code § 65590(c)).

In 2003, the Coastal Act was modified to add Public Resources Code section 30604, subdivisions (f) and (g), directing the Commission to “encourage housing opportunities for persons of low and moderate income” and precluding the local government or the Commission from reducing density bonuses below what is otherwise allowable in the Government Code, unless specific findings are made regarding Chapter 3 policies:

(f) The commission shall encourage housing opportunities for persons of low and moderate income. In reviewing residential development applications for low- and moderate-income housing, as defined in paragraph (3) of subdivision (h) of Section 65589.5 of the Government Code, the issuing agency, or the commission, on appeal, may not require measures that reduce residential densities below the density sought by an applicant if the density sought is within the permitted density or range of density established by local zoning plus the additional density permitted under Section 65915 of the Government Code, unless the issuing agency or the commission on appeal makes a finding, based on substantial evidence in the record, that the density sought by the applicant cannot feasibly be accommodated on the site in a manner that is in conformity with Chapter 3 (commencing with Section 30200) or the certified local coastal program.

(g) The Legislature finds and declares that it is important for the commission to encourage the protection of existing and the provision of new affordable housing opportunities for persons of low and moderate income in the coastal zone.

Since that time, the Commission has interpreted these provisions as direction to encourage affordable housing by supporting it, including density bonuses, unless there is a specific inconsistency with the policies of Chapter 3, but not to require authorization of density bonuses beyond what is allowed by the Government Code.

Although the 1981 amendments to the Coastal Act (repealing former Section 30213) repealed the Commission’s ability to require affordable housing and Section 30500.1 prohibits the Commission from requiring affordable housing policies in LCPs, nothing precludes local governments from submitting Land Use Plan Amendments with provisions that protect and encourage affordable housing consistent with the Chapter 3 policies of the Coastal Act. Once certified, these Land Use Plan policies become the standard of review for both implementation plan amendments and coastal development permits issued by the local government and the Commission on appeal.

The Coastal Act includes many policies that support "smart growth," among them: concentrating development (Pub. Resources Code § 30250), establishing urban-rural boundaries (Id. at § 30241), enhancing public access to the coast through facilitation of transit and non-automobile circulation within developments (Id. at § 30252), and minimizing energy use and vehicle miles travelled (Id. at § 30253). Other Coastal Act policies assure that smart growth housing development is undertaken consistent with the protection of public access and coastal natural and scenic resources. An example of this is illustrated in the following LCP Amendment action on the City of Capitola LCP. See reports: Part 1 and Part 2.

The Commission has taken numerous other actions that address provision of accessory dwelling units, reasonable accommodations and density bonuses/inclusionary housing. Some examples of these can be found in the Commission LUP Update Guide.A report on the Commission's housing program history is contained as an Attachment to the Executive Director's report of April 15, 2015.

While the Coastal Act does not define what constitutes "maximum public participation" there are numerous provisions in the Coastal Act and the California Code of Regulations (Title 14) that specify standards for preparation, review and submittal of documents, for required noticing, scheduling and for conduct of hearings. For example, the Coastal Act:

States the Legislature's findings and declarations that the public should fully participate and that the process should include the widest opportunity for public participation (Pub. Resources Code § 30006).

Outlines the Commission's duties to ensure full and adequate public participation (Pub. Resources Code § 30339).

Mandates opportunities for public participation in a LCP program, including requirements that a local government must, prior to submittal of the program, hold a public hearing or hearings on that portion of the program that has not been subjected to public hearings within four years of such submission (Pub. Resources Code §§ 30500, 30503, 30504).

Requires submittal pursuant to a resolution (Pub. Resources Code § 30510(a)).

Requires public participation in port planning and decisions (Pub. Resources Code § 30711).

In addition, the California Code of Regulations (Title 14) includes requirements for public participation in carrying out the Coastal Act provisions.

SEA LEVEL RISE IN THE COASTAL ZONE

As part of an LCP, update, or amendment, local governments should evaluate and plan for sea level rise. Sea level rise potentially increases the risk of coastal hazards as identified in Public Resources Code Section 30253 (geologic flood, and fire), as well as potentially increasing impacts on coastal resources identified throughout the Coastal Act. The analysis can be performed through a vulnerability assessment, climate action plan or other document and is best coordinated with the guidance in the general plan guidelines on how to address climate change risk, vulnerability and adaptation. The Coastal Commission maintains Sea Level Rise Policy Guidance on how to plan for sea level rise within an LCP or permit at http://www.coastal.ca.gov/climate/SLRguidance.html.

Additional information on LCP planning, such as updating certified LCPs and Best Practices for amending LCPs, can be found here: https://www.coastal.ca.gov/rflg/.

10

CEQA

Designing Healthy, Equitable, Resilient, and Economically Vibrant Places

Introduction

Because general plans govern the type and location of new development, new or amended general plans may lead to significant changes in the environment. The California Environmental Quality Act, also known as "CEQA," requires cities and counties to study those potential environmental impacts as part of the adoption or update process (Pub. Resources Code §§ 21000, et seq.; see also CEQA Guidelines § 15378). Where those impacts may be significant, the city or county must prepare an environmental impact report (EIR). The primary purpose of an EIR is to inform decision-makers and the public of the potential significant environmental effects of a proposal and possible ways to reduce or avoid any significant environmental effects. This information enables environmental considerations to influence policy development, thereby ensuring that the plan's policies will address potential environmental impacts and the means to avoid them. This chapter addresses some key considerations for complying with CEQA in preparing a new general plan, a general plan update, or a general plan amendment. Some of those considerations include:

- Identifying major points of intersection between the general plan and CEQA processes;
- Comparing different types of EIRs to determine which might best suit the needs of the city or county and that would enable use of several streamlining mechanisms for later development approvals, and
- Mitigation Monitoring and General Plan Implementation

Key CEQA Policies to Remember

Before describing specific considerations for CEQA review of general plans, it is useful to first review several key policies underlying CEQA that are relevant to the general plan process.

- **CEQA should be integrated into planning processes and guide development of the plan itself.** (Pub. Resources Code § 21003(a)). Information developed as part of the CEQA process should influence the development of general plan policies. CEQA should not just be a post hoc rationalization of decisions that have already been made. (Laurel *Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal. 3d 376, 395 ("the later the environmental review process begins, the more bureaucratic and financial momentum there is behind a proposed project, thus providing a strong incentive to ignore environmental concerns that could be dealt with more easily at an early stage of the project")).

- **While the CEQA process should occur early enough to influence development of the general plan, it should not happen until environmental review will produce meaningful information.** (CEQA Guidelines § 15004). For example, an EIR will not provide meaningful information if it is prepared before actual policy language is developed.
- **The CEQA process should be efficient.** (Pub. Resources Code § 21003(f)). "An EIR on a project such as the adoption or amendment of a ... local general plan should focus on the secondary effects that can be expected to follow from the adoption, or amendment, but the EIR need not be as detailed as an EIR on the specific construction projects that might follow." (CEQA Guidelines § 15146(b)). Further, once a general plan EIR has been certified and the general plan adopted, the general plan EIR should be used to inform and streamline CEQA review for later project applications.

These policies can help guide planners as they confront questions about precisely how to conduct environmental review for a general plan process.

Considerations for General Plan EIRs

The procedure for preparing and using an EIR is described in detail in the state CEQA Guidelines (Title 14, California Code of Regulations, §§ 15000, et seq.). A summary of the CEQA process is provided in the California Planning Guide (OPR, Dec. 2005). The following discussion highlights some of the key points that are particularly important when preparing an EIR for a new general plan, an element, or a comprehensive revision.

A general plan for which an EIR is prepared is considered a project of statewide, regional, or areawide significance (CEQA Guidelines § 15206). This means that the lead agency must conduct at least one scoping meeting and the EIR must be circulated through the State Clearinghouse for review by relevant state agencies. In addition, the city or county must consult with transportation planning agencies during the development of the general plan and EIR (Id. at § 15086(a)(5)).

The plan EIR, to a certain extent, can be seen as describing the relationship between the proposed density and intensity of land use described by the plan and potential environmental constraints within the planning area.

Baseline

The EIR must describe the existing local and regional physical environment, as they exist when the notice of preparation of the EIR is published, emphasizing those features that are likely to be affected by the plan and the environmental constraints and resources that are rare or unique to the area (CEQA Guidelines §§ 15125(a), 15125(c)). It should describe existing infrastructure, such as roads, water systems, and sewage treatment facilities, along with their capacities and current levels of use. It should also discuss any inconsistencies between the proposed plan and adopted regional plans as they may relate to environmental issues (Id. at § 15125(d)). For example, cities and counties should discuss any inconsistencies between the proposed general plan and the regional transportation plan including any applicable sustainable communities strategy.

When a new general plan or a revision is being considered, the EIR must evaluate the proposed plans or revision's effects on both the existing physical environment and the environment envisioned by any adopted plan (*Environmental Planning and Information Council v. County of El Dorado* (1982) 131 Cal.App.3d 354; see also CEQA Guidelines § 15125(e)). When a city or county proposes to amend a general plan, the environmental analysis should focus on the changes proposed in the amendment. Reanalysis of unchanged portions of the general plan is not required (*Black Property Owners Assn. v. City of Berkeley* (1994) 22 Cal. App. 4th 974).

Level of Detail in Analysis

The general plan EIR need not be as detailed as an EIR for the specific projects that will follow (CEQA Guidelines § 15146). Its level of detail should reflect the level contained in the plan or plan element being considered (*Rio Vista Farm Bureau Center v. County of Solano* (1992) 5 Cal.App.4th 351). However, the lead agency cannot defer its analysis of any significant effect of the general plan to later-tiered EIRs (*Stanislaus Natural Heritage Project v. County of Stanislaus* (1996) 48 Cal.App.4th 182). "With a good and detailed analysis of the [general plan], many subsequent activities could be found to be within the scope of the project described in the [general plan] EIR, and no further environmental documents would be required." (CEQA Guidelines § 15168(c)(5); see also id. at § 15183.3 (streamlining for infill projects)).

Mitigation

The EIR must identify mitigation measures and alternatives to avoid or minimize potential impacts, to the extent feasible. The general plan EIR is a particularly useful tool for identifying measures to mitigate the cumulative effects of new development. For example, a general plan might anticipate a significant increase in industrial employment in the community. If this proposal would lead to increased automobile commuting, the EIR could identify measures to reduce peak-hour traffic volumes, such as new transit routes or improved bicycle facilities. Where other agencies are responsible for mitigating the effects of the general plan, they should be identified in the EIR. Pursuant to Public Resources Code section 21081.6, the general plan must incorporate the approved mitigation measures identified in the EIR into its policies and programs.

Alternatives

The EIR for a general plan must describe a reasonable range of alternatives and analyze each of their effects (CEQA Guidelines § 15126.6). Each of the alternatives should avoid or lessen one or more of the significant effects identified as resulting from the proposed general plan. A reasonable range of alternatives would typically include different levels of density and compactness, different locations and types of uses for future development, and different general plan policies.

The alternatives should not all have the same level of impacts. This discussion of alternatives will enable environmental considerations to influence the ultimate design of the general plan.

The EIR must also evaluate the "no project" alternative (CEQA Guidelines § 15126.6(e)). This would describe what physical changes might reasonably be expected to occur in the foreseeable future if the new or revised general plan were not adopted, based on the existing general plan (if any) and available infrastructure and services. This "no project" alternative must also evaluate how the changing environment, such as through climate change and drought, may affect the community if a new or revised general plan were not adopted.

Cumulative Impacts

The EIR must analyze the cumulative effects of the plan's land use designations, policies and programs on the environment. For example, a general plan authorizing rural residential uses in or near wild lands could cumulatively increase the potential severity of fire damage by hindering wildfire suppression efforts. Increasing reliance on automobile use in a general plan, through dispersed land uses for example, could contribute not only to cumulative air quality impacts in non-attainment areas and increased energy use, but also indirect effects such as increased water pollution (due to runoff from roads) and adverse effects to public health (due to decreased physical activity). When cumulative impacts are adequately addressed in a general plan EIR, further analysis should not be needed at the project level (See CEQA Guidelines § 15183(j)).

Growth Inducing Impacts

Growth-inducing impacts must also be analyzed (Pub. Resources Code § 21100(b)(5); CEQA Guidelines § 15126.2(d)). These may include any policies and programs of the general plan likely to stimulate community growth and development. Examples include policies and programs leading to street and highway improvements in undeveloped areas, wastewater treatment plant expansion, or expansion of employment in basic industries, any of which is likely to increase pressure for or facilitate residential and other development.

Irreversible Environmental Changes

The environmental analysis for a general plan must address any irreversible environmental changes. For example, once a general plan designates certain areas for development and that development occurs, such areas are unlikely to ever be returned to a natural condition. Thus, the environmental effects of locking in certain uses for the foreseeable future must be analyzed in a general plan's environmental analysis. "Irretrievable commitments of resources should be evaluated to assure that such current consumption is justified." (CEQA Guidelines § 15126.2(c), see also Pub.

Resources Code §§ 21100.1, 21000(a) ("maintenance of a quality environment for the people of this state now and in the future is a matter of statewide concern") (emphasis added)).

Timing

The purpose of preparing an environmental analysis is not only to inform decision-makers and the public of a general plan's potential adverse environmental impacts, but also to allow environmental considerations to influence the design of the plan itself. To accomplish this purpose, the CEQA analysis should be prepared in coordination with the development of the general plan.

Careful coordination between the CEQA process and the general plan process can also minimize unnecessary duplication of work.

Public Review of the EIR and Consultation

Both CEQA and the Government Code require extensive consultation with the public and other public agencies during the development of a general plan. For example, Government Code section 65352 requires consultation with, among others:

- A city or county, within or abutting the area covered by the proposal.
- Any special district that may be significantly affected by the proposed action.
- An elementary, high school, or unified school district within the area covered by the proposed action.
- The local agency formation commission.
- An areawide planning agency whose operations may be significantly affected by the proposed action.
- A federal agency if its operations or lands within its jurisdiction may be significantly affected by the proposed action.
- The military.

- Public water systems.
- The Bay Area Air Quality Management District for a proposed action within the boundaries of the district.
- A California Native American tribe that is on the contact list maintained by the Native American Heritage Commission, with traditional lands located within the city or county's jurisdiction.
- The Central Valley Flood Protection Board for a proposed action within the boundaries of the Sacramento and San Joaquin Drainage District.

In addition, the city or county must provide for at least one scoping meeting to receive input on the scope and content of the draft EIR. (Pub. Resources Code § 21083.9). Refer to Chapter 3: Community Engagement and Outreach, for methods to seek meaningful community input.

Adoption and Certification

Before adopting the general plan, element, or revision for which the EIR was prepared, the city council or county board of supervisors must consider the final EIR, certify its adequacy, and make explicit findings explaining how the significant environmental effects identified in the EIR have been or should be mitigated or explain why mitigation measures and identified alternatives are not feasible (CEQA Guidelines § 15091). The city or county cannot approve the general plan unless the approved plan will not result in a significant effect on the environment or, more commonly, the city or county has eliminated or substantially lessened all significant effects where feasible and made a written statement of overriding considerations explaining the reasons why any remaining unavoidable significant effects are acceptable (Id. at §§ 15092, 15093). The jurisdiction must also adopt a mitigation monitoring or reporting program to ensure that the mitigation incorporated into the plan in accordance with the EIR will be implemented (Id. at § 15091(d)).

Program and Master EIRs

In order to minimize the need to reanalyze a series of projects related to the general plan, CEQA and the state CEQA Guidelines encourage using a general plan EIR to address subsequent discretionary projects, such as adopting zoning ordinances and approving specific capital improvement or development projects that are consistent with the general plan. By using a programmatic approach, the environmental review for a subsequent project can be limited to those project-specific significant effects that either were not examined or not examined fully in the general plan EIR.

Later environmental analysis for more specific actions can use analysis from the general plan EIR in several ways. The following paragraphs present a brief discussion of program EIRs, master EIRs, streamlining under Public Resources Code sections 21083.3 and 21094.5, and the use of certain statutory exemptions.

Program EIRs

The program EIR prepared for a general plan examines broad policy alternatives, considers the cumulative effects and alternatives to later individual activities where known, and contains plan-level mitigation measures. Later activities that have been described adequately under the program EIR will not require additional environmental documents (CEQA Guidelines § 15168(c)(2)). When necessary, new environmental documents, such as a subsequent or supplemental EIR or a negative declaration, will focus on the project-specific impacts of later activities, filling in the information and analysis missing from the program EIR (Id. at subd. (d)).

The "project" being examined in the program EIR is the general plan, element, or revision. The CEQA Guidelines recommend that program EIRs deal with the potential effects of a general plan, element, or revision "as specifically and comprehensively as possible." The program EIR's level of detail should be commensurate with the level of detail contained in the general plan or element (See *Rio Vista Farm Bureau Center v. County of Solano* (1992) 5 Cal.App.4th 351).

A program EIR should pay particular attention to the following EIR components:

- The significant environmental effects, including cumulative effects of anticipated later activities under the plan or element.
- Mitigation measures, including plan-wide measures.
- Alternatives to the basic policy considerations set forth by the plan or element.

When evaluating a later activity to determine whether it is eligible for consideration under a program EIR, OPR suggests the following sequential approach.

First, the lead agency must determine whether the subsequent activity meets both of the following criteria:

1. It is consistent with the plan or element for which the program EIR was certified. (A general plan amendment obviously would not qualify (See *Sierra Club v. County of Sonoma* (1992) 6 Cal.App.4th 1307).
2. It incorporates the feasible mitigation measures and alternatives developed in the program EIR. (Additional mitigation measures and alternatives may also be applied when a subsequent or supplemental EIR is prepared.)

Second, the lead agency must evaluate the later activity and its location to determine whether the environmental effects of that activity were adequately described in the program EIR. If there are any new effects from the later activity, the lead agency must prepare an initial study to determine the significance of those effects. No subsequent EIR is necessary for a project that is essentially part of the "project" described by the general plan's program EIR unless:

1. The later project would propose substantial changes in the plan that were not described in the program EIR, requiring revisions to the program EIR due to the involvement of a new significant effect or a substantial increase in the severity of a previously identified effect.
2. Substantial changes have occurred in the circumstances under which the general plan was undertaken, requiring revisions to the program EIR due to the involvement of a new significant effect or a substantial increase in the severity of a previously identified effect.
3. New information of substantial importance that was not known and could not have been known at the time the program EIR was certified indicates that significant effects were not adequately analyzed or that mitigation measures or alternatives should be revisited.

(See CEQA Guidelines §§ 15162, 15168(c)). If no subsequent EIR is required, the project is deemed to be within the scope of the program EIR and no additional environmental document would be required.

Case law provides good examples of when further environmental review may, or may not, be required. For example, the City of San Diego's redevelopment agency was not required to conduct additional environmental review of a hotel project because it had previously prepared a program EIR addressing development in its downtown that adequately examined the hotel's potential environmental effects (See *Citizens for Responsible Equitable Envt'l Dev. v. San Diego Redevelopment Agency (2005)* 134 Cal.App.4th 598). On the other hand, additional environmental review was required for a proposal to use land for mining purposes because it included a new method of reclamation that was not "within the scope" of the program EIR (See *Sierra Club v. County of Sonoma* (1992) 6 Cal.App.4th 1307).

If a subsequent EIR must be prepared, it is subject to the standard EIR content requirements (i.e., project description, environmental setting, significant effects, mitigation measures, etc.). However, the subsequent EIR need not duplicate information and analysis that is already included in the program EIR. This may include such areas as environmental setting, project alternatives, and cumulative impacts. Pertinent discussions from the program EIR, to the extent that it examines regional influences, secondary effects, cumulative effects, broad alternatives, and other factors that apply to the later project, should be incorporated by reference into the subsequent EIR (CEQA Guidelines § 15168(d)).

Master EIRs

Another option for conducting programmatic review is to prepare and certify a master EIR (MEIR) (Pub. Resources Code §§ 21157, et seq. and CEQA Guidelines §§ 15175, et seq.). The MEIR is intended to be the foundation for analyzing the environmental effects of subsequent projects. Those projects that have been described in some detail in the MEIR may avoid the need for a later EIR or negative declaration. Other projects will only require analysis in a focused EIR that examines project-specific impacts while referencing the MEIR's analysis of cumulative and growth-inducing impacts.

Sections 15176(d) and 15177 of the CEQA Guidelines specifically allow later projects that are consistent with the land use designations and the permissible densities and intensities of use described in the general plan to proceed under the MEIR. This avoids the need for another EIR or negative declaration. The OPR publication Focusing on Master EIRs offers detailed technical information about using MEIRs.

In practice, an MEIR is similar to a program EIR. However, there are at least three differences worth noting.

- First, the requirements for preparing and applying an MEIR and its associated focused EIRs are described in detail in both statute and the CEQA Guidelines. Requirements for program EIRs, on the other hand, are less specifically described in the CEQA Guidelines.
- Second, once a subsequent project is determined to be within the scope of the MEIR, a focused EIR must be prepared whenever it can be fairly argued on the basis of substantial evidence in the record that the project may have a significant effect, even if evidence exists to the contrary.
- Third, to use an MEIR for a subsequent project, the MEIR must be re-examined and, if necessary, supplemented at least once every five years. This ensures that the analysis contained in an MEIR remains topical.

Streamlining in Public Resources Code Section 21083.3

Public Resources Code section 21083.3 contains a specific limitation on CEQA for projects that are consistent with a general plan. When an EIR has been certified for a general plan, the CEQA analysis of later projects can be limited to those significant effects that "are peculiar to the parcel or to the project" and that either were not addressed as significant effects in the plan's EIR or that new information shows will be more significant than when the plan's EIR was certified. The requirements of this option are detailed in CEQA Guidelines § 15183.

Streamlining for Infill Projects in Public Resources Code Section 21094.5

Similar to the provision described above, section 21094.5 of the Public Resources Code limits the CEQA analysis of infill projects. Specific rules on this provision are contained in Section 15183.3 and Appendix M of the CEQA Guidelines. Because the primary criteria for eligibility is proximity to transit, cities can maximize the streamlining benefit of a general plan EIR by carefully analyzing residential, commercial and school uses in transit corridors.

COMPARING EXISTING STREAMLINING MECHANISMS

	Program EIRs	Master EIRs	Section 21083.3	Streamlining Under Section 21094.5
Time Limit on Prior EIR	None	5 Years	None	None
Plan Consistency	General Plan and zoning consistency not explicitly required, but if project is not consistent, it may not be "within the scope" of the PEIR.	Silent	Requires consistency with General Plan and Zoning	Project may include general plan amendments or zoning variances, provided that new effects would need to be analyzed
Project-Level Description	Not required, but a PEIR "will be most helpful in dealing with subsequent activities if it deals with the effects of the program as specifically and comprehensively as possible."	Projects relying on the Master EIR must have been specifically identified	Not required in general plan or zoning EIR	Not required in EIR for a planning level decision
Project Contribution to Significant Effects	Analysis does not need to be repeated at the project level if the project is "within the scope" of the PEIR.	Analysis does not need not be repeated at the project level	Analysis does not need not be repeated at the project level	Analysis does not need not be repeated at the project level
Document Containing Programmatic Analysis	An EIR prepared for a program, plan, policy or ordinance	A Master EIR for specified projects	An EIR for a comprehensive general plan amendment or zoning code	An EIR for a planning level decision, as well as any supplements or addenda thereto
Effect of Development Standards	Can be used as thresholds of significance in an analysis, but not conclusively	Can be used as thresholds of significance in an analysis, but not conclusively	Can be used to address peculiar effects of the project, only if adopted by a city or county with a finding that the standard will substantially mitigate the effects of future projects	Can be used to address either new specific effects or effects that are more significant than previously analyzed, provided the finding is made at project approval

Integrating Annual Reporting with Mitigation Monitoring and Implementation

When a general plan is enacted or amended based upon an EIR or a mitigated negative declaration, the city council or board of supervisors must also adopt a reporting or monitoring program for ensuring compliance with the adopted mitigation measures (Pub. Resources Code § 21081.6). The city or county should coordinate general plan policies and environmental mitigation measures during the planning process so that the mitigation measures will be reflected in the plan policies and those policies realistically can be implemented.

The city or county must adopt a specific program that will enable it to track compliance with the mitigation measures. One approach is to use the yearly "status of the plan" report prepared for the city council or board of supervisors pursuant to Government Code section 65400(b) as the reporting program for a new general plan. See OPR's publication Tracking Mitigation Measures Under AB 3180 for more information about designing a mitigation monitoring program. Transportation information resulting from the mitigation monitoring program must be submitted to the local transportation planning agency and to Caltrans (Pub. Resources Code § 21081.7; CEQA Guidelines §15097(g)).

A general plan can be measured by how well its goals, policies, and programs are implemented. The same is true for the mitigation measures identified in the plan's EIR. When drafting mitigation measures, consider how they can be reflected in plan goals, policies, and programs and how they will be implemented. The mitigation measures should be an integral part of the plan, not an afterthought.

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Appendix A

Example Model Goals, Objectives, and Policies and Programs

The policies contained in this appendix were selected through a combination of public outreach, stakeholder engagement, expert input, and independent research. They are organized by element, with relevant subheadings and grouped into policies by area consistent with the general plan sections. Many policies could be classified under various elements; for instance, a policy relevant to circulation could also be classified under healthy communities or environmental justice. However, rather than repeat the policies in several areas, the document is searchable for key words. Policies can be used as a reference or as a starting point to meet the needs of different local jurisdictions. As with the entire general plan, the policies need to be consistent across elements.

The goals, objectives, policies, programs, and actions (heretofore referred to as 'policies') listed were gathered through extensive outreach and public comment. Where available, cities and counties that have adopted the policies are listed in parenthesis. Often, these are the exact policies from the listed jurisdictions. Some policies, however, have been modified or combined to be more widely applicable, and have different wording than the general plan(s) from which they were pulled. Where the policy language varies significantly from any cities and counties that have implemented them, the policy is listed as "general." In some instances, numerous jurisdictions have different versions of the same policies, written with slight variations. In such instances, the policy has been modified slightly to be broad, and numerous jurisdictions are listed as examples. The goal in modifying policies is to retain the intent, while making them relevant for a broad range of jurisdictions.

While much research and effort was put into assuring inclusive representation of policies from diverse areas, including rural, urban, agricultural, and suburban, some jurisdictions are listed more prominently than others due to the complexity of their general plans, and the availability of information. As the GPG is updated, additional policies will be added to this document.

Definitions- for more detailed definitions, see Appendix E: Glossary

This appendix combines all items into goals, objectives, and policies and programs. General plans vary in their terminology, and may include other categories such as vision and actions. For this appendix, all items have been consolidated into the following three areas:

Goal

A goal is a general direction-setter. It is an ideal future end related to the public health, safety, or general welfare. A goal is a general expression of community values and, therefore, may be abstract in nature. Consequently, a goal is generally not quantifiable or time-dependent.

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Objective

An objective is a specified end, condition, or state that is an intermediate step toward attaining a goal. It should be achievable and, when possible, measurable and time-specific. An objective may pertain to one particular aspect of a goal or it may be one of several successive steps toward goal achievement. Consequently, there may be more than one objective for each goal.

Policies, Programs, Actions

A policy is a specific statement that guides decision-making. It indicates a commitment of the local legislative body to a particular course of action. A policy is based on and helps implement a general plan's vision. Programs can be short or long term groupings of projects or services that help achieve policy goals. Actions are specific methods to achieve policy goals. In this appendix, policies, programs, and actions are listed together.

Example Policies by Element

Land-Use Planning

- Design for Sustainability and Stability
- Provide for New Development
- Create Economically Vibrant Communities
- Improve Community Life

Circulation

- Transportation Planning
- Parking
- Public Transit
- Biking and Walking
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Housing

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Conservation

Biological Resources

Mineral Resources

Cultural Resources

Water Resources

Agricultural Resources

Open Space

Open Space for Habitat and Conservation

Open Space for Recreational Uses

Visual Resources

Safety

Numerous safety element policy recommendations are included throughout the general plan guidelines and in guidance from the office of emergency services (CalOES) in support of local hazard mitigation planning. Rather than relying on this appendix entirely for recommended policies, OPR recommends accessing the resources available by CalOES for local hazard mitigation planning and those outlined in the Safety Element, in addition to those resources listed in the table in Chapter 4, Tools to Address Climate Adaptation. See also: *"Healthy Communities: A Changing Climate and Resiliency"*

Avoiding and Mitigating Natural Disasters

Emergency Preparedness and Prevention

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Environmental Justice

Pollution Exposure

Food Access

Safe and Sanitary Homes

Physical Activity

Access to Public Amenities

Noise

Air Quality

Healthy Communities

Economics and Health

A Changing Climate and Resiliency

Social Connection and Safety

Health and Human Services

Economic Development

Equitable and resilient communities

Community Engagement

A

Climate Change

Numerous element specific climate change policy recommendations are included throughout the general plan guidelines. Further policy guidance is included in the resources outlined in the table included in Chapter 8, Climate Change. Goals, policies, and actions to address climate change adaptation and greenhouse gas emissions reductions are constantly evolving. Rather than relying on this appendix entirely for recommended climate related policies, OPR recommends referencing the variety of resources readily available on the *California Air Resources Board Cool California website* and the *Office of Planning and Research's Integrated Climate Adaptation Resiliency Program's (ICARP) Adaptation Clearinghouse.*

Code Changes, Zoning Changes, and/or Policy

- Energy
- Transportation and Land Use
- Natural and Working Lands (NWL)
- Agriculture
- Water
- Waste Management
- Short-Lived Climate Pollutants
- Green Buildings

Mitigation

- Construction
- Operation

A

Land–Use Planning

Design for Sustainability and Stability

Provide for New Development

Create Economically Vibrant Communities

Improve Community Life

Design for Sustainability and Stability

Goal: Accommodate the development of a mix of land uses that meet the diverse needs of residents and businesses, with places to live, work, shop, be entertained and culturally enriched, engage in healthy lifestyles, and engage with one's community. (Sacramento, Pasadena, La Habra)

Objective 1: Regulate and Optimize Density (General)

Policies, Programs, Actions:

- Regulate the levels of building intensity and population density consistent with the designations established by the Land Use Diagram. Within these designations, cumulative development shall not exceed (insert number) additional persons (or housing units) and (insert number) additional employees (or non-residential building square feet) by (insert year). (Sacramento, La Habra)
- Review the General Plan's residential and commercial capacities every five years and modify, as necessary, to reflect development that has occurred, its impacts, evolving market and economic conditions, and consistency with community values. (Pasadena)
- Allocate sufficient land at densities sufficient to support the development of businesses offering jobs matched to the education and skills of the city's residents and housing affordable to employees of local businesses, thereby reducing commutes to and from outside of the community. (La Habra)
- Avoid the overconcentration of uses and facilities in any neighborhood or district where their intensities, operations, and/or traffic could adversely impact the character, safety, health, and quality of life. (Pasadena)

Objective 2: Enhance areas at the local level to increase livability and bolster local economy while reducing automobile traffic. (General)

Policies, Programs, Actions & Programs:

- Provide for and encourage the development of a broad range of uses in the city's commercial centers and corridors that reduce the need to travel to adjoining communities and capture a greater share of local spending. (La Habra)

- Require that development is located and designed to assure compatibility among land uses and districts. (La Habra)
- Encourage school districts and park and recreation districts to locate school sites and parks within or adjacent to existing or planned residential and mixed use neighborhoods. (Butte County)
- Encourage development of local, citywide, and regional mixed-use centers that address different community needs and market sectors, and complement and are well-integrated with surrounding neighborhoods. (Sacramento)
- Facilitate the redevelopment of the city's auto-oriented commercial corridors and suburban centers to create vibrant, mixed-use boulevards by clustering higher density, pedestrian-oriented mixed use on larger parcels at key intersections, while re-using intervening parcels for housing mixed with neighborhood-oriented commercial services and/or public plazas. (Sacramento, La Habra)
- Support uses that meet daily needs such as grocery stores, local-serving restaurants, and other businesses, activities, and community-supportive facilities within walking or biking distance of residences to reduce the frequency and length of vehicle trips. (La Habra)

Objective 3: Incorporate existing buildings into community design. (General)

Policies, Programs, Actions:

- Prevent deteriorating conditions in areas of the city with buildings that are aging and not properly maintained through public and private conservation and rehabilitation programs. (La Habra)
- Encourage the adaptive re-use and application of green technologies of existing buildings as a preference for demolition and replacement to retain the structure's embodied energy, increase energy efficiency, and reduce waste. (Sacramento, Rialto)

Provide for New Development

Goal: Support development projects that provide a diversity of urban and suburban neighborhood opportunities. Ensure that new residential growth areas include neighborhoods that provide a mix of residential types and densities, and appropriate transitional features integrating the area with adjacent existing neighborhoods and development. (Fresno, Sacramento, Citrus Heights)

Objective 1: Plan new development that is high-quality and well-integrated into existing cities and communities. (General)

Policies, Programs, Actions:

- Provide opportunities for interested and affected parties to have input in proposed planning activities as early as possible. (Citrus Heights)
- Encourage the retention and production of diverse types of housing within Urban Service Areas in order to provide adequate housing choices for current and future residents. (Sonoma County)
- Coordinate the development of capital facilities and infrastructure with the timing of growth to ensure adequate and high levels of services for existing and new development. (Pasadena)

- Provide for a diversity and variation of building types, densities, and scales of development in order to reinforce the identify of individual neighborhoods, foster a variety of market-based options for living and working to suit a large range of income levels, and further affordable housing opportunities. (Fresno)
- Require that new development and reconstruction comply with the California Green Buildings Standards Code with amendments and update periodically to reflect future amendments. (La Habra)
- Require that the scale and massing of new development in higher-density centers and corridors provide appropriate transitions in building height and bulk and are sensitive to the physical and visual character of adjoining lower-density neighborhoods. (Sacramento, Pasadena)
- Require that buildings are designed as a high-quality, long-term addition to the City's urban fabric; exterior design and buildings shall exhibit permanence and quality, minimize maintenance concerns, and extend the life of the building. (Pasadena)

Objective 2: Promote compact development patterns, mixed-use, and higher densities that use land efficiently; reduce automobile dependence and pollution and greenhouse gas emissions, and facilitate walking, bicycling, and transit use, including through mixed-use corridors and activity centers. (Sacramento, Fresno)

Policies, Programs, Actions:

- Target growth and new construction in infill areas by redeveloping underutilized commercial, residential, and industrial properties. (Pasadena)
- Site a mix of housing and jobs in close proximity or through mixed use development so that bicycling, walking and transit use is a viable option for residents and employees. (General)
- Protect and conserve land that is used for agricultural purposes, including cropland and grazing land. (Butte County)
- Encourage new neighborhoods to be designed to locate all housing within ½ mile of a central gathering place that incorporates public spaces, shopping areas, access to transit, and/or community-supportive facilities and services. (Sacramento)
- Encourage the consolidation of small parcels, joint public-private partnerships, and land clearance and re-sale to facilitate the revitalization of underused and obsolete commercial and industrial properties. (La Habra)

Objective 3: Incorporate practices that preserve aesthetics and environments simultaneously. (General)

Policies, Programs, Actions:

- Encourage the renovation, infill, and redevelopment of existing suburban centers that reduces the visual prominence of parking lots, makes the centers more pedestrian friendly, reduces visual clutter associated with signage, and enhances the definition and character of the street frontage and associates streetscape. (Sacramento)

- Promote and, where appropriate, require sustainable building practices that incorporate a "whole systems" approach for design and construction that consume less energy, water, and other non-renewable resources, facilitate natural ventilation, effectively use daylight, and are healthy, safe, comfortable, and durable. (Sacramento, Long Beach, San Diego County)
- Encourage the strategic selection of street tree species to enhance neighborhood character and identity and preserve the health and diversity of the urban forest. (Sacramento)

Create Economically Vibrant Communities

Goal: Foster a robust local economy that provides high-quality employment for residents and attracts stable businesses. (General)

Objective 1: Use smart planning to create a favorable economic environment. (General)

Policies, Programs, Actions:

- Increase the amount of land properly zoned, consistent with the General Plan, and ready to be expeditiously developed, redeveloped, and/or revitalized for economic development and job creation purposes. (Fresno)
- Ensure that the city has appropriate resources in place to implement its economic development strategy and work in close coordination with other public agencies, private entities, the non-profit sector, and multi-cultural communities to coordinate economic development efforts on a region-wide basis. (Fresno)
- Prioritize the provision of necessary major street infrastructure and utility capacities for properly zoned-land, consistent with the General Plan, so this land can be developed in a timely manner to support economic development. (Fresno)
- Modify and monitor zoning codes to create economic incentives for more intensified forms of land use on previously developed but underutilized parcels.(La Habra)
- Promote, educate, and market the benefits of a "buy local" campaign. (Fresno)
- Support the development of locally-grown and based retail businesses as an alternative to national chain brands. (Pasadena)

Objective 2: Ensure fair financial management. (General)

Policies, Programs, Actions:

- Require new residential and commercial development to pay its fair and proportional share of needed community improvements through impact fees, assessment districts, and other mechanisms. (Fresno)
- Periodically conduct comprehensive fee studies to determine whether impact fees fully account for the recovery of costs, consistent with applicable law.(Fresno)

Objective 3: Attract and retain long-term, economically sustainable businesses. (Sacramento)

Policies, Programs, Actions:

- Encourage a balance between job type, the workforce, and housing development to reduce the negative impacts of long commutes and provide a range of employment opportunities for all city residents. (Sacramento)
- Explore and identify target industries with well-paying occupations that match or can enhance the skill base and training capacity of local residents. (La Habra)
- Establish a list of "ready-to-go" or "shovel-ready" sites in consultation with property owners, and provide the list to interested developers and businesses seeking sites in the city. (Fresno)
- Cultivate an entrepreneurial and academic environment that fosters innovation.(Pasadena)
- Promote the local workforce as a marketable resource for job placement companies serving the area and target industries. (La Habra)
- Provide incentives to existing small and startup businesses, including minority- and women-owned businesses, to facilitate their expansion and job creation. (Sacramento)
- Work with universities, the local chamber of commerce, and other groups to encourage businesses working with cutting-edge technology to locate in the city. (Sacramento)

Objective 4: Promote the development and retention of a skilled workforce. (General)

Policies, Programs, Actions:

- Reduce barriers to gainful employment such as lack of public transportation, training, job information, and child care.(Pasadena)
- Work with local organizations in developing links between public and private providers of primary, secondary, and post-secondary education and with local businesses and industries to develop and promote educational programs relevant to the needs of the local economy. (Sacramento)
- Work to improve the quality of life in the city to retain existing skilled workers and attract skilled workers from beyond the region. (Sacramento)
- Create a program to provide incentives for local businesses to offer internship, mentoring, and apprenticeship programs to high school and college students in partnership with local educational institutions. (Fresno)

Improve Community Life

Goal: Provide services to promote the health, safety, and well-being of all residents. (General)

Objective 1: Provide a diversity of uses and services supporting the city's residents such as facilities for governance, public safety, seniors and youth, community gatherings, and comparable activities. (La Habra)

Policies, Programs, Actions:

- Work with external agencies and non-profit organizations to encourage the provision of services and facilities not subject to city jurisdiction, such as public schools and quasi-public infrastructure. (La Habra)
- Ensure that sufficient parks, open space, and trails are planned throughout the city to ensure adequate facilities are available to existing and future residents. (Sacramento)
- Require higher-density urban neighborhoods and mixed-use districts to incorporate small public spaces and have broad tree-lined sidewalks furnished with appropriate pedestrian amenities providing comfortable and attractive settings for high levels of pedestrian activity. (Sacramento)
- Promote the co-location of parks, schools, police, police and fire facilities, health services, and other community facilities to support community interaction, enhance neighborhood identity, and leverage limited resources. (Sacramento)

Objective 2: Strive to make communities socially equitable. (General)

Policies, Programs, Actions:

- Ensure that parks and recreation facilities, community services, public facilities, and amenities are equitably distributed and accessible throughout the city. (Pasadena, La Habra)
- Discourage features in residential development that tend to isolate residents from the sense of an integrated community, such as walls and gated single-family neighborhoods. (Citrus Heights)
- Promote an equitable distribution of housing types for all income groups throughout the City and promote mixed-income developments rather than concentrations of below market-rate housing in certain areas. (Sacramento)
- Promote the design of neighborhoods, centers, streets, and public spaces that enhances public safety and discourages crime by providing street-fronting uses ("eyes on the street"), adequate lighting and sight lines, and features that cultivate a sense of community ownership. (Sacramento)
- Prohibit or control land uses that pose potential health and environmental hazards to residents of neighborhoods and districts. (Pasadena)

Promote the development of uses providing healthy and locally-grown food choices for the city's residents (i.e., brick and mortar facilities, community gardens, and farmer's markets). (Pasadena)

A

Circulation

Transportation Planning

Parking

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Biking and Walking

Preserving Neighborhood Character

Economics and Transportation

Transportation Planning

Goal: Develop a transportation system that meets the needs of all segments of the community, including those of residents, businesses, visitors, and the region. (San Pablo, Pasadena)

Objective 1: Design and operate city streets based on a "Complete Streets" concept that enables safe, comfortable, and attractive access and travel for pedestrians, bicyclists, motorists, and transit users. (San Pablo)

Policies, Programs, Actions:

- Include "Complete Streets" considerations in the design of all circulation improvement projects. These new design considerations include, but are not limited to, the following:
- Landscaping (trees, medians, key intersections and gateways) that uses drought-resistant plant species, whenever possible, to conserve water;
- Minimized ingress and egress points, consolidated entries;
- Public transit facilities and improvements;
- Safety criteria such as lighting and traffic calming devices for residential streets;
- Sign design (including commercial signs, street signs, entry signs, directional signs)
- Street furniture;
- Bus stop locations and sidewalk widening, as needed; and
- On and off-street parking management (San Pablo)
- Design intersections and public right-of-ways to include adequate and safe access for all users including pedestrians, bicyclists, and motorists of all ages and abilities. (San Pablo)

- Encourage connectivity and accessibility to a mix of land uses that meet residents' daily needs within walking distance. (Pasadena)
- Provide an ongoing review of emergency operations plans and provisions to ensure that the City's program for emergency transportation services is coordinated with other local and regional jurisdictions and incorporates updated procedures and programs as appropriate. (Pasadena)
- Coordinate transportation options for major community and commercial events to increase transit access, ridesharing and bicycle access and parking options. (Pasadena)
- Design sidewalks and pedestrian paths to provide defensible space and adequate sight lines between adjoining development to insure safety and security. Sidewalks should feel comfortable and welcoming at all times of the day and night. (Sonoma County)

Objective 2: Improve safety for all modes by developing and coordinating between the Police Department and the Transportation Department the implementation of traffic management, education, and enforcement. Increase options for walking and bicycling to recreate, shop, and services while improving safety for all modes. (Pasadena)

Policies, Programs, Actions:

- Install traffic calming devices, such as signage, road bulbs (also called curb extensions), raised crosswalks, and speed humps, as needed and appropriate in existing neighborhoods. (San Pablo)
- Work with transit providers to implement a Safe Routes to Transit program for bicycle and pedestrian access to transit stops and stations. (Sonoma County)
- Manage traffic speeds on neighborhood streets to reduce cut-through traffic. (Pasadena)
- Promote efficient use of existing transportation facilities through the implementation of transportation demand management concept (San Pablo)
- Establish travel demand management programs to reduce peak-hour traffic congestion and help reduce regional vehicle miles traveled (San Pablo, Pasadena)
- Continuously evaluate the operation of the City's transportation system to manage the speed of travel at or below the speed limit, manage queues at intersections and develop improvements to increase safety of all transportation services. (Pasadena)
- Promote greater linkages between land uses and transit, as well as non-vehicular modes of transportation to reduce vehicular trip related emissions. (Pasadena)
- Promote safe travel in neighborhoods and coordinate with the Pasadena Police Department to enforce traffic regulations with particular attention given to sensitive uses such as schools, senior centers, hospitals, community service facilities, and parks. (Pasadena)

- Limit the intrusion of commercial truck traffic on City streets, especially residential neighborhoods, by directing truck traffic to the city's designated truck routes and coordinating with the Pasadena Police Department to enforce related regulations on local streets. (San Pablo, Pasadena)
- Collaborate with the business community to encourage truck deliveries to be made in off-peak hours especially in areas where nearby residents would be affected. This policy must be consistent with provisions of the City's noise ordinance. (Pasadena)

Goal: Create a transportation system that encourages health benefits for all community members. (General)

Objective: Improve air quality from transportation sources to protect human and environmental health, and minimize impacts on sensitive populations. (General)

Policies, Programs, Actions:

- Designate truck routes that avoid sensitive land use areas in combination with adequate signage and enforcement. (General)
- Prohibit overnight parking of trucks on secondary streets or publicly habitable space located in residential zones. (General)
- Prohibit idling of on-road and off-road diesel vehicles and equipment for more than 5 minutes. (General)
- Partner with the local air quality management district to establish a program facilitating diesel engine retrofitting or replacement in existing automobiles, trucks, rail, and ships. Identify feasible technologies and funding. (General)
- Collaborate with regional agencies to establish best practices for emissions reduction. (General)
- Create residential and commercial units located along higher density corridors and areas where increased intensity of use may result in higher levels of vehicular traffic on adjacent streets. Identify recommendations for mitigation, including design standards and public transportation (Richmond)
- Balance commercial goods movement with the health and quality of life priorities of the community by routing heavy truck traffic away from residential zones and promoting safety at rail crossings (San Pablo)

Parking

Goal: Foster practical parking solutions to serve community needs while avoiding excessive amounts of surface parking that disrupt the urban fabric of the city. (San Pablo)

Objective: Amend the Zoning Ordinance to establish "green" parking design standards that have multiple benefits, such as shared parking for mixed use projects, photovoltaic panels on parking structures to generate energy for parking lot lighting, landscaping and trees in surface parking, and pervious paving to improve groundwater recharge and promote innovative surface parking design that avoids the appearance of a "sea of asphalt" and reduces environmental impacts. (San Pablo)

Policies, Programs, Actions:

- Promote the use of time, motion-sensing, and/or solar powered parking lot lights or security lights, wherever feasible (San Pablo)
- Establish specific standards for perimeter landscaping, including the type and coverage required along the edges of surface parking areas adjacent to streets (San Pablo)
- Require a minimum number of trees per parking stall in surface parking areas (e.g. 1 per 8 stalls for double-loaded bays) to provide shade, and reduce urban heat island effects (San Pablo)
- Separate pedestrian pathways from car lanes where possible (San Pablo)
- Promote the use of porous paving and a variety of drainage features according to the site (San Pablo)
- Restrict use of vacant lots as vehicle parking and outdoor storage of commercial equipment, construction equipment, and similar items unless screened from view from adjacent streets (San Pablo)
- Promote use of innovative parking technologies, such as parking lifts and automated parking (San Pablo)
- Require convenient and accessible parking facilities for persons with disabilities, consistent with Americans with Disabilities Act (ADA) requirements (San Pablo, Pasadena)
- Limit parking within the public right of way based upon considerations of safety, street width ,visibility and access to properties (San Pablo)
- Enforce regulations that prohibit parking of commercial, recreational, and non-operable vehicles in residential areas, including the staging of taxi services (Pasadena)
- Plan for the deployment of autonomous vehicles and related smart cities infrastructure through modifications to the jurisdiction's implementing documents such as zoning, parking, bike/ped plans, congestion management plans, etc. (General)
- Maintain and better utilize existing private and public parking structures through shared parking opportunities and advanced traveler information services to direct parkers to available spaces (Pasadena)
- Continue to enforce parking regulations and prevent spillover of parking from commercial areas into residential neighborhoods (San Pablo, Pasadena)

Public Transit

Goal: Plan for transportation modes and strategies that ensure good air quality, reduce greenhouse gas emissions, reduce petroleum consumption and reduce the need to devote additional lands to transportation uses (Butte County)

Objective: Facilitate the use of public transportation in by making it more comfortable and convenient (San Pablo, Pasadena)

Policies, Programs, Actions:

- Assess ways to improve availability of transit for underserved populations (Pasadena)
- Continue coordination efforts with public transit providers to maintain transit service that is safe and efficient with convenient connections to high use and activity intersections in the city (San Pablo)
- Assess implications of autonomous vehicles on transit and mobility planning infrastructure. (General)
- Where feasible and appropriate, and where non-motorized travel is reasonably expected, the width of existing streets shall be reduced through bulbouts, medians, pedestrian islands and similar methods, and planting shade trees in landscaped areas within and adjacent to streets, while not jeopardizing emergency response and future capacity requirements. (Butte County)
- Seek funding to enhance accessibility by increasing routes, frequency and hours of operation for the transit system throughout the community. (Pasadena)
- Encourage carpooling by providing additional carpool pickup and park-and-ride locations near transit centers and at freeway interchanges. (Butte County)
- Facilitate coordination between transit providers to improve seamless transit service. (Pasadena)
- Promote safety at railroad crossings through the following measures, as necessary:
    - Improvements to pedestrian warning devices at existing railroad crossings to maintain the visibility of warning devices and approaching trains; and
    - Rail safety awareness programs to educate the public about the hazards of at grade crossings.
    - Installation of additional warning signage and/or channelization;
    - Improvements to traffic signaling at intersections adjacent to crossings;
    - Prohibition of parking near crossings to improve the visibility of warning devices and approaching trains (San Pablo)

Biking and Walking

Goal: Develop a safe and comprehensive bicycle and pedestrian network to improve access and public health. (San Pablo, Pasadena)

Objective: Expand and maintain a safe and comprehensive bicycle system that connects the City's neighborhoods to regional bicycle routes. (San Pablo, Pasadena)

Policies, Programs, Actions:

- Require the provision of bicycle parking and related facilities in new employment-generating development and multi-family housing to facilitate multi-modal commute choices. (San Pablo)

- Develop and maintain a comprehensive and integrated system of reduced stress bikeways and increase bicycle parking at destinations to promote bicycle riding as a mode of transportation. (Pasadena)
- Encourage local and regional transit agencies to provide and maintain convenient and secure bike parking facilities, all-weather shelters, and other amenities at major transit stops and transportation centers. (Sonoma County)
- Explore bicycle share programs or any other bicycle programs (e.g., discounts for bikes, free bikes, inexpensive bike loans or rentals) that will provide greater access to bicycles for visitors and those that may not own a bicycle. (Pasadena)
- Increase walking and bicycling to local destinations and regional transportation services by developing wayfinding signage for pedestrians and bicyclists. (Pasadena)
- Adopt and periodically update a Bicycle Master Plan to enhance bicycle circulation and planning and be coordinated with the Countywide Bicycle and Pedestrian Plan. (San Pablo)
- Use brightly-colored paint or a one-foot buffer strip along bicycle routes to provide a visual signal to drivers to watch out for bicyclists and nurture a "share the lane" ethic. Start with areas of town where automobile-bicycle collisions have occurred in the past, based on data from the Statewide Integrated Traffic Records System maintained by the California Highway Patrol. (San Pablo)
- Develop measures to reduce conflict areas for bicyclist such as driveways and right turn lanes. (Pasadena)
- Amend an existing transportation impact fee to include pedestrian and bicycle improvements. (Pasadena, City of Santa Cruz)
- Develop a schedule and comprehensive funding program for proposed bike system improvements within the Capital Improvements Program. (City of Santa Cruz)
- Implement Safe Routes to School program where funded. (City of Santa Cruz)
- Incorporate projects listed in the Bicycle Transportation Plan in any relevant future area, neighborhood, or similar plans that are prepared. (General)
- Assure that right-of-way acquisition and street design will support pedestrian and bike improvements and transit. (City of Santa Cruz);
- Facilitate bicycling connections to all travel modes. (City of Santa Cruz)
- Encourage all educational facilities to provide for safe and convenient pedestrian and bike access. (City of Santa Cruz)
- Replace or retrofit storm drain grates and channels that are hazardous to bicycles. (General)
- Ensure all traffic control detection systems are designed, adjusted, and marked for bicycle detection and that signals allow enough time for bicycle passage through controlled intersections. (General)
- Provide design guidelines for safe and secure bicycle parking and promote bicycle access for special events. (City of Santa Cruz)

A

Goal: Increase the opportunities, where appropriate, for transit systems, pedestrians, bicycling and other alternative modes to reduce the demand for automobile travel. (Sonoma County)

Objective: Increase the viability of walking and biking as a method of transportation (General)

Policies, Programs, Actions:

- Routinely consider the needs of pedestrians and bicyclists and, where possible, accommodate in all roadway construction and renovation projects. (Napa County)
- Collect and analyze bicycle, pedestrian, and transit trip data by establishing routine collection of alternative trip information on collector and arterial roadways and require such information be provided as part of project traffic studies. (Sonoma County)
- Incorporate Americans with Disabilities Act (ADA) requirements throughout the City, but especially in high-volume pedestrian areas. (City of El Monte)
- Require major employment centers and employers to provide facilities and Traffic Demand Management (TDM) programs that support alternative transportation modes, such as bike and shower facilities, telecommuting, flexible schedules, etc. These programs may apply to existing employers as well as to new development (Sonoma County)
- Regularly inspect streets and maintain pavement in a condition that keeps maintenance costs at a minimum, encourages bicycling, and ensures that repairs are acceptable and long-lasting. (City of Santa Cruz)
- Provide regular sweeping, pavement repairs, striping, and signs along bike routes. (City of Santa Cruz)
- Work with appropriate agencies to seek funding for pedestrian and bicycle projects and submit applications to all available regional, state and federal funding sources. (City of Santa Cruz)
- Assure a high level of bicycle user amenities. (City of Santa Cruz)
- Use the City/county's web site to promote walking and cycling and publicize routes and facilities. (General)
- Implement bicycle safety programs and cooperate with other agencies in the enforcement of bicycle safety. (City of Santa Cruz)
- Complete and enhance the pedestrian network with an interconnected system of walkways, continuous sidewalks on both sides of the street, and pedestrian crossings. (San Pablo)
- Support neighborhood walk-to-school efforts. (Pasadena)
- To maintain walkability and pedestrian safety, reduce curb-to-curb road widths and employing roadway design features such as islands, pedestrian refuges, and pedestrian count-down signal. (San Pablo)
- Provide pedestrian facilities that are accessible to persons with disabilities and ensure that roadway improvement projects address accessibility and universal design concept. (San Pablo)

- In mixed-use areas or other areas with high pedestrian traffic, provide mid-block pedestrian crossings, where feasible, to create more direct walking routes and slow vehicle speeds (San Pablo)

Preserving Neighborhood Character

Objective: Protect the character of local residential streets. (San Pablo)

Policies, Programs, Actions:

- Ensure that public right-of-way improvement designs are consistent with the character of each neighborhood. (San Pablo, Pasadena)
- Minimize street and intersection widening to facilitate pedestrian crossings and protect historic resources and open space. (Pasadena)

Economics and Transportation

Objective: Maintain economic health and viability while making improvements to transportation infrastructure. (General)

Policies, Programs, Actions:

- Ensure that new development pays its fair share of the costs of new and improved transportation facilities. (San Pablo)
- Pursue funding opportunities such as grants, impact fees or fair share contributions from development to implement programs and projects that contribute to the City's Mobility Element objectives. (Pasadena)
- Emphasize transportation projects and programs that will contribute to a reduction in vehicles miles traveled per capita, while maintaining economic vitality and sustainability. (Pasadena)
- Manage curb-space parking to support neighborhood protection and economic vitality. (Pasadena)

A

Housing

Special Populations and Homelessness

Affordability

Housing and Neighborhoods

Infill Housing

Special Populations and Homelessness

Objective: Support provision of housing to address the needs of the disabled, mentally ill, persons with substance problems, persons with HIV/AIDS, and other groups needing transitional and supportive housing. (Long Beach)

Policies, Programs, Actions:

- Encourage universal design of housing products and environments, making them usable by a wide range people with different physical and mental abilities. (Long Beach)
- Integrate and disperse special needs housing within the community and in close proximity to transit and public services. (Long Beach)
- Adopt a written reasonable accommodation ordinance to provide exception in zoning and land-use for housing for persons with disabilities, for development standards such as building setbacks and parking requirements. (City of Lindsay)

Affordability

Objective: Increase the availability of affordable housing. (General)

Policies, Programs, Actions:

- Where the City provides financial assistance, require the inclusion of affordable units. (Long Beach)
- Support programs and projects which link affordable housing with other community development goals and resources. (Long Beach)
- Utilize development agreements as a tool to achieve a mix of affordability levels in large-scale projects. (Long Beach)
- Expedite the processing of residential development proposals and permits and granting priority queuing to permit applications for affordable housing projects. (Simi Valley)
- Convene a working group made up of building industry and affordable housing experts to explore new funding sources for affordable housing. (City of Sacramento)

- Conduct a seminar with affordable housing developers to discuss priority sites as well as to promote new development standards and programs that promote affordable housing. (City of Sacramento)

Housing and Neighborhoods

Objective: Plan and maintain housing with a view to creating safe and functional neighborhoods. (General)

Policies, Programs, Actions:

- Promote strong, on-site management of multi-family complexes to ensure the maintenance of housing and neighborhood quality. (Long Beach)
- Support the development of housing that is technology-friendly and designed to meet the housing needs of the emerging information and technology industry workforce. (Long Beach)
- Invest in infrastructure and public facilities to ensure that adequate water, sewer, roads, parks, and other needed services are in place to serve existing and future residential developments. (Kings County)
- Incorporate other community goals with the production, conservation, and protection of housing, including encouraging sustainable development, providing supportive services, increasing walkability and non-motorized forms of transportation, improving and maintaining public safety, and ensuring ongoing public participation efforts. (Santa Monica)
- Encourage and provide incentives for the development of housing in mixed-use zoning districts near transit opportunities. (Santa Monica)
- Ensure that architectural design of new housing development is compatible with the surrounding neighborhood. (Santa Monica)
- Encourage residential projects to utilize a variety of housing types, unit clustering, and special construction techniques, where these will preserve natural topographic, landscape and scenic qualities. (Alameda County)
- Mandate that residential projects be sited, designed and landscaped to: ensure privacy and adequate light, air and ventilation to units and residential open space areas; provide adequate and usable private indoor and outdoor spaces; and ensure adequate visual and acoustical buffering and/or separation between residential units and adjoining nonresidential units and major transportation facilities. (Alameda County)
- Encourage institutions of higher education to build student, staff, and faculty housing to meet the needs of their students and employees. (Long Beach, California State University)

A

Infill Housing

Also see the Infill Compendium

Objective: Make use of existing and new policies to encourage compact development and infill. (General)

Policies, Programs, Actions:

- Prepare a study recommending new financing options to provide infrastructure in infill areas. New sources of financing could include state and federal grants, the General Fund, the use of impact fees, bond measures and financing sources. (City of Sacramento)
- Encourage and facilitate transit-oriented development in key locations by maintaining a webpage with a map of sites in transit priority areas, and near services and amenities. (City of Sacramento)
- Revise County ordinances and fees to encourage development of secondary dwellings, and further promote secondary dwellings. For example, the County will consider revising road requirements and public facility fees for secondary dwellings or according to home size. (San Luis Obispo County)
- Explore ways to provide incentives for development of mixed use projects such as reduced or deferred fees and revised ordinance standards for mixed use. The County will consider the relationship between the amount of public benefit (such as reduced traffic and enhanced business viability) and proposed incentives. (San Luis Obispo County)
- Provide assistance for project design (e.g. site planning, engineering, and/or preliminary architectural services) and infrastructure improvements (e.g. cost-sharing and/or fee waivers) for: 1) infill housing development and/or redevelopment projects, especially when located in or near downtown; or 2) housing development projects that promote land or energy conservation. (City of Lindsay)
- Encourage development of residential uses in strategic proximity to employment, recreational facilities, schools, neighborhood commercial areas, and transportation routes (Long Beach)

Conservation

Biological Resources

Mineral Resources

Cultural Resources

Water Resources

Agricultural Resources

Biological Resources

Goal: Protect and enhance biodiversity and special ecosystems outside of preserves as development occurs according to the underlying land use designation. (San Diego County)

Objective 1: Ensure wildlife populations have sufficient habitat, including habitat corridors, to maintain viable numbers. Particular attention shall be focused on retaining habitat areas that are contiguous with other existing natural areas and/or wildlife movement corridors. (City of Sacramento, Yolo County)

Policies, Programs, Actions:

- Identify existing conservation lands and develop a coordinated biological preserve system that includes Pre-Approved Mitigation Areas, Biological Resource Core Areas, wildlife corridors, and linkages to allow wildlife to travel throughout their habitat ranges. Development should avoid adverse impacts to areas of conservation priority, wildlife movement corridors and nursery sites (e.g., nest sites, dens, spawning areas, breeding ponds). (San Diego County, Yolo County)
- Require that impacts to species listed under the State or federal Endangered Species Acts, or species identified as special-status by the resource agencies, be avoided to the greatest feasible extent. If avoidance is not possible, minimize and fully mitigate impacts consistent with applicable local, State, and Federal requirements. (Yolo County)
- Allow for appropriate public access to open space lands for recreation activities while protecting and restoring the natural ecosystem and minimizing environmental damage, as appropriate. (Redwood City)
- Habitat preserved as a part of any mitigation requirements shall be preserved in perpetuity through deed restrictions, conservation easement restrictions, or other method to ensure that the habitat remains protected. All habitat mitigation must have a secure, ongoing funding source for operation and maintenance. (Yolo County)

Objective 2: Preserve, maintain, and expand the number of trees in the urban forest, on both public and private property. (Redwood City)

Policies, Programs, Actions:

- Incorporate existing trees into development projects. Avoid adverse effects on health and longevity of native trees or other significant trees through appropriate design measures and construction practices. When tree preservation is not possible, require appropriate tree replacement. (City of Citrus Heights)
- Require the retention of trees of significance (such as heritage trees) by promoting stewardship of such trees and ensuring that the design of development projects provides for the retention of these trees wherever possible. Where tree removal cannot be avoided, the City shall require tree replacement or suitable mitigation (City of Sacramento)

Objective 3: Protect and enhance streams, channels, seasonal and permanent marshland, wetlands, sloughs, riparian habitat and vernal pools in land planning and community design. (Yolo County)

Policies, Programs, Actions:

- Enhance fisheries habitat and restore access for native fishes in creeks. (Redwood City)
- Promote floodplain management techniques that increase the area of naturally inundated floodplains and the frequency of inundated floodplain habitat, restore some natural flooding processes, river meanders, and widen riparian vegetation, where feasible. (Yolo County)
- Ensure ecosystem connectivity and fish passage. (General)
- In conjunction with new development located along existing creeks and streams and where appropriate, incorporate daylighting for culverted portions or other bank naturalizing approaches for channeled sections as a means of creek and stream restoration. (Redwood City)
- Prohibit development within a minimum of 100 feet from the top of banks for all lakes, perennial ponds, rivers, creeks, sloughs, and perennial streams. A larger setback is preferred. The setback will allow for fire and flood protection, a natural riparian corridor (or wetland vegetation), a planned recreational trail where applicable, and vegetated landscape for stormwater to pass through before it enters the water body. (Yolo County)
- Require development to preserve existing natural wetland areas and associated transitional riparian and upland buffers and retain opportunities for enhancement. Require development projects to mitigate any unavoidable losses of wetlands, including its habitat functions and values. (San Diego County)

Mineral Resources

Objective: Encourage the production and conservation of mineral resources, balanced by the consideration of important social values, including recreation, water, wildlife, agriculture, aesthetics, flood control, and other environmental factors. (Yolo County)

Policies, Programs, Actions:

- Ensure that mineral extraction and reclamation operations are compatible with land uses both on-site and within the surrounding area and are performed in a manner that does not adversely affect the environment. (Yolo County)
- Discourage development or the establishment of other incompatible land uses on or adjacent to areas classified or designated by the State as having important mineral resources (MRZ-2), as well as potential mineral lands identified by other government agencies. The potential for the extraction of substantial mineral resources from lands classified by the State as areas that contain mineral resources (MRZ-3) shall be considered by the County in making land use decisions. (San Diego County)
- Require all mining projects to be conducted in accordance with a reclamation plan that meets the minimum reclamation standards required by the California Surface Mining and Reclamation Act and associated regulations. Require the reclamation plan to include a phasing plan that provides for the completion of the surface mining on each segment of the mined lands so that the reclamation can be initiated at the earliest possible time on those portions of the mined lands that will not be subject to further disturbance by the surface mining operation. (San Diego County)
- Permit plant nurseries, recreational open space, and other temporary uses in State-designated mineral resource sectors prior to and pending their development for mineral extraction. (Rialto)

Cultural Resources

Objective: Encourage the preservation, protection and restoration of historic sites, properties and public works through the coordination of activities of the various City departments, non-profit organizations, and other associations concerning historic preservation. (City of Woodland)

Policies, Programs, Actions:

- Encourage the preservation and/or adaptive reuse of historic sites, structures, and landscapes as a means of protecting important historic resources as part of the discretionary application process, and encourage the preservation of historic structures identified during the ministerial application process. (San Diego County)
- Preserve important archaeological resources from loss or destruction and require development to include appropriate mitigation to protect the quality and integrity of these resources. Require development to avoid archeological resources whenever possible. If complete avoidance is not possible, require development to fully mitigate impacts to archaeological resources. (San Diego County)
- After consultation with local Native American Tribes affected by the plan, determine which areas may be of cultural significance and determine how the areas can be preserved. Consultation with tribes should continue to occur as the general plan is implemented. (General)
- Promote the formation and maintenance of neighborhood organizations to foster neighborhood conservation programs, giving special attention to transitional areas. (City of Woodland)

- Require archaeological inventories that consist of field survey, record search, and archival research of all proposed developments which have not been surveyed within the last five years. Archaeologists conducting such surveys shall be proficient in identifying both historical and prehistoric sites. (General)

Water Resources

Objective 1: Manage groundwater resources on a sustainable yield basis that can provide water purveyors and individual users with reliable, high quality groundwater to serve existing and planned land uses during prolonged drought periods. (Yolo County)

Policies, Programs, Actions:

- Protect aquifer recharge features and areas of important aquifers from degradation of water quality and reduction of recharge. (City of Riverside)

Objective 2: Preserve and protect surface water through the use of careful and empirically-backed planning. (General)

Policies, Programs, Actions:

- Maximize stormwater filtration and/or infiltration in areas that are not subject to high groundwater by maximizing the natural drainage patterns and the retention of natural vegetation and other pervious surfaces. This policy shall not apply in areas with high groundwater. (San Diego County)
- Coordinate with water purveyors and water users to manage supplies to avoid long-term overdraft, water quality degradation, land subsidence and other potential problems. (Yolo County)
- Conserve and where feasible create or restore areas that provide important water quality benefits such as riparian corridors, buffer zones, wetlands, undeveloped open space areas, levees, and drainage canals. (Sacramento)

Objective 3: Require development to reduce the waste of potable water through use of efficient technology and conservation efforts that minimize the County's dependence on imported water and conserve groundwater resources. (San Diego County)

Policies, Programs, Actions:

- Support projects that provide reliable and sustainable surface water from a variety of energy efficient sources. Sources should be sufficient to serve existing and planned land uses in prolonged drought periods and protect natural resources and surface water flows. (Yolo County)
- Require new development to protect the quality of water bodies and natural drainage systems through site design, source controls, storm water treatment, runoff reduction measures, best management practices (BMPs) and Low Impact Development (LID), and Hydromodification strategies consistent with permits. (Yolo County)
- Require all development to have an adequate water supply. Require significant discretionary projects to demonstrate adequate long-term and sustainable water supplies by preparing a verified water supply assessment. (Yolo County)

- Require new development to demonstrate that adequate water is available before project approval and to fund its fair-share costs associated with the provision of water service. (Redwood City)
- Require efficient irrigation systems and in new development and encourage the use of native plant species and non-invasive drought tolerant/low water use plants in landscaping. (San Diego County)
- Require development to minimize the use of directly connected impervious surfaces and to retain stormwater run-off caused from the development footprint at or near the site of generation. (San Diego County)
- Continue to develop and implement water conservation programs in response to community input and to keep pace with changing technology. (Redwood City)
- Support the integrated management of surface and groundwater, stormwater treatment and use, the development of highly treated wastewater, and desalinization where feasible. (Yolo County)
- Develop a recommended native, low-water-use, and drought-tolerant plant species list for use with open space and park development. Include this list in the landscape standards for private development. (City of Riverside)
- The City shall require all new development to contribute no net increase in stormwater runoff peak flows over existing conditions associated with a 100-year storm event. (Sacramento County)

Agricultural Resources

Goal: Encourage maintenance of a strong and robust agricultural land base (General)

Objective 1: Strongly discourage the conversion of agricultural land for other uses. (Yolo County)

Policies, Programs, Actions:

- Prohibit land use activities that are not compatible within agriculturally designated areas. (Yolo County)
- Establish a coherent and logical pattern of urban uses that protect and enhance open space and agricultural uses by providing a clear and permanent boundary for urban uses with the [city, county]'s planning area. (City of Livermore)
- Preserve agricultural lands using a variety of programs, including the Williamson Act, Farmland Preservation Zones (implemented through the Williamson Act), conservation easements, greenbelts, Agricultural Lands Conversion Ordinances and Right-to-Farm Ordinances. (Yolo County, San Diego County)
- Prohibit redesignation of Agricultural or Open Space lands to other land use designation unless all of the following findings can be made:

  (A) There is a public need or net community benefit derived from the conversion of the land that outweighs the need to protect the land for long-term agricultural use.

  (B) There are no feasible alternative locations for the proposed project that are either designated for non-agricultural land uses or are less productive agricultural lands.

(C) The use would not have a significant adverse effect on existing or potential agricultural activities on surrounding lands designated Agriculture. (Yolo County)

- Develop agricultural mitigation policy which, among other things, sets a ratio of no less than 1:1 for the conversion of agricultural lands, requires funds be set aside for ongoing administration and management of mitigation lands, and identifies agricultural lands appropriate for mitigation purposes. (Santa Clara County)
- Maintain large parcel sizes within agricultural zones and strict requirements regarding division of farmland (Yolo County, Napa County)
- Require the development of vacant lands within city boundaries prior to conversion of agricultural lands. (Santa Clara County)

Objective 2: Mitigate the impacts of urban areas on agricultural lands. (General)

Policies, Programs, Actions:

- Requiring development to minimize potential conflicts with adjacent agricultural operations through the incorporation of adequate buffers, setbacks, and project design measures to protect surrounding agriculture and minimize conflicts. (San Diego County, Riverside, Woodland)
- Discourage leapfrog development and development in peninsulas extending into agricultural lands to avoid adverse effects on agricultural operations. (Woodland)
- Encourage the coordinated placement of agricultural conservation easements on land most threatened by development, particularly those lands located close to cities and unincorporated communities. (Yolo County)
- Implement an urban growth boundary to prescribe growth limits in an attempt to control urban sprawl. (Gilroy)

Objective 3: Promote the economic feasibility of agriculture and preserve traditional farmland while encouraging the development of urban agriculture. (General)

Policies, Programs, Actions:

- Establish an Agricultural District overlay designation to enhance and aggressively promote the distinctive agricultural and recreational character of unique regions within the County. Agricultural Districts shall be established in areas where agricultural business development and expansion (including industrial processing, commercial sales and agricultural tourism) will be encouraged through the use of targeted regulatory streamlining, financial incentives, specialized marketing efforts, and other programs as may be determined to be appropriate. (Yolo County)
- Support the economic competitiveness of agriculture and encourage the diversification of potential sources of farm income, including value added products, agricultural tourism, roadside stands, organic farming, and farmers' markets. (San Diego County)
- Provide venues for farmer's markets, particularly in areas that lack access to fresh and healthy foods, and encourage serving locally grown and organic foods at City public facilities. (City of Sacramento)
- Promote urban agriculture by supporting community and rooftop gardens and recognize their value in providing fresh food in urban areas in addition to their recreational, community building, landscaping, and educational value. (City of Sacramento)

A

Open Space

Open Space for Habitat and Conservation

Open Space for Recreational Uses

Visual Resources

Open Space for Habitat and Conservation

Goal: Expand and enhance an integrated network of open space to support recreation, natural resources, historic and tribal resources, habitat, water management, aesthetics, and other beneficial uses. (Yolo County)

Objective: Create a network of regional parks and open space corridors that highlight unique resources and recreational opportunities for a variety of users. (Yolo County)

Policies, Programs, Actions:

- Support the preservation of open space consistent with this General Plan, via acquisition of fee title or easement interest by land trusts, government agencies, and conservancies from willing landowners. (Yolo County)
- Maintain habitat corridors to connect conservation areas such as parks, [marine protected areas], and open space, protect biodiversity, accommodate wildlife movement and sustain ecosystems. (City of Citrus Heights)
- Establish an open space acquisition program that identifies acquisition area priorities based on capital costs, operation and maintenance costs, accessibility, needs, resource preservation, ability to complete or enhance the existing open space linkage system and unique environmental features. (City of Riverside)
- Maximize public benefits in the reclamation of mineral extraction and sanitary landfill areas. (City of Rialto)
- Develop an integrated creekside trail system including low impact development strategies. (City of Citrus Heights)
- Promote acquisition and improvement of both developed and undeveloped park sites and provide recreation facilities necessary to meet or exceed the level of 3.55 parkland acres per 1,000 residents. (City of Citrus Heights)
- work with the Park District to seek locations for and the development of neighborhood parks in those neighborhoods which lack park acreage. (City of Citrus Heights)

Open Space for Recreational Uses

Objective: Develop a high-quality network of parks and recreational facilities that meet the needs of families, young adults, seniors, children, and disabled individuals. (City of Brea)

Policies, Programs, Actions:

- Work with the School District to provide joint-use facilities in areas where park and recreation facility deficits exist. Mitigate issues associated with school open space, such as vandalism, wear and tear, maintenance, and school expansion. (City of Rialto)
- Provide for recreational trail rights-of-way along creek channels through development easements and agreements. (City of Citrus Heights)
- Work with the Park District to seek locations for and the development of neighborhood parks in those neighborhoods which lack park acreage. (City of Citrus Heights)
- Develop, wherever possible, recreation facilities that have multi-use capabilities and high degree of adaptability to more intensive use or uses as recreation demand changes and/or population density increases. (City of Brea)
- Ensure that sports facilities for organized sports do not displace existing casual use facilities and parks. (City of Brea)
- Locate new local parks and recreation facilities near other community-oriented public facilities such as schools, libraries, and recreation centers where feasible, so that they may function as the "heart" of a community. (City of San Diego)
- Design parks that reflect community character and identity, incorporate local natural and cultural landscapes and features, and consider the surrounding land uses and urban form and cultural and historic resources. (City of San Diego)
- Connect public parks to trails and pathways and other pedestrian or bicycle networks where feasible to provide linkages and connectivity between recreational uses. (City of San Diego)

Visual Resources

Objective: Preserve visual resources located in the community. (General)

Policies, Programs, Actions:

- Require the protection of scenic highways, corridors, regionally significant scenic vistas, and natural features, including prominent ridgelines, dominant landforms, reservoirs, and scenic landscapes. (San Diego County)
- Require development within visually sensitive areas to minimize visual impacts and to preserve unique or special visual features, particularly in rural areas, through the following:
  - Creative site planning
  - Integration of natural features into the project
  - Appropriate scale, materials, and design to complement the surrounding natural landscape
  - Minimal disturbance of topography

- ▷ Clustering of development so as to preserve a balance of open space vistas, natural features, and community character
- ▷ Creation of contiguous open space networks (San Diego County)

- Protect undeveloped ridgelines and steep hillsides by maintaining semi-rural or rural designations on these areas. Recognize the value of ridgelines, hillsides and arroyos as significant natural and visual resource sand strengthen their role as features which define the character of the City and its individual neighborhoods. (San Diego County, City of Riverside)
- Restrict outdoor light and glare from development projects in Semi-Rural and Rural Lands and designated rural communities to retain the quality of night skies by minimizing light pollution. (San Diego County)
- Minimize obtrusive light by limiting outdoor lighting that is misdirected, excessive, or unnecessary. The City shall require that new development avoid the creation of incompatible glare through development design features. (City of Sacramento)
- Manage stands of mature trees, particularly native species, as unique and visual resources. (City of Brea)
- Require new development to place utilities underground and encourage "undergrounding" in existing development to maintain viewsheds, reduce hazards associated with hanging lines and utility poles, and to keep pace with current and future technologies. (Yolo County)

A

Safety

Avoiding and Mitigating Natural Disasters

Emergency Preparedness and Prevention

Avoiding and Mitigating Natural Disasters

Objective: Protect communities from natural disasters and hazards. (General)

Policies, Programs, Actions:

- Require geotechnical investigations by certified engineering geologist or other qualified professionals for all grading and construction projects subject to geologic hazards, including fault rupture, severe ground shaking, liquefaction, landslides, and collapsible or expansive soils. (Rialto)
- Promote the strengthening of planned utilities, the retrofit and rehabilitation of existing weak structures and lifeline utilities, and the relocation or strengthening of certain critical facilities to increase public safety and minimize potential damage from seismic and geologic hazards. (Rancho Cucamonga)
- Continue enforcement of the Development Guidelines to allow for prudent development and redevelopment of all properties located on slopes greater than 10 percent, and continue to preserve as open space properties located on slopes greater than 30 percent. (Rancho Cucamonga)
- For properties located within designated 100-year flood zones, require the submittal of information prepared by qualified specialists which certifies compliance with development standards established for 100-year flood zones. (Rialto)
- Maintain structural and operational integrity of essential public facilities in the event of a flooding hazard, and locate new essential public facilities outside of flood hazard zones. (Rancho Cucamonga)
- For new development in the tsunami evacuation zone, require use of low-impact engineering techniques, such as elevating structures above projected water levels, to mitigate impacts to people and structures. (Pacifica)
- Site critical public facilities—including hospital and healthcare facilities, emergency shelters, police and fire stations, and emergency communications facilities—outside of the tsunami evacuation zone and 100-year flood plains. (Pacifica)
- Ensure that a defensible perimeter is maintained around residential located in high or very high wildfire hazards zones, as per Fire Department guidelines. (Rialto)
- Locate new buildings associated with new discretionary development outside of avalanche hazard areas. (Truckee)
- Continue to identify avalanche hazard areas, and to enforce special standards for construction in avalanche hazard areas. (Truckee)

- Use technology to improve safety at grade crossings while causing the least environmental harm, including Quiet Zone improvements such as upgraded and updated warning devices additional gate arms, extended and raised medians, improved signage, and coordinated traffic signals. (City of Riverside)

Emergency Preparedness and Prevention

Objective: Develop plans for dealing with emergencies, both community-wide and individual. (General)

Policies, Programs, Actions:

- Reduce the loss of life, property, and injuries incurred as a result of fires by offering and supporting comprehensive fire prevention, public education, and emergency response programs. (Rancho Cucamonga)
- Require adequate water supply and fire flow throughout the City to meet fire demand during times of peak domestic water demand through a cooperative relationship with the Water District. (Rancho Cucamonga)
- Minimize the risk of potential hazards associated with aircraft operations through the adoption and implementation of the Airport Protection Overlay Zone and the County Airport Land Use Compatibility Plan. (City of Riverside)
- Ensure that new roadways are developed in accordance with standards the Municipal Code. In all new development, require adequate access to be provided for emergency vehicles, including adequate widths, turning radii, hard standing areas, and vertical clearance. (Pacifica)
- Develop a plan to widen critical rights-of way that do not provide adequate clearance for emergency vehicles. For areas that are not feasibly accessible to emergency vehicles, develop a contingency plan for reaching and evacuating people in need of treatment. (Pacifica)
- Identify and establish specific travel routes for the transport of hazardous materials and wastes, with key considerations being capacity to safely accommodate additional truck traffic, avoidance of residential areas, and use of interstate or State divided highways as preferred routes. (Rialto)
- Encourage and promote practices that will reduce the use of hazardous materials and the generation of hazardous waste at their source, recycle the remaining hazardous wastes for reuse, and treat those wastes which cannot be reduced at the source or recycled. (Rialto, Rancho Cucamonga)
- Continue to provide community programs that develop positive relationships between the Police Department and community members, such as the Area Commander Program and Crime Free Multi-Housing Program, which provide a safe and secure environment for the community to discuss gang-related issues and effective solutions to help reduce crime and provide a safer living environment. (Rialto)
- Continue to promote neighborhood watch programs for residential areas aimed at empowering neighborhoods to watch for and report any suspicious activity. (Rancho Cucamonga)

- Continue to provide high-quality patient care with cross-trained firefighter/paramedics and emergency medical technicians. Improve the level of patient care in the community through the development and implementation of innovative emergency medical service delivery strategies. (Rancho Cucamonga)
- Notify all developers, particularly those of multi-story or critical structures, of potential impacts resulting from winds, and require appropriate structural and design treatment. (Rancho Cucamonga, Santa Ana Winds)
- Create policies or procedures that provide flexibility regarding how prospective buyers and tenants of properties within the Airport Influence Area are informed of potential aircraft overflight impacts. (Rancho Cucamonga)
- Work to achieve consistency between General Plan land use and related policies and the Airport Comprehensive Land Use Plan, as is appropriate for the community. Measures may include restrictions on permitted land uses and development criteria, including height restrictions. (Redwood City)
- When an adequate model with sufficient local detail is available to project the impacts of sea level rise, take into account potential erosion caused by sea level rise by the year 2050 in the determination of developable area and the assessment of whether coastline-altering structures would be needed in the future to protect new development. (Pacifica)

A

Environmental Justice

Pollution Exposure

Food Access

Safe and Sanitary Homes

Physical Activity

Access to Public Amenities

Pollution Exposure

Goal: Integrate air quality, land use and transportation planning and policy to reduce the emission of criteria pollutants and greenhouse gases from mobile sources. (City of Arvin)

Objective: Improve or maintain air quality for the promotion of population and environmental health. (General)

Policies, Programs, Actions:

- Ensure that new development with sensitive uses located adjacent TAC sources minimizes potential health risks. The City shall require new development with sensitive uses located adjacent to TAC sources be designed with consideration of site and building orientation, location of trees, and incorporation of ventilation and filtration to lessen any potential health risks. In addition, the City shall require preparation of a health risk assessment. (Sacramento)
- Require that development be located and designed to reduce vehicular trips (and associated air pollution) by utilizing compact regional and community-level development patterns while maintaining community character.(San Diego County)
- Require projects that generate potentially significant levels of air pollutants and/or GHGs such as quarries, landfill operations, or large land development projects to incorporate renewable energy, and the best available control technologies and practices into the project design. (San Diego County)
- Ensure that affected residents have the opportunity to participate in decisions that impact their health. (Jurupa Valley)

Goal: Improve the quality of the built and natural environment in the city to support a thriving community and to reduce disparate health and environmental impacts, especially on low-income and disadvantaged communities. (City of Richmond)

Policies and Programs:

- Protect the population from impacts of stationary and non-stationary sources of pollution. Monitor and assess the impact of air pollution on health. Avoid locating new sensitive uses such as schools, childcare centers, and housing in proximity to polluting

A

mobile and stationary sources of pollution. Design buildings to mitigate poor air quality. Sources of pollution include heavy industry, port, truck routes, and busy roadways. (City of Richmond)

- Consider environmental justice issues as they are related to potential health impacts associated with land use decisions, including enforcement actions to reduce the adverse health effects of hazardous materials, industrial activity and other undesirable land uses, on residents regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location. (National City)
- Require industry to reduce emissions that negatively impact public health and the natural environment. Revise and strengthen the existing ordinance that defines penalties and mitigation measures for toxic releases and accidents. Encourage County, State, Federal environmental regulators to increase penalties for toxic releases and accidents to prevent lax adherence to regulations. (City of Richmond)
- Concentrate commercial, mixed-use, and medium to high density residential development along transit corridors, at major intersections, and near activity centers that can be served efficiently by public transit and alternative transportation modes. (National City)
- Consider environmental justice issues as they are related to the equitable provision of desirable public amenities such as parks, recreational facilities, community gardens, and other beneficial uses that improve the quality of life. (National City)
- Ensure that contaminated sites in the city are adequately remediated before allowing new development. Engage the community in overseeing remediation of toxic sites and the permitting and monitoring of potentially hazardous industrial uses. Develop a response plan to address existing contaminated sites in the city. Coordinate with regional, state, and federal agencies. Include guidelines for convening an oversight committee with community representation to advise and oversee toxic site cleanup and remediation on specific sites in the city. Address uses such as residential units, urban agriculture, and other sensitive uses. (City of Richmond)
- Ensure adequate buffers or noise mitigation measures between sensitive uses. Sensitive uses include residential units and major noise polluters such as roadways, railroads, port, and heavy industry. (City of Richmond)

Goal: Minimize exposure of the public to hazardous air pollutant emissions, particulates and noxious odors from highways, major arterial roadways, industrial, manufacturing, and processing facilities. (City of Arvin)

Policies and Programs:

- Coordinate with the SJVAPCD to ensure that construction, grading, excavation and demolition activities within the County's jurisdiction are regulated and controlled to reduce particulate emissions to the maximum extent feasible. (City of Arvin)
- Require that all access roads, driveways, and parking areas serving new commercial and industrial development be constructed with materials that minimize particulate emissions and are appropriate to the scale and intensity of use. (City of Arvin)

Goal: Proactively coordinate City air quality improvement activities with County and regional programs and those of neighboring communities. (City of Arvin)

Policies and Programs:

- Designate an Air Quality and Climate Change Coordinator to coordinate City efforts and work with neighboring jurisdictions and affected agencies to minimize cross-jurisdictional and regional transportation and air quality issues. (City of Arvin)
- Consult with the SJVAPCD and KernCOG during CEQA review of discretionary projects having the potential for causing adverse air quality, transportation, and climate change impacts. Participate in the SJVAPCD Climate Change Action Plan implementation. (City of Arvin)
- Actively work with and support agricultural activities to develop, implement and find funding sources for programs and initiatives that improve air quality, reduce greenhouse gases and particulate matter. (City of Arvin)

Goal: Clean, breathable indoor and outdoor air. (City of Murrieta)

Policies and Programs:

- Update and enforce tobacco control laws that pertain to location and retailing practices, smoking restrictions, and smoking-free home and workplace laws. (City of Murrieta)
- Disseminate information to tenants and property owners about indoor mold growth hazards, reduction, and prevention methods. (City of Murrieta)
- Encourage smoke free workplaces, multifamily housing, parks, and other outdoor gathering places to reduce exposure to second-hand smoke. (National City)

Food Access

Goal: Reduced Rates of Obesity, Eating Disorders, and Chronic Disease Such as Heart Disease and Breast Cancer. Improve individual and community health through prevention, screening, education, and treatment strategies regarding nutrition and physical activity related health issues. (County of Marin)

Objective 1: Ensure that sources of healthy foods are available in all neighborhoods. (City of Chino)

Policies, Programs, Actions:

- Promote nutrition education and access to healthy foods. Provide affordable healthy foods, and fresh, locally grown fruits and vegetables in schools and other public places. (County of Marin)
- Increase access to healthy foods/beverages. Support neighborhood-oriented, specific sources of healthful foods, such as farmers' markets and local outlets. Support food banks, pantries, and other sources that help provide federal food assistance to low-income residents so that all families, seniors, schools, and community-based organizations are able to access, purchase, and increase intake of fresh fruits, vegetables, and other nutritious foods. (County of Marin)

- Ensure that all residences are within walking distance of sources of fresh food, including grocery stores, farmers' markets, and community gardens, and shall prioritize underserved areas for new sources of healthy food. (City of Chino)
- Support the development of new retail venues that sell local, fresh produce, including farmers' markets, community-supported agriculture programs, and grocery stores. (City of Chino)
- Identify and utilize the provision of programs, incentives, and/or grants to encourage small grocery or convenience stores to sell fresh foods in underserved areas. These programs could include grants or loans to purchase updated equipment (refrigeration), publicity or directories of healthy food outlets, or connecting stores to wholesale sources of healthy, local, or organic food. (City of Chino, City of Murrieta)
- Allow the development of community gardens in residential and other land use designations. (City of Chino)
- The City shall encourage farmers' markets to accept food stamps and other public food benefits. (City of Chino)
- Take steps toward meeting the City's own food needs (e.g. cafeterias, public functions) and those of the schools through the purchase of local and organic food. (City of Chino)
- Work with the School District to establish strong nutritional standards for school lunches and to phase out vending machines and sugar sweetened beverages, particularly at elementary schools. (City of Chino)
- Identify and inventory potential community garden and urban farm sites on existing parks, public easements, right-of-ways, and schoolyards, and develop a program to establish community gardens in appropriate locations. (City of Chino)
- Identify and prioritize neighborhoods underserved by healthy food sources for development of healthy food sources. (City of Chino)
- Establish a process through which a neighborhood can propose and adopt a site as a community garden. (City of Chino)
- Identify appropriate locations for farmers markets and community- supported agriculture drop-off sites and prioritize such uses in these areas. (City of Chino)
- Develop a program to provide fast-track permitting for grocery stores in underserved areas. (City of Chino)

Objective 2: Avoid disproportionate concentrations of unhealthy food sources within neighborhoods. (City of Chino)

Policies and Programs:

- Restrict approvals of new liquor and convenience stores in areas with an existing high concentration of such stores. (City of Chino)
- Identify and inventory areas with a high ratio of convenience, liquor, and fast food stores, and develop a program to prioritize the development of new sources of healthy foods in these areas. (City of Chino)

Safe and Sanitary Homes

Goal: Encourage a range of housing opportunities for all segments of the community. (City of Sacramento)

Objective: Promote an equitable distribution of housing types for all income groups throughout the city and promote mixed income neighborhoods rather than creating concentrations of below-market-rate housing in certain areas. Encourage new projects to include a range of housing types including single-family residences, townhomes, condominiums and rental units. (City of Sacramento, Richmond.)

Policies, Programs, Actions:

- Facilitate the development of housing to meet the community's fair share of the County's and region's housing needs. (San Jose)
- Increase, preserve and improve the affordable housing stock. (San Jose)
- Incentivize affordable housing through permit streamlining and financial incentives. (Jurupa Valley)
- Update the City's dispersion policy: 1) to align the location of future affordable housing developments with planned future Growth Areas identified in the Envision General Plan; 2) to be consistent with the City's inclusionary housing ordinance; 3) to maximize the access of transit, retail, services, and amenities to affordable housing developments; and 4) to reemphasize the support for integration and complete communities. (San Jose)
- Consider the economic integration of neighborhoods when financing new multifamily affordable housing projects. (City of Sacramento)
- Promote the siting, production, rehabilitation, and preservation of housing for ELI (Extremely Low-Income) households, including nontraditional housing types. (City of Sacramento)
- Remove regulatory constraints to equal housing opportunity. (Chico)
- Enhance low income independent housing for seniors, continue to develop and expand senior housing services (Marin County)
- Strongly enforce fair housing laws to protect residents from housing discrimination. Provide education, outreach, and referral services for residents regarding their rights as tenants and buyers. Provide education and outreach to landlords, property managers, real estate agents, and others on their obligations when housing is made available the City shall support fair housing education programs offered by local organizations such as the Apartment Owner's Association and the Board of Realtors. (Chico, and City of Sacramento)
- Pursue and maximize the use of all appropriate state, federal, local and private funding for the development, preservation, and rehabilitation of housing affordable for extremely low-, very low-, low-, and moderate income households, while maintaining economic competitiveness in the region. (City of Sacramento)
- Work with social service agencies and all federal, state, and local jurisdictions to provide an integrated system of care for people experiencing homelessness. (Richmond)

A

Goal: Improve and maintain the quality of housing and residential neighborhoods. (Kings County)

Policies and Programs:

- Promote and improve the quality of residential properties by ensuring compliance with housing and property maintenance standards. (Kings County)
- Assist in the repair, rehabilitation, and improvement of residential structures; demolish and replace structures which are dilapidated and beyond repair. (Kings County)
- Preserve assisted rental housing for long-term occupancy by low- and moderate-income households. (Kings County)

Goal: Facilitate and encourage the provision of a range of housing types and prices to meet the diverse needs of residents. (Kings County)

Policies and Programs:

- Provide adequate sites for housing through appropriate land use, zoning and development standards to accommodate the regional housing needs for the 2009–2014 planning period. (Kings County)
- Work collaboratively with nonprofit and for-profit developers to seek state and federal grants to support the production of affordable housing. (Kings County)
- Support the construction of high quality single- and multi-family housing which is well designed and energy efficient. (Kings County)

Objective: Provide a variety of housing types that meet the housing needs of residents of all income levels in Chino. (City of Chino)

Policies and Programs:

- Residential neighborhoods should contain a mix of housing types including single-family homes on a range of lot sizes; townhomes; duplexes, triplexes and four-plexes; and apartments. (City of Chino)
- Wherever feasible, affordable housing shall be integrated into both new and established neighborhoods. (City of Chino)
- Allow and encourage non-traditional housing types that can provide affordable housing, such as accessory dwelling units. (City of Chino)
- Encourage the development of senior housing and assisted living facilities, especially near transit, recreational facilities, medical centers and hospitals, neighborhoods well served by pedestrian facilities, and access to healthy food. (City of Chino)
- Develop a program to work with large employers developing new projects in Chino to ensure local housing opportunities for their employees. (City of Chino)

Physical Activity

Goal: City resources for parks and recreation facilities are leveraged through partnerships, joint use agreements, private facilities, outside funding, and community volunteers. (City of Murrieta)

Policies and Programs:

- Maintain the joint use agreement with Murrieta Valley Unified School District and look for additional opportunities to partner in expanding resident access to shared facilities. (City of Murrieta)
- Continue to cooperate with school districts in locating schools to allow for park development adjacent to campuses. (City of Murrieta)
- Cooperate with federal, state, and county agencies to provide regional open space and recreation facilities for local residents. (City of Murrieta)
- Encourage the development of private and commercial recreation facilities. (City of Murrieta)
- Seek agreements and joint ventures with private entities to provide recreation facilities and activities. (City of Murrieta)
- Pursue support from federal, state, and private sources to assist with acquisition, design, and construction of parks and recreation facilities. (City of Murrieta)
- Promote a sense of community responsibility for maintaining and improving the parks and recreation system, and offer ways for individuals, groups, and businesses to invest time and resources in that effort. (City of Murrieta)

Goal: Recreation programs enrich the lives of residents across a broad spectrum of ages, interests, and abilities. (City of Murrieta)

- Seek resident involvement and feedback to create recreation programming that is relevant to a broad spectrum of community members. (City of Murrieta)
- Offer and encourage cultural arts programs and events that provide entertainment, such as concerts, as well as those that develop skills in dancing, drama, music, and the arts. (City of Murrieta)
- Use recreation programming to promote physical activity, healthy eating, and other healthy lifestyle habits. (City of Murrieta)
- Collaborate with other providers to expand therapeutic recreation programs for residents with special needs. (City of Murrieta)

Goal: Youth are a special focus of recreation facilities and programs. (City of Murrieta)

Policy and Programs:

- Expand recreation programs for youth and teens, including before- and afterschool care, sports and fitness, outdoor activity and excursions, and arts education. (City of Murrieta)
- Use recreation programming to promote success in school. (City of Murrieta)

- Provide safe places for teens to socialize and participate in recreation activities. (City of Murrieta)
- Expand opportunities for youth to be involved in planning recreation programs, services, and events for youth. (City of Murrieta)
- Continue providing the Youth Advisory Committee for middle school and high school students. (City of Murrieta)

Policy and Programs:

- Create a Safe Routes to School plan in all schools. Prioritize improvements with the highest safety concerns. Actively seek State and Federal funding to support the Safe Routes to School plan. (City of El Monte)
- Pedestrian Safety. Enhance pedestrian safety by completing sidewalks, identifying areas for crosswalks and signaling, and prioritizing the funding, construction, and maintenance of safe routes to schools, parks, and public facilities. (City of El Monte)
- Bicyclist Safety. Improve bicycle safety by creating well-defined bicycle lanes, working with the school districts to educate children about safe cycling practices, and providing information about safe routes to school. (City of El Monte)
- Streetscape Design. Develop detailed standards and guidelines for the treatment of public streetscapes to improve safety and walkability. Recommendations should address street trees, street lighting, street furniture, traffic calming, and related items. (City of El Monte)
- Promote increased physical activity, reduced driving, and increased walking, cycling, and transit use. Such policies include those which:
  - Support the development of compact, transit-adaptive, and pedestrian- and bicycle-friendly development patterns.
  - Reduce driving and increase opportunities for active transportation (walking and biking) and transit use.
  - Require the incorporation of pedestrian and bicycle facilities in new development and on all new and renovated transportation facilities built and/or managed by the County.
  - Evaluate development based on its impacts to the environment, economy, infrastructure, and services. (Riverside County)

Goal: Excellent pedestrian and bicycle networks throughout the City. (City of South Gate)

Objective 1: Create a high quality pedestrian network in all areas of the City so that residents can safely walk to their destinations. (City of South Gate)

Policies and Programs:

- Creating a continuous, safe, and attractive pedestrian environment should be a key strategy for improving community health. (City of South Gate)
- Walking will be considered an integral mode of transportation for the City's circulation network. (City of South Gate)
- Balance the needs of pedestrians and cyclists with the needs of motor vehicles in decisions made about the transportation network. (City of South Gate)

- To the extent that funding is available, the City will maintain sidewalks to protect public safety and create a visually attractive environment. (City of South Gate)
- Improve unsafe and unattractive pedestrian areas, as resources become available. The City will promote streets as public, pedestrian oriented places through the appropriate placement of new buildings, parked cars and garages. (City of South Gate)
- New development projects and public infrastructure projects will be required to provide safe and direct pedestrian connections to transit stops. (City of South Gate)
- Private development on street frontages that do not currently include sidewalks will be required to install sidewalks in front of the property when new development occurs. (City of South Gate)
- Allow sufficient pedestrian cross times, particularly for the elderly and strollers, when setting traffic light timing. (City of South Gate)

Objective 2: Create a citywide bicycle network that enables cycling to be used for both recreation and transportation. (City of South Gate)

Policies and Programs:

- Creating a continuous, safe, and attractive cycling network that connects all the City's neighborhoods and districts will be an important strategy for improving community health. (City of South Gate)
- Implement the policies and programs in the Mobility Element that provide for an extensive, safe and complete bicycle network that connects all the City's neighborhoods and districts. (City of South Gate)
- Balance the needs of bicycles with the needs of motor vehicles in all transportation and public works decisions. (City of South Gate)
- The City's bicycle network should be safely and directly connected to the regional bicycle network and the bicycle networks of adjacent jurisdictions. (City of South Gate)
- Where feasible, bicycle lanes and other bicycle facilities will be included as part of street improvement projects. (City of South Gate)
- Support regional efforts to increase cycling as a transportation alternative. (City of South Gate)
- Encourage or require a sufficient quantity of well-placed bike parking in all new development. (City of South Gate)

Access to Public Amenities

Policies, Programs, Actions:

- Maintain and improve access to transit stops and stations for mobility-challenged population groups such as youth, the disabled, and seniors. (San Jose)
- Create a balanced park system that provides all residents access to parks, trails, open space, community centers, dog parks, skate parks, aquatics facilities, sports fields, community gardens, and other amenities. (San Jose)
- Apply resources to meet parks, recreation, and open space needs in underserved areas of the city, prioritizing lower income and higher density areas, which may have a demonstrably greater need for these amenities. (San Jose)

Noise

Goal: Ensure that existing and planned land uses are compatible with the current and projected noise environment (Yolo County)

Objective: Minimize the impact of noise from transportation sources including roads, rail lines, and airports on nearby sensitive land uses. (Yolo County, County of San Diego)

Policies, Programs, Actions:

- Increase setbacks between noise generators and noise sensitive areas (County of San Diego)
- Employ technologies when appropriate that reduce noise generation (i.e. alternative pavement materials on roadways). (County of San Diego)
- Protect schools, hospitals, libraries, churches, convalescent homes, and other noise sensitive uses from excessive noise levels by incorporating site planning and project design techniques to minimize noise impacts. The use of noise barriers shall be considered after all practical design-related noise measures have been integrated into the project. In cases where sound walls are necessary, they should help create an attractive setting with features such as setbacks, changes in alignment, detail and texture, murals, pedestrian access (if appropriate), and landscaping. (City of Murrieta)
- For County road improvement projects, evaluate the proposed project against ambient noise levels to determine whether the project would increase ambient noise levels by more than three decibels. If so, apply the limits in the noise standards listed in Table xx for noise sensitive land uses that may be affected by the increased noise levels. For federally-funded roadway construction projects, use the limits in the applicable FHWA standards (San Diego County)
- Integrate noise considerations into land use planning decisions to prevent new noise/land use conflicts. (City of Murrietta)
- Avoid placing noise-sensitive land uses (e.g., residential uses, hospitals, assisted living facilities, group homes, schools, day care centers, etc.) within the high noise impact areas (over 65 dB CNEL) for (designated airports) in accordance with the County Airport Land Use Compatibility Plan (City of Riverside)
- Evaluate noise impacts on any sensitive receptors from frequent, high-noise events when considering whether to approve the development proposal, taking into account potential for sleep disturbance, undue annoyance, and interruption in conversation, to ensure that the proposed development is compatible within the context of its surroundings. (City of Sacramento)
- If the noise source is BART, then the outdoor noise exposure criterion should be 70 Ldn for future development, recognizing that BART noise is characterized by relatively few loud events. (City of El Centro)
- Orient buildings such that the noise sensitive portions of a project are shielded from noise sources. (County of San Diego)
- Incorporate noise considerations into the site plan review process, particularly with regard to parking and loading areas, ingress/egress points and refuse collection areas. (City of Riverside)
- Use sound–attenuating architectural design and building features. (County of San Diego)

- Require construction projects anticipated to generate a significant amount of vibration to ensure acceptable interior vibration levels at nearby residential and commercial uses based on the current City or Federal Transit Administration (FTA) criteria. (RDR) The City shall require new residential and commercial projects located adjacent to major freeways, hard rail lines, or light rail lines to follow the FTA screening distance criteria (City of Sacramento)
- Use the Noise Compatibility Guidelines and the Noise Standards as a guide in determining the acceptability of exterior and interior noise for proposed land uses. (County of San Diego)
- Discourage the use of noise walls. In areas where the use of noise walls cannot be avoided, evaluate and require where feasible, a combination of walls and earthen berms and require the use of vegetation or other visual screening methods to soften the visual appearance of the wall. (County of San Diego)
- Require an acoustical study to identify inappropriate noise level where development may directly result in any existing or future noise sensitive land uses being subject to noise levels equal to or greater than 60 CNEL and require mitigation for sensitive uses in compliance with the noise standards listed. (County of San Diego)
- Require new development to include noise mitigation to assure acceptable interior noise levels appropriate to the land use type: 45 dBA Ldn for residential, transient lodgings, hospitals, nursing homes and other uses where people normally sleep; and 45 dBA L eq (peak hour) for office buildings and similar uses. (City of Sacramento)

A

Healthy Communities

Economics and Health

A Changing Climate and Resiliency

Social Connection and Safety

Health and Human Services

Economics and Health

Goal: Encourage economic and racial integration, fair housing opportunity, and the elimination of discrimination. (City of Sacramento)

Policies, Programs, Actions:

- Provide widespread access to diverse employment and training opportunities and strive to increase job growth, particularly jobs that provide self-sufficient wages and health care benefits, to allow the community to broadly share in the region's prosperity. (San Jose)
- Attract and retain a diverse mix of businesses and industries that can provide jobs for residents of all skill and education levels to support a thriving community. (San Jose, Washington D.C.)
- Attract job opportunities accessible to all residents, particularly residents in low-income neighborhoods. (San Jose)
- Partner with educational, civic, labor, and business institutions to provide job training programs that enable the unemployed, under-employed, or economically or socially disadvantaged to enter or move up in the labor force. Support and enhance education, training and recruitment programs and services for local residents to increase job and employment opportunities and compete in the regional economy. Connect local businesses with such programs, organizations, or educational institutions. (Richmond and San Jose, modified)
- Encourage businesses and industries to hire locally and to demonstrate reasons for not hiring local employees. (Richmond)

Objective: Develop policies to benefit residents economically (General)

Policies, Programs, Actions:

- Continue to encourage new businesses to give local residents preference in hiring decisions, and develop incentives to support this effort. (San Pablo)
- Enhance aesthetics and quality of the housing stock and remove blight by implementing policies and programs identified in the Housing Element. (San Pablo)

- Develop programs to attract and retain industries that can provide a living wage, provide health insurance benefits, and meet existing levels of workforce education. (Murrieta)
- Promote uses that address daily needs within the City and close to neighborhoods, reducing the need for residents to travel long distances to access jobs, goods and services. (City of Arvin)
- Encourage development that reduces VMT, decreases distances between jobs and housing, reduces traffic impacts, and improves housing affordability (Sonoma County).
- The attraction and retention of high quality grocery stores and other healthy food purveyors should be pursued as an economic development strategy for the City. Healthy food outlets include full-service grocery stores, regularly-held farmer's markets, fruit and vegetable markets, and convenience stores or corner stores that sell a significant proportion of healthy food. (City of South Gate)

Goal: Health and well-being for those who live, work, and play in the city. (City of Murrieta)

Policies and Programs:

- Develop programs to attract and retain industries that can provide a living wage, provide health insurance benefits, and meet existing levels of workforce education. (City of Murrieta)
- Encourage local employers to adopt healthy living/healthy employee programs and practice such as health challenges (e.g., weight loss contests, stop smoking, lunchtime/worktime sponsored events, bike to work days), healthy food choices, and healthy work environments. (City of Murrieta)
- The City can lead by example by expanding the Healthy Murrieta program and by developing City-sponsored programs to address employee health for city employees. Suggested programs could include weight loss challenges, exercise challenges, lunchtime exercise programs, sponsoring bike and walk to work days, and providing transit passes for employees. (City of Murrieta)

A Changing Climate and Resiliency

Policies, Programs, Actions:

- Plan for Climate Change. Plan for the public health implications of climate change, including disease and temperature effects. (County of Marin)
- Identify Potential Responses to Climate Change. Work with the Intergovernmental Panel on Climate Change (IPCC) and other leading health organizations to identify critical public health issues and identify potential responses necessary related to climate change.(County of Marin)

Goal: Recognize the multiple functions of the natural environment for safety, recreation, protection from climate changes, and economic uses. (County of Solano)

Goal: Increase awareness of the effect humans have on the environment and encourage individuals and organizations to modify habits and operations that cause degradation to the environment and contribute to climate change. (County of Solano)

Goal: Prepare for and adapt to the effects of climate change. (County of Solano)

Goal: Promote a sustainable future where residents can enjoy a high quality of life for the long term, including a clean and beautiful environment and a balance of employment, housing, infrastructure, and services. (County of Sonoma)

Policies and Programs:

- Encourage reduction in greenhouse gas emissions, including alternatives to use of gas-powered vehicles. Such alternatives include public transit, alternatively fueled vehicles, bicycle and pedestrian routes, and bicycle- and pedestrian-friendly development design. (County of Sonoma)

Goal: Mitigate against climate change. (City of Rancho Cucamonga)

Policies and Programs:

- Consult with State agencies, SCAG, and the San Bernardino Associated Governments (SANBAG) to implement AB32 and SB375 by utilizing incentives to facilitate infill and transit oriented development. (City of Rancho Cucamonga)
- Encourage renewable energy installation, and facilitate green technology and business and a reduction in community-wide energy consumption. (City of Rancho Cucamonga)
- Encourage development of transit-oriented and infill development, and encourage a mix of uses that foster walking and alternative transportation. (City of Rancho Cucamonga)
- Provide enhanced bicycling and walking infrastructure, and support public transit, including public bus service, the Metrolink, and the potential for Bus Rapid Transit (BRT). (City of Rancho Cucamonga)
- Provide green building incentives, assess green building techniques as a formal stage of project review, and develop a green building ordinance or program that addresses both new and existing buildings. Adaptation strategies will also include increased water efficiency in buildings. (City of Rancho Cucamonga)
- Support tree planting, planting more vegetation (including native and drought-resistant planting), and preservation of open space. (City of Rancho Cucamonga)
- Develop green procurement plans and ensure energy savings in City operations and maintenance. (City of Rancho Cucamonga)
- Develop energy- or climate change-themed publications and workshops, facilitating energy audits for residents, and establishing partnerships to reduce greenhouse gas emissions. Increase public awareness about climate change, and encourage residents and businesses to become involved in activities and lifestyle changes that help reduce greenhouse gas emissions. (City of Rancho Cucamonga)

Social Connection and Safety

Goal: Improve public safety for all residents. (General)

Objective: Use the built environment and city planning tools to deter crime, increase respect for neighbors and property, and improve the public perception of safety throughout the community. (San Pablo)

Policies, Programs, Actions:

- Orient building and windows to provide maximum surveillance of exterior areas, and locate entryways such that they are visible to adjacent neighbors or passersby. (San Pablo)
- Encourage the development of complete neighborhoods that provide for the basic needs of daily life and for the health, safety, and mental well-being of residents (Riverside County)
- Use landscaping such as low hedges and flowerbeds to identify points of entry and movement on property, and use signage and symbolic barriers to direct vehicular and pedestrian traffic. (San Pablo)
- Make it easier to maintain property by recommending graffiti-resistant surface materials, vandal-proof lighting, and landscaping selected for durability and easy maintenance. (San Pablo)
- Promote activity in public areas throughout the day by coordinating shared uses of facilities (parking lots, parks, sports fields). (San Pablo)
- Ensure that minimum illumination standards for streetlights are met and, if necessary, update the standards to reflect best practices for safety lighting. (San Pablo)

Goal: Create and foster a sense of community among residents (General)

Objective 1: Promote social activities for community residents and foster a sense of community (General)

Policies, Programs, Actions:

- Coordinate with local businesses, organizations, colleges, and the school district to support a year-round calendar of community events in Davis Park and other City parks. Events should be geared toward families and youth, and contain components of physical activity, healthy food, arts, and music. (San Pablo)
- Encourage a sense of ownership, community pride and civic respect as a means of improving the safety and image of the City. (San Pablo)
- Continue community policing and relationship- building programs, including educational and mentoring initiatives with schools. (San Pablo)
- Continue to involve residents in neighborhood improvement efforts, including issues concerning safety, neighborhood character, planning, and revitalization. (San Pablo)
- Create public plazas with seating, art, and play features near shopping and business districts. (Murrieta)

- Work with restaurants and cafes to create sidewalk outdoor seating areas to activate the sidewalk. (Murrieta)
- Allow and encourage residents to apply for street closure permits for neighborhood block parties and community wide social events, that strengthen neighborhood cohesion. (Murrieta, City of El Monte)
- Build an affordable, accessible, and flexible central gathering/meeting space that individuals and community groups can rent for a variety of social, cultural, educational, and civic purposes. (Murrieta)
- Encourage the development and display of public art to promote the history, heritage, and culture of the community. (Murrieta)
- Consider adopting a public art ordinance that 1) provides incentives for businesses to provide public art and 2) establishes a fee for commercial and industrial projects that do not wish to install public art. (Murrieta)

Objective 2: Help members on the margins of society integrate and become productive community members. (General)

Policies, Programs, Actions:

- Support organizations that provide substance abuse treatment services (San Pablo, Murrieta)
- Connect formerly-incarcerated persons to educational and job-training opportunities available at community college and elsewhere in the community. (San Pablo)

Objective 3: Enhance overall community safety by placing more emphasis on preventative measures to reduce crime, including the incorporation of crime prevention features in the built environment of each community to increase overall safety of residents and visitors within these communities. (Kings County)

Policies and Programs:

- Encourage new development to integrate Crime Prevention Through Environmental Design (CPTED) strategies and applications to enhance crime prevention in the County's Community Districts and serve as deterrents to crime. (Kings County)
- Coordinate community planning efforts with the County Sheriff's Department to build a sustainable positive law enforcement presence that results in safer living environments within community districts. (Kings County)
- Support community policing, neighborhood watch, and other law enforcement efforts that engage community residents. (Kings County)
- Support programs aimed at intervention with at risk youth as a preventative measure to reduce future crime potential. (Kings County)
- Invest in community planning efforts that aim to reverse trends of community deterioration and blight which lead toward the decline of personal and property safety within the County's community districts. (Kings County)

Health and Human Services

Objective: Ensure residents have access to basic health services

Policies, Programs, Actions:

- Establish relationships and collaborate with local health officials, planners, non- profit organizations, hospitals, local health clinics, and community groups to improve community health. (Murrieta)
- Work with local and regional health care agencies to promote preventive treatment and broad access to health care. (Murrieta)
- Work with existing organizations and agencies to support high-quality affordable and convenient access to a full range of traditional and alternative primary, preventive, emergency, and specialty health care options. (Murrieta)
- Partner with community groups encourage school-based health centers. (Murrieta)

Goal: Improve public health through implementation of programs and community design. (General)

Objective: Apply innovative and model best practices in the community health field. (Murrieta)

Policies, Programs, Actions:

- Collaborate with the County Department of Public Health's efforts to systematically collect, track, and analyze community health and social, economic, and physical environmental data. (Murrieta)
- Implement policies and programs that encourage bicycling and walking as alternatives to driving and as a means of increasing levels of physical activity. Encourage bicycle and pedestrian safety through education and incentive programs. (City of El Monte)
- Seek opportunities to promote healthy lifestyles, activities, and food choices at City offices and City-organized events. (Murrieta)
- Incentivize health promotion groups to participate at City-sponsored events (i.e., waive booth fees at fairs, etc.). (Murrieta)
- Promote the health and well-being of City employees through health challenges (e.g., weight loss contests, stop smoking, lunchtime/worktime sponsored events, bike to work days), healthy food choices, and healthy work environments, when feasible. (Murrieta)

Goal: Seek input from the County Department of Public Health and others on proposed development projects or other land use and transportation decisions to encourage that the decisions promote health. (Murrieta)

Objective 1: Minimize commutes and promote neighborhood cohesion. (General)

Policies, Programs, Actions

- Evaluate and make changes to the project review and permitting process to encourage and facilitate incorporation of universal, lifecycle design principles in new residential development, allowing community members to stay in their homes, and neighborhoods, longer and increasing community cohesion. (San Pablo)

- Establish travel demand management programs to reduce peak-hour traffic congestion and help reduce regional vehicle miles traveled. (San Pablo)

Objective 2: Improve indoor air quality, both indoor and outdoor, as a public health measure. (General)

Policies, Programs, Actions

- Update and enforce tobacco control laws that pertain to location and retailing practices, smoking restrictions, and smoking-free home and workplace laws. (Murrieta)
- Disseminate information to tenants and property owners about indoor mold growth hazards, reduction, and prevention methods. (Murrieta)
- Encourage that the municipal vehicle fleet achieve the highest possible number of fuel-efficient and low emissions vehicles commercially available. (Murrieta)

Objective 3: Ensure that residents have a range of choices for accessible, affordable, and nutritious foods (Murrieta)

Policies, Programs, Actions

- Encourage equitable distribution of healthy food retail and dining options in all commercial and employment areas of the City. (Murrieta)
- Research and consider land use regulations to limit fast food outlet density. (Murrieta)
- Encourage restaurants to voluntarily eliminate transfats from their menus. (Murrieta)
- Identify and utilize available incentives, grants, and/or programs to encourage restaurants to create a healthier dining experience for customers by highlighting healthy dishes, offering smaller portion sizes, and disclosing nutrition facts. (Murrieta)
- Support community education programs on healthy eating habits and lifestyles, including topics such as nutrition, physical activity, and vegetable gardening. (Murrieta)
- Encourage larger food retailers to carry specialty ethnic food items and support the opening of smaller ethnic food stores. (Murrieta)

Air Quality

Objective 1: Reduce exposure to localized air pollution and improve overall air quality (General)

Objective 2: Minimize and mitigate air quality concerns through design, incentives, and coordination. (General)

Policies, Programs, Actions:

- Require that new multi-family residential buildings and other sensitive land uses in areas with high levels of localized air pollution be designed to achieve good indoor air quality through landscaping, ventilation systems, or other measures. (City of Murrieta)
- Provide incentives to promote air pollution reductions, including incentives for developers who go above and beyond applicable requirements and mitigate pollution for facilities and operations that are not otherwise regulated. (City of Chula Vista)
- Require uses such as smog check stations, automotive painting and repair facilities conduct such activities in enclosed and filtered spaces to prevent odors and emissions from affecting passers-by, nearby residents, and building occupants. (National City)
- Adopt land use policies and decisions that improve environmental quality and reduce resident and worker exposure to toxins and pollution. (Salinas)
- Encourage non-polluting industry and clean green technology companies to locate to the City. (City of Murrieta)

Objective: Require design of residential subdivisions and nonresidential development through "green" and sustainable land development practices to conserve energy, water, open space, and natural resources. (San Diego County)

Policies, Programs, Actions:

- Reduce greenhouse gas emissions from new development by discouraging auto-dependent sprawl and dependence on the private automobile; promoting water conservation and recycling; promoting development that is compact, mixed use, pedestrian friendly, and transit-oriented; promoting energy-efficient building design and site planning; improving the jobs/housing ratio in each community; and other methods of reducing emissions. (Sacramento)
- Retrofit existing buildings using low maintenance, durable building materials and high-efficiency energy systems and appliances. (Citrus Heights)
- Incorporate solar considerations into development regulations that allow existing and proposed buildings to use solar facilities. Encourage construction and subdivision design that allows the use of solar energy systems (City of Riverside)
- Require that property setbacks and building massing of new construction located within existing developed areas maintain an envelope that maximizes solar access to the extent feasible. (San Diego County)

- Employ strategies that reduce driving rates and improve air quality through land use and urban design will be implemented by the City and other responsible parties. These strategies include transit-oriented development, compact development, an appropriate mix of land uses, a jobs/housing balance, transit oriented development, and walkable streets. (Southgate)

Objective: Require all new building projects to incorporate energy-conserving design, construction, and operation techniques and features into all aspects of the project including buildings, roofs, pavement, and landscaping. (Yolo County)

Policies, Programs, Actions:

- Require that new buildings be designed and constructed in accordance with "green building" programs that incorporate techniques and materials that maximize energy efficiency, incorporate the use of sustainable resources and recycled materials, and reduce emissions of GHGs and toxic air contaminants (San Diego County)
- Encourage the use of building materials and methods that increase energy efficiency a minimum of 15 percent beyond State Title 24 standards for residential buildings and 20 percent beyond State Title 24 standards for commercial buildings (Yolo County)
- Strongly encourage LEED certification or equivalent for all public, private and existing buildings and strongly encourage LEED Neighborhood Design (ND) certification or equivalent for other applicable projects, particularly within the Specific Plan areas. (Yolo County)

Objective: Consider GHG reduction in aspects of city planning and work on lowering emissions (General)

Policies, Programs, Actions:

- Provide incentives such as expedited project review and entitlement processing for developers that maximize use of sustainable and low GHG land development practices in exceedance of State and local standards. (San Diego County)
- Prepare, maintain, and implement a climate change action plan with a baseline inventory of GHG emissions from all sources; GHG emissions reduction targets and deadlines, and enforceable GHG emissions reduction measures. (San Diego County)
- Promote and, as appropriate, develop standards for the retrofit of existing buildings to incorporate design elements, heating and cooling, water, energy, and other elements that improve their environmental sustainability and reduce GHG (San Diego County)
- Require County operations and encourage private development to provide incentives (such as priority parking) for the use of low- and zero-emission vehicles and equipment to improve air quality and reduce GHG emissions. (San Diego County)
- Analyze and research the feasibility of using small scale energy-producing technologies in public buildings, where feasible, including solar or wind energy and other green technologies. (Redwood City)

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Equitable and resilient communities

Community Engagement

Community Engagement

Objective: Increase participation in community events. (City of South Gate)

Policies and Programs:

- The City will strive to preserve and strengthen social capital by supporting formal and informal social networks in the community. (City of South Gate)
- Increase rates of participation in community events such as voting, youth activities, adult education, senior activities and family-oriented programs. (City of South Gate)
- Prioritize projects that significantly address social and economic needs of the economically vulnerable populations. Address and reverse the underlying socioeconomic factors and residential social segregation in the community that contributes to crime and violence in the city. (City of Richmond)
- Information about community events should continue to be distributed to a wide range of community organizations including churches, senior facilities, schools, etc. using existing city-sponsored platforms such as the City website. (City of South Gate)
- Pursue the following cross-cutting strategies to support social capital: (City of South Gate)
  - Implement land use policies that reduce commute times.
  - Support policies and programs to beautify neighborhoods.
  - Create public gathering places, such as parks and plazas.
  - Take actions to reduce crime and violence across the City.
  - Support neighborhood watch or policing programs.
  - Support neighborhood associations throughout the City.
  - Actively enforce code violations.
  - Reduce conditions of blight and poverty across the City.
- Actively develop community awareness, understanding, and interest in land use issues and public policy issues, including land use, and empower the community to engage in the shaping of those policies. (San Jose)

- Strengthen ethnic, cultural, and socioeconomic diversity by supporting programs that celebrate cultural differences and similarities and promote tolerance. (Chico)
- Provide a transparent process for public engagement of diverse stakeholders. (San Jose)
- Provide support for increased community participation, particularly in areas, such as those with language barriers or a concentration of low income households that historically have had less familiarity or experience with participation in the development and implementation of City policies and particularly those communities that historically have been impacted by power plants, trash transfer stations, and other municipal or industrial uses, in the planning and development processes. (San Jose, City of Sacramento)
- Facilitate the involvement of community residents, businesses, and organizations in the development, adoption, and implementation of community health initiatives and consider their input throughout the decision-making process. (National City)

Economic Development

Goal: – Promote economic development through focused land use planning, targeted circulation and infrastructure improvements, and expanded resource availability. (Salinas)

Objective: Create land use and infrastructure conditions to attract economic development. (General)

- Increase the flexibility of Zoning Code standards and regulations to accommodate the types of economic development activity desired by the City and making the locations identified in the Economic Opportunity Areas more attractive for development. Allow more approvals to be issued at the administrative level. (Salinas)
- Encourage a balance between job type, the workforce, and housing development to reduce the negative impacts of long commutes and provide a range of employment opportunities for all residents. (Sacramento)
- Require the provision of bicycle parking and related facilities in new employment-generating development to facilitate multi-modal commute choices. (San Pablo)
- establish a list of "ready-to-go" or "shovel-ready" sites in consultation with property owners, and provide the list to interested developers and businesses seeking sites in the city (Fresno)
- Redesign existing wastewater and storm drainage infrastructure systems, including broad municipal level wastewater and storm water solutions for water reuse, and ensure that outdated infrastructure is upgraded to accommodate existing and future businesses. (Salinas)
- Ensure an adequate supply of appropriately zoned land that is readily served by infrastructure to support local economic development for base level job growth. (Chico)
- Promote quality in-fill housing along corridors and on infill sites in adjacent neighborhoods to support retail development. (City of Highland)

Goal: Maintain and implement an Economic Development Strategy to enhance long-term prosperity. (Chico)

Objective: Foster collaborative relationships between public sector, private businesses, and community. (General)

- Invest in a coordinated program that attracts investment capital and research activity in agricultural technology to Salinas and the Salinas Valley. (Salinas)
- Develop an infrastructure funding toolkit which describes infrastructure funding options/mechanisms available to the City and for partnerships with the private sector. (Salinas)

Goal: Enhance retail, entertainment, and tourism opportunities throughout the City. (Salinas)

Objective: Attract new businesses and consumers while protecting existing residents and employers. (General)

- Develop and maintain a business retention and expansion program.(Salinas)
- Provide an appropriate mix of retail development in focused commercial centers along commercial corridors. (City of Highland)
- Encourage projects and programs that help increase the quality of life for local businesses and their employees. Support the development and enhancement of "Third Places" (places people go after work or when not at home), including open space, recreation, art, and entertainment venues. (Chico)

A

Climate Change

Code Changes, Zoning Changes, and/or Policy

Energy

Transportation and Land Use

Natural and Working Lands (NWL)

Agriculture

Water

Waste Management

Short-Lived Climate Pollutants

Green Buildings

Mitigation

Construction

Operation

This appendix is a general reference document. It is not official guidance that dictates requirements for a city or county in addressing GHGs in its general plan or for local project CEQA mitigation.

This is not an exhaustive list, nor does it represent the complete list of actions identified by the State to help meet the 2030 or 2050 target. Local governments are encouraged to examine additional policies and refine existing policies and measures to address GHG emissions to meet their specific needs. There is no "one size fits all" solution and different policies will be more suitable in urban and suburban areas versus rural areas, among other considerations.

Climate change planning documents from the California Air Pollution Control Officers Association (CAPCOA) provided the basis for much of the content for these recommendations. Refer to the climate change chapter and resource referenced in the introduction for addition guidance on policies, emissions targets and other aspects of developing a GHG emissions reduction program.

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Due to the nature of climate change policies and programs, this section is organized differently than preceding sections.

PART 1

Generalized examples of local municipal code changes, zoning changes, or policy directions that could apply broadly to the community within the general plan or climate action plan area:

Energy

- Adopt and implement a zero net energy goal for the community.
- Building and energy efficiency actions present a general plan opportunity for local GHG emission reduction action. Nearly 70 percent of all single family homes in California were built before the adoption of California's Building Energy Efficiency Standards. Many local governments have already adopted energy efficiency standards for existing buildings that exceed Title 24. In addition, some local governments have adopted time-of-sale ordinances requiring energy efficiency upgrades exceeding Title 24 upon a change of title.
- Adopt a Community Choice Aggregation Ordinance, or work with the local utility to offer renewable energy purchasing to customers.
- Streamline permitting and environmental review and reduce fees for small-scale renewable energy systems.
- Create property-assessed clean energy financing districts or other financing mechanisms to fund permanent energy efficiency, water-efficiency, and renewable energy improvements in the residential and commercial sectors.
- Adopt local ordinance to require energy efficiency upgrades at time of a major remodel.
- Reduce permit fees and streamline permitting requirements for energy-efficiency- and renewable energy-related building renovations.
- Amend the building code to improve energy efficiency in new construction and in repairs and alternations to existing buildings.
- Implement building energy audit and retrofit programs and residential solar programs.
- Adopt residential and commercial energy conservation, renewable energy, and/or zero net energy ordinances (consider requirements for audits or updates at major renovation or time of sale).
- Incorporate renewable energy and energy efficiency into public facilities capital improvements.
- Replace public lighting with energy-efficient lighting.
- Permit renewable energy generation facilities as of right in zones with compatible uses.
- Create incentive program to promote building energy efficiency projects

- Create incentive programs to promote the use of biomass wastes, including agricultural, forest, and urban woody waste materials, and livestock manure and sewage sludge, for the generation of biofuels and electricity.
- Implement large scale energy storage in commercial and industrial buildings to control peak loads.

Transportation and Land Use

- Local and regional actions have a significant influence on vehicle miles traveled (VMT). ARB regulates vehicle fuel efficiency and the carbon intensity of fuel, but VMT is impacted by land use decisions and continues to increase in California. Regional and local governments and agencies influence VMT-related GHG emissions both on a project-level basis and in integrated, long-term blueprints such as the sustainable community strategy and regional transportation plan. In addition, local land use decisions can promote climate-friendly policies such as transit-oriented and mixed-use development that can also create consistency with the region's SCS, if applicable.
- Update Lead Agency's transportation impact analysis guidelines and congestion management plans to comply with SB 743.
- Adopt general plan policies and diagram designations and zone map and standards that are consistent with the Sustainable Communities Strategy.
- In appropriate locations, adopt as-of-right zoning to enable mixed use, walkable compact development.
- Streamline permitting and environmental review and reduce fees for construction of secondary units to promote infill in targeted areas.
- Streamline local permitting and siting for hydrogen fueling and electric vehicle (EV) charging infrastructure.
- Adopt a jurisdiction-wide transportation demand management plan.
- Require employer-based trip reduction programs and provide funding to support them if feasible.
- Update code of ordinances to reduce parking requirements and eliminate parking minimums.
- Adopt an electric vehicle (EV) readiness plan.
- Adopt green building standards that exceed minimum State building standards for EV-capable parking spaces (e.g., by requiring installation of EV chargers and/or a larger number of EV-capable parking spaces).
- Replace public fleet vehicles and trips with electric or alternative fueled vehicles as much as feasible and provide EV chargers in public spaces.
- Adopt and implement a bicycle and pedestrian master plan.
- Develop a transportation impact fee program.
- Develop environmental credit program.
- Support biogas use in the transportation sector.

- Adopt community design and neighborhood development standards that encourage. mixed use, walkable, infill development that includes a range of housing types and affordability levels.
- Provide incentives for certifying development plans and projects using LEED for Neighborhood Development or similar third-party certification system.
- Partner with local/regional transit agencies to enhance transit ridership.
- Adopt a Transportation Management Ordinance to require carpool and/or vanpool preferential parking spaces close to the major employment areas.
- Promote a Safe Routes to School Program that encourages youth to walk or ride bicycles to schools.
- Promote intelligent traffic management systems to improve traffic flow.
- Promote use of alternative fuel or high-fuel efficient vehicles by public agencies and private businesses.
- Require local specific plans for rideshare-designated parking spaces, new bus stops, employment centers, and commercial areas.
- Expand transit and rail services and clean fueled transit vehicles.
- Promote ridesharing and last-mile connections.

Natural and Working Lands (NWL)

- Policy in this sector should balance carbon sequestration with other co-benefits. The overall objective is to maintain NWL as a carbon sink and minimize the net GHG and black carbon emissions associated with management, biomass disposal, and wildfire events. Examples that could be considered include:
- Incorporate NWL conservation into local land use plans including adoption of a natural and working lands climate plan.
- Adopt policies that encourage management practices known to enhance carbon sequestration on NWL.
- Adopt policies to expand urban forests for net long-term carbon storage.
- Adopt urban forestry and green infrastructure programs.
- Adopt ordinance preserving and enhancing carbon sequestration of wetlands, forests, croplands, and grasslands.
- Adopt plans to conserve lands, water, and other natural features and resources for habitat and natural community.
- Adopt ordinance preserving trees through the review of proposed land use developments where trees are presented on either public or private property.
- Adopt plans and support projects for forest management activities to restore California forest lands that have high tree mortality and unnaturally dense fuel loads to a fire resilient condition that will mitigate wildfire size and severity.

- Promote and encourage the development of value-added alternatives, such as compost, energy, biochar, and wood products to avoid open burning of forest biomass wastes.
- Develop strategies to value the benefits of forest fuels reductions on upper-watershed water quality, quantity, and timing.

Agriculture

- Incorporate farmland conservation in local land use plans.
- Provide incentives for carbon sequestration and carbon-based conservation farming techniques - including the use of biochar and compost from biomass wastes that would have otherwise been landfilled or open pile burned.
- Promote value-added alternatives, such as compost, energy, biochar, and wood products to avoid open burning of agricultural biomass wastes.
- Develop incentives to reduce application of pesticides and fertilizers.

Water

- Adopt water-efficient landscaping ordinance, including use of compost/mulch, to reduce water use.
- Develop a plan requiring water recycling, and greywater and rain water reuse and provide funding for incentives and other program delivery mechanisms if feasible
- Develop a residential water efficiency auditing program.
- Create an incentive program to promote efficient water use projects.

Waste Management

- Prohibit disposal of organic materials at landfills and/or prohibit jurisdiction's hauler(s) and self-haulers from taking organic material to landfills.
- Require that collected organics materials be used in edible food recovery programs or as feedstock for composting and anaerobic digestion; include assessment of 15 years organics recycling capacity needs in General Plan; and provide appropriate zoning in compatible areas for large and community-scale compost and digestion operations.
- Require implementation of residential and commercial recycling, organics collection, and edible food recovery programs.
- Require generators of edible food to have contracts/agreements with food rescue organizations and prohibit edible food from being disposed or destroyed.
- Require procurement of locally produced biogas, compost, and mulch.
- Adopt ordinance for zero waste goals.
- Adopt ordinance requiring hauling routes that minimize vehicle emissions compared to current practice (e.g., through use of renewable fuels, route optimization plan, etc.).

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- Adopt a construction & demolition waste recycling ordinance.
- Adopt green building standards that include targets to exceed minimum State building standards for new construction, including requiring new construction to include bin space for organics recycling.
- Require that landfills incorporate the financial impact of organics disposal reductions pursuant to SB 1383 into their Financial Assurance plans.
- Create an effective solid waste management plan to reduce source generation and to divert waste from landfills to achieve emission reductions.
- Ensure compost materials meets standards to be used in rural lands application for carbon sequestration.

Short-Lived Climate Pollutants

- Require biogas generation at wastewater treatment plants and methane capture at landfill facilities.
- Require that air conditioning and refrigeration units in new construction (and at major renovation) rely on refrigerants with low global warming potential (e.g., they use CO2 or ammonia instead of hydro fluorocarbons).
- Promote alternative disposal options for woody biomass wastes to avoid open pile burning.
- Support hazardous fuel reduction, defensible space clearing and forest fuel reduction in rural forested areas with high tree mortality and unnaturally high fuel loads to reduce the size and severity of catastrophic wildfires which reduces the release non-anthropogenic black carbon and methane.
- Adopt use of low global warming potential (GWP) alternative refrigerants.
- Adopt programs, ordinances, or regulations to reduce wood smoke from residents, commercial, and recreational activities.
- Require alternatives to wood heating in new developments, where natural gas infrastructure is available.
- Provide incentives to reduce wood smoke by changing out uncertified wood heating devices to either certified devices, or to gas, electric, or pellet devices.

Green Buildings

- Require energy efficiency upgrades to existing buildings, where appropriate, upon issuing a permit for substantial modification.
- Require new construction to achieve third-party green building certification, such as the GreenPoint Rated program and the LEED rating system.
- Certify to LEED for Existing Buildings: Operations and Maintenance green building rating system.
- Establish target dates and pathways toward transitioning to zero net carbon buildings.
- Require electrification of residential heating.

- Incentivize development of "living buildings" and support off-grid allowances for proposals that meet the requirements of the "Living Buildings Challenge" or equivalent certification program.
- Require local ordinance to provide for adequate space for recycling/organics collection in all new residential and commercial construction.
- Require implementation of CALGreen building code requirements to divert and recycle construction and demolition waste, and use locally-sourced building materials and recycled content building materials, including mulch/compost, to the extent possible.
- Adopt Community Design Guideline for new buildings to maximize energy conservation designs to promote passive solar energy generation, natural ventilation, effective use of daylight, or other on-site electricity generation.
- Encourage the use of renewable energy and storage.
- Link green building with transportation planning to encourage lowest possible transportation impacts.
- Develop strategies to reduce urban heat islands through cool roofs or parking lot PV systems.

PART 2

Examples of mitigation measures that could be required of individual projects

Construction

- Enforce idling time restrictions for construction vehicles.
- Require construction vehicles to meet latest engine standards.
- Divert and recycle demolition waste, and use locally-sourced building and recycled content materials to the extent possible.
- Minimize tree removal, and mitigate indirect GHG emissions from vegetation removal.
- Utilize existing on-site power poles rather than temporary gasoline/diesel power generators.
- Increase use of electric and renewable fuel construction equipment.
- Require diesel equipment fleets to exceed any current emission standard.
- Require best available emissions control technology for all construction equipment.

Operation

- Achieve a zero net emissions goals for all new development.
- Develop an offsite retrofit program to support the conversation of existing housing stock to be more efficient at resource consumption.

- Comply with lead agency's standards for mitigating transportation impacts under SB 743.
- Require on-site EV charging capabilities for parking spaces serving the project.
- Provide fewer on-site parking spaces than required by code if appropriate
- Dedicate on-site parking for shared vehicles.
- Provide adequate, safe, convenient, and secure on-site bicycle parking and storage in multi-family residential projects and in non-residential projects.
- Provide on- and off-site safety improvements for bike/ped/transit connections and/or implement relevant improvements identified in an applicable bicycle and/or pedestrian master plan.
- Require on-site renewable energy generation.
- Prohibit wood-burning fireplaces in new development.
- Require cool roofs.
- Require net energy metering (NEM) ready roofs.
- Require organic collection in new development.
- Require low-water landscaping in new development. Require water efficient landscape maintenance to conserve water and reduce landscape waste.
- Achieve Zero Net Energy performance.
- Require new construction to achieve third-party green building certification, such as the GreenPoint Rated program and the LEED rating system.
- Require the design of bike lanes to connect the regional bicycle network.
- Expand urban forestry and green infrastructure in new land development.
- Require preferential parking spaces for park and ride to incentivize carpooling, vanpooling, commuter bus, and rail service.
- Require a transportation management plan for specific plans.
- Develop a rideshare program to facilitate participation of commuters to the major employment centers.
- Require design of bus stops/shelter/express lane in new development to promote the usage of mass-transit.
- Require that gas outlets be provided in residential backyards for use with outdoor cooking appliances such as gas barbeques if natural gas service is available.

- Require that electrical outlets be installed on the exterior walls of both the front and back of residences to promote the use of electric landscape maintenance equipment.
- Require the design of an electric box in residential unit garage to promote electric vehicle usage.
- Require electric vehicle charging station (conductive/inductive) and signage for non-residential developments.
- Provide electric outlets to promote electric landscape maintenance equipment be utilized to the extent feasible on parks and public/quasi-public lands.
- Require each residential unit to be pre-plumber and structurally engineered for the future installation of a solar energy system.
- Require the installation of energy conservation appliances such as tankless water heaters and whole house fans.
- Require each residential and commercial building be equipped with energy efficient AC units and heating system with programmable thermostat timers.
- Require each residential and commercial building utilize low flow water fixtures such as low flow toilets and faucets.
- Require the use of energy efficient lighting for all street, parking, and area lighting.
- Require the landscaping design for parking lots with shade trees to reduce urban heat island.
- Incorporate water retention in design of parking lots and landscape.

Appendix B

Transportation Safety

Addressing Transportation Safety

Transportation by its nature involves some degree of collision risk. Every addition or change to land use or the transportation system will affect transportation patterns, and as a result may involve some redistribution of that risk. This section is not intended to provide a comprehensive list of potential transportation safety risks, but rather guidance on how to approach safety analysis given numerous potential risks.

In the past, transportation safety has focused on streamlining automobile flow and accommodating driver error. An updated and more holistic approach has developed over the past decade, however. This updated approach focuses on three overlapping strategies:

- Reduce speed and increase driver attention
- Protect vulnerable road users
- Reduce overall VMT and sprawl (see Ewing et al. (2003) below for definition of "sprawl")

Designing streets with pedestrians in mind can decrease crashes and injuries

Image source https://*usa.streetsblog.org*

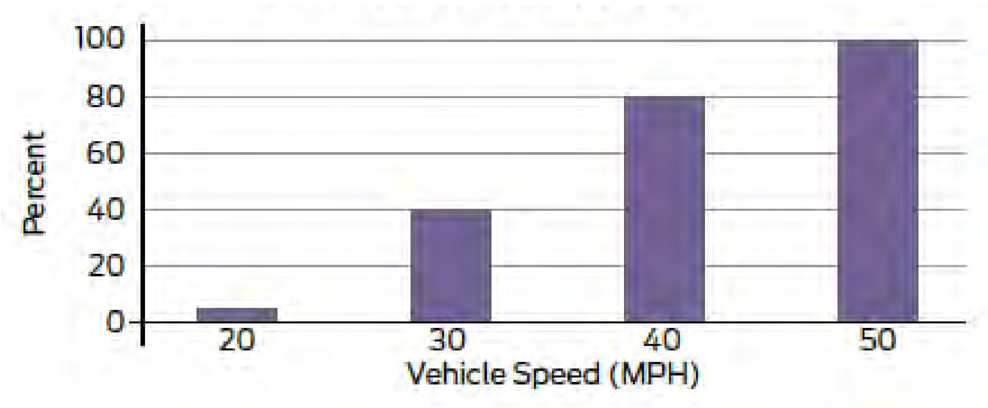
Newer design guidance builds on more recent research on transportation safety and articulates this updated approach. For example, the NACTO guidelines (which have been endorsed by Caltrans, as well as the cities of Davis, Oakland, San Francisco, San Diego, and San Mateo) state:

> "Conventional street design is founded in highway design principles that favor wide, straight, flat and open roads with clear zones that forgive and account for inevitable driver error. This is defined as "passive" design. In recent years a new paradigm has emerged for urban streets called proactive design. A proactive approach uses design elements to affect behavior and to lower speeds. Embracing proactive design may be the single most consequential intervention in reducing pedestrian injury and fatality. Since human error is inevitable, reducing the consequences of any given error or lapse of attention is critical. Cities around the country that have implemented measures to reduce and stabilize speed have shown a reduction in serious injuries and deaths for everyone on the road, from drivers to passengers to pedestrians."

Reducing Speed and Increasing Driver Attention

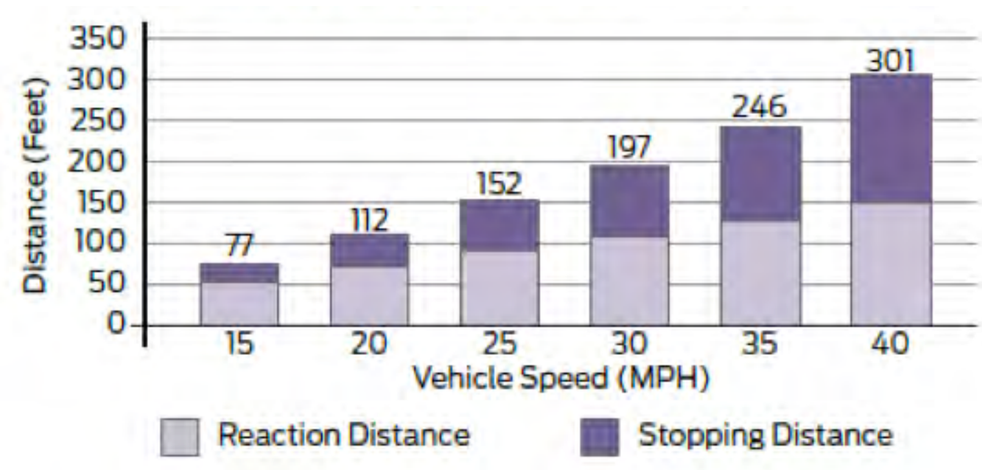
Vehicle speed plays a fundamental role in transportation safety. The NACTO Urban Street Design Guide, reports: "Vehicle speed plays a critical role in the cause and severity of crashes." The chart below shows increased pedestrian fatality risk associated with higher motor vehicle speeds.

Risk of Pedestrian Fatality by Auto Speed



Source: Federal Highway Administration

Reaction & Stopping Distance vs. Speed



Source: Federal Highway Administration

Higher speeds increase both the likelihood and severity of collisions (Elvik (2005)). According to Elvik:

- "Speed is likely to be the single most important determinant of the number of traffic fatalities."
- "...[S] peed has a major impact on the number of accidents and the severity of injuries and that the relationship between speed and road safety is causal, not just statistical."
- "Changes in speed are found to have a strong relationship to changes in the number of accidents or the severity of injuries."
- "The relationship between speed and road safety is robust and satisfies all criteria of causality commonly applied in evaluation research."

Regardless of posted speed limits, designing roads to accommodate higher speeds safely actually leads to higher speeds. Except on limited access highways (i.e. freeways), widening and straightening roads does not increase safety. "Wider and straighter roadways lead motorists to travel at higher speeds, thus offsetting any safety benefits associated with increased sight distances" (Dumbaugh et al., 2009, citing Aschenbrenner & Biehl, 1994; Wilde, 1994).

Dumbaugh et al. (2009) breaks the problem down into its constituent parts, (1) crash incidence and (2) crash severity:

> "The safety problem with urban arterials can best be understood as a product of systematic design error. Widening and straightening these roadways to increase sight distances also has the effect of enabling higher operating speeds, which in turn increase stopping sight distance, or the distance a vehicle travels from the time when a driver initially observes a hazard, to the time when he or she can bring the vehicle to a complete stop. Higher stopping sight distances pose little problem when vehicles are traveling at relatively uniform speeds and have few reasons for braking. When these operating conditions can be met, as they are on grade-separated freeways, higher operating speeds have little or no effect on crash incidence.

Speed reduction and improved multi-modal infrastructure can improve safety

Image by Urban Advantage, Moule & Polyziodes

> "But these operating conditions typically cannot be met on urban surface streets, where pedestrians, bicyclists, and crossing vehicles are all embedded in the traffic mix. Avoiding crashes under these conditions often requires motorists to bring their vehicles to a quick stop, which higher operating speeds and stopping sight distances make more difficult (Dumbaugh, 2005b; 2006). The result is a systematic pattern of error in which drivers are unable to adequately respond to others entering the roadway, leading to increased crash incidence."

Dumbaugh et al. also points out that speed reduction requires design features and/or commercial vibrancy and activity that provide cues to motorists to slow their vehicle's speed, rather than simply a slower posted speed limit:

"...Placing commercial uses on arterial thoroughfares created a pedestrian safety problem... In practice, the solution to this problem in the United States has been to continue to locate such uses on arterial thoroughfares, but to reduce posted speed limits. In the absence of aggressive police enforcement, however, such practices have been uniformly unsuccessful at reducing vehicle operating speeds (Armour, 1986; Beenstock, Gafni, & Goldin, 2001; Zaal, 1994). The principal alternative, adopted by European designers, is to design urban surface streets to reduce vehicle speeds to safe levels.

"We found pedestrian-scaled retail (the type of retail that was abandoned during the postwar period) to be associated with reductions in all types of crashes, and at significant levels for both total and injurious crashes. This is consistent with recent research on the subject, which finds that the pedestrian-scaled nature of these environments communicate to motorists that greater caution is warranted, leading to increased driver vigilance, lower operating speeds, and thus a better preparedness to respond to potential crash hazards that may emerge. The effective result is a reduction in crash incidence (Dumbaugh, 2005a; 2005b; 2006b; Garder, 2004; Naderi, 2003; Ossenbruggen, Pendharkar & Ivan, 2001)" (Dumbaugh et al. 2009, p. 323).

Dumbaugh et al. concludes that, except for limited-access freeways, reducing speeds is essential for safety, and also helps create livability:

"In areas where pedestrian activity is present or expected, or where eliminating a roadway's access function [to businesses, residences, jobs, etc.] is either undesirable or inappropriate, the primary alternative to access management is to reduce operating speeds to levels that are compatible with the street's access-related functions (see Figure 8). This approach, sometimes referred to as the livable street approach, incorporates design features that encourage lower operating speeds, such as making buildings front on the street, incorporating aesthetic street lighting or landscaping along the roadside, enhancing the visual quality of pavement and signage, and adopting traffic calming or intersection control measures. In short, livable streets emphasize access over mobility. When compared to conventional arterial treatments, livable streets report roughly 35–40% fewer crashes per mile traveled, and completely eliminate traffic-related fatalities (Dumbaugh, 2005a; Naderi, 2003)" (Dumbaugh, 2009, p. 325).

Providing greater clear space around a roadway, e.g. wider shoulders or clearing trees, can lead to degraded driver attention, in addition to higher speeds. "In dense urban areas, less-"forgiving" design treatments—such as narrow lanes, traffic-calming measures, and street trees close to the roadway—appear to enhance a roadway's safety performance when compared to more conventional roadway designs. The reason for this apparent anomaly may be that less-forgiving designs provide drivers with clear information on safe and appropriate operating speeds" (Ewing and Dumbaugh, 2009). Greater accommodation of driver error especially increases risk to vulnerable road users such as pedestrians and cyclists.

Lane width has a particularly discernable impact on safety. The traditional approach to sizing lanes opts for wider lanes to accommodate driver error and to attempt to increase throughput. However, research reveals that wider lanes hinder both of these objectives. Karim (2015) examined the relationship between lane width and crash rates. A number of findings were corroborated across cities:

- Wider lanes (over 10.8 to 11.2 feet) are associated with 33% higher impact speeds and higher crash rates.
- Both narrow (less than 9.2 feet) and wide (over 10.2 to 10.5 feet) lanes have proven to increase crash risks, with equal magnitude. Wider lanes (wider than 10.8 feet) adversely affect overall side-impact collisions.

- The overall capacity of narrower lanes is higher.
- For large vehicles, no difference on safety and carrying capacity is observed between narrower and wider lanes.
- Pedestrian volumes decline as lanes widen.
- Intersections with narrower lanes provide the highest capacity for bicycles.

The study finds that the street environment impacts driver behavior, and narrower lanes in urban areas result in less aggressive driving and more ability to slow or stop a vehicle over a short distance to avoid collision. It also points out that co-benefits of narrower lanes include utilization of space to provide an enhanced public realm, including cycling facilities and wider sidewalks, or to save money on the asphalt not used by motorists (Karim, 2015).

Yeo et al (2014) summarizes past studies that show both reducing intersection density and widening traffic lanes to worsen safety:

> "Wider traffic lanes turn out to be the reason for a higher risk of fatal crashes (Noland and Oh 2004), whereas a street with a narrower curb-to-curb distance is relatively safe (Gattis and Watts 1999). Areas with a high level of intersection density also tend to have fewer fatal crashes (Ladron de Guevara et al. 2004). According to Ewing and Dumbaugh (2009), the aforementioned road designs and street patterns create a less forgiving environment for drivers and thus help decrease traffic speed" (Yeo et al., 2014, p. 402).

Numerous studies found that narrowing lanes from today's standard practice would improve safety. However, one multi-state study found three specific circumstances where narrower lanes did not increase safety in all states studied, but only some of them. The following is provided as a caveat:

> "The research found three situations in which the observed lane width effect was inconsistent—increasing crash frequency with decreasing lane width in one state and the opposite effect in another state. These three situations are:
>
> - Lane widths of 10 feet or less on four-lane undivided arterials.

Street design greatly impacts safety for all users of the transportation system

Image by Urban Advantage, Raimi & Associates

- Lane widths of 9 feet or less on four-lane divided arterials.
- Lane width of 10 feet or less on approaches to four-leg STOP-controlled arterial intersections.

"Because of the inconsistent findings mentioned above, it should not be inferred that the use of narrower lane must be avoided in these situations. Rather, it is recommended that narrower lane widths be used cautiously in these situations unless local experience indicates otherwise" (Potts, et al. 2007).

Protecting Vulnerable Road Users

Safety measures should focus first on protecting people. Thus, for example, lead agencies might analyze how a land use project or transportation infrastructure project that increases traffic speeds may burden its travel-shed with additional, undue risk. These risks might be mitigated by, for example, (1) reducing motor vehicle travel speeds, (2) increasing driver attention, (3) protecting vulnerable road users (e.g. providing a protected, Class IV bicycle path and/or shortening pedestrian crossing distances and providing pedestrian refuges and bulb-outs), or (4) reducing VMT by providing VMT mitigation. Mitigation should avoid creating additional risk to vulnerable road users and it should not reduce active transportation mode accessibility or connectivity.

Generally speaking, the safety of vulnerable road users (e.g. pedestrians and bicyclists) should be given relatively more attention, due to their vastly increased risk of serious injury and fatality. Also, policy and planning priorities to encourage multimodal and low-carbon travel, and improving safety is a key step in increasing use of those modes. Where there are safety tradeoffs, therefore, it is important to prioritize protection of vulnerable road users. Impacts to potential vulnerable road users should be considered whether or not specific facilities for those users are present.

Active transportation has substantial health benefits, so restricting pedestrian or bicycle access and connectivity in order to reduce collision risk may worsen overall health outcomes. And, any decision about whether to apply a safety measure that restricts access by pedestrians and cyclists should consider (1) the reduction in walking and biking that will result, and the resulting reduction in "safety in numbers" as well as overall health, and (2) the risk created by pedestrians or cyclists subverting the design purpose for convenience (e.g. crossing a street where prohibited) that might lead to additional safety risk.

Reducing overall VMT and Sprawl

Higher total amounts of motor vehicle travel create higher crash exposure. Reducing vehicle miles traveled reduces collision exposure and improves safety (Dumbaugh and Rae, 2009, p. 325; Ewing, Scheiber, and Zegeer, 2003). As a result, infill development, which exhibits low VMT, itself provides safety benefits by reducing motor vehicle collision exposure, lowering speeds, and increasing pedestrian and cyclist volumes leading to "safety in numbers" (in addition to improving overall health broadly and substantially).

The fundamental relationship between VMT and safety is summarized by Yeo et al. (2014):

"Multiple traffic safety studies showed that higher VMT was positively associated with the occurrence of traffic crashes or fatalities (e.g., Ewing et al. 2002, 2003; NHTSA 2011). The causal relationship between the mileage of total vehicle trips and crash occurrences can be explained by probability. With higher VMT, it is more likely that more crashes will occur (Jang et al. 2012)."

Sprawl-style development has also been shown to lead to elevated crash risk. The cause lies both in higher VMT levels and in design variables which influence speed and driver behavior (Yeo 2014). Ewing et al. (2003) points out that "[s]uburban and outlying intersections have been significantly overrepresented in pedestrian crashes compared with more urban areas, after control for exposure and other location factors."

More generally, Ewing et al. (2003) reveals that sprawl development (measured by (1) lowness of density, (2) lack of mixing of uses, (3) absence of thriving activity centers such as strong downtowns or suburban town centers, and (4) largeness of block sizes and poorness of street connectivity) leads to elevated transportation risk levels:

> "Our study indicates that sprawl is a significant risk factor for traffic fatalities, especially for pedestrians. The recognition of this relationship is key; traffic safety can be added to the other health risks associated with urban sprawl—namely, physical inactivity and air and water pollution.
>
> "...Sprawling areas tend to have wide, long streets that encourage excessive speed. A pedestrian struck by a motor vehicle traveling at 40 mph has an 85% chance of being killed, compared with a 45% chance of death at 30 mph and a 5% chance at 20 mph. Thus, developing land in a more compact manner may reduce pedestrian deaths, provided that the street network is designed for lower-speed travel."

Ewing et al. (2003) further demonstrates that, on the whole, counties characterized by the most sprawling land use patterns exhibit substantially higher crash risk (between four and five times the all-mode fatality rate) compared to the most compact counties:

TABLE 2: US COUNTIES WITH HIGHEST AND LOWEST SPRAWL INDEX VOLUMES

County	Sprawl Index*	All-mode traffic fatality rate (per 100,000)
Counties with more compact urban form		
New York, NY (New York)	352	4.42
Kings County, NY (New York)	264	4.46
Bronx County, NY (New York)	250	4.20
Queens County, NY (New York)	219	4.58
San Francisco County, CA (San Francisco)	209	6.31
Hudson County, NJ (Jersey City)	190	5.91
Philadelphia County, PA (Philadelphia)	188	8.04
Suffolk County, MA (Boston)	179	4.49
Richmond County, NY (New York)	163	5.63
Baltimore City, MD (Baltimore)	163	7.68

*Lower sprawl index values indicate more sprawling urban form.

Source: Ewing et al., 2003.

County	Sprawl Index*	All-mode traffic fatality rate (per 100,000)
Counties with more sprawling urban form		
Stokes County, NC (Winston Salem)	71	15.66
Miami County, KS (Kansas City)	71	38.80
Davie County, NC (Winston Salem)	71	25.84
Isanti County, MN (Minneapolis St. Paul)	70	12.78
Walton County, GA (Atlanta)	70	19.77
Yadkin County, NC (Winston Salem)	69	38.52
Goochland County, VA (Richmond)	68	35.58
Fulton County, OH (Toledo)	67	38.02
Clinton County, MI (Lansing)	67	16.99
Geauga County, OH (Cleveland)	63	20.90

*Lower sprawl index values indicate more sprawling urban form.
Source: Ewing et al., 2003.

Beyond crash incidence rates and severity, delay in receiving medical care after a crash contributes to worse health outcomes from transportation safety in sprawling neighborhoods. Traditional impact analysis focuses on congestion as an inhibitor to emergency responses times. However, research shows that emergency response suffers more from greater distances to destinations found in sprawling areas than from congestion in compact and congested areas:

> "Emergency medical service (EMS) delay is another possible mediator that could help explain the direct non-VMT-involved sprawl effect on traffic fatalities. Urban sprawl increases EMS waiting time, and delay in ambulance arrival can increase the severity of traffic-related injuries (Trowbridge et al. 2009). 'For every 10% increase in population density'...the models estimated by Lambert and Meyer (2006, 2008) predict 'a 10.4% decrease in EMS run time' in the Southeastern United States and nationwide 'an average 0.61 percent decrease in average EMS run time'" (Yeo et. al, 2014).

Collectively, research points to an approach on safety that aligns well with other state priorities and laws (e.g. infill priority, greenhouse gas reduction), as well as with the visions of many local jurisdictions for their own growth. Compact infill development, in addition to providing livable and vibrant neighborhoods, walkable communities, environmental benefits, land conservation, fiscal benefit and cost reduction for citizens, also improves traffic safety:

> "Our study, which addresses the built environment in a more comprehensive manner [than past studies], found population density to be associated with significantly fewer total and injurious crashes. ...Individuals living in higher density environments drive less (Ewing & Cervero, 2001), thus reducing their overall exposure to crashes. When these reductions in VMT are aggregated across a larger population, they can potentially add up to notable reductions in population-level crash incidence" (Dumbaugh and Rae, 2009).

"[Our] research findings suggest that enhancing traffic safety by reducing fatalities can be achieved by fighting against urban sprawl and promoting smart growth countermeasures. It will be important to revive city centers, to increase density, and to provide for mixed land uses. Urban design solutions that can enhance walkability at the meso- and microlevels may help reduce traffic fatalities" (Yeo et. al, 2014).

Addressing Tradeoffs and Finding Win-Win Safety Improvements

When addressing safety impacts, a jurisdiction should frame and address those risks in a manner that helps forward the community's overall goals, while improving safety. Some modern approaches to reducing safety risk, developed over the past decade or two based on research, allow all safety to be improved while meeting these other goals. Here are three examples:

(1) Adding additional lanes to a roadway leads to additional risk for pedestrian crossing. Addressing that risk by adding extra green time in the traffic signal timing will lead to shorter pedestrian crossing times and/or additional pedestrian wait time. Addressing these secondary risks by prohibiting pedestrian crossing will reduce connectivity of the pedestrian network, leading to reduced pedestrian mode share, which will increase risk by decreasing "safety in numbers" benefits and impact the health benefits associated with active mode travel. Meanwhile, improving safety with street design features that lower travel speeds to reduce crash incidence and severity can increase use of active modes.

(2) Surface roadway lanes can be redesigned from traditional 12.0 foot widths to with 9.2 to 10.8 foot widths with little or no down-side. Such a narrowing of lanes maintains motor vehicle capacity, increases bicycle capacity, maintains large vehicle capacity and safety, improves pedestrian crossings safety and comfort, increases pedestrian volumes, improves driver attention, decreases crash rates, decreases crash severity, reduces construction costs, reduces maintenance costs, reduces impermeable surface area, reduces construction and maintenance air quality and GHG emissions, and reduces space consumption (Karim, 2015).

(3) Improving safety by adding signage and pavement markings that help reduce speeds and increase pedestrian visibility can have an array of benefits, including:

- Decrease in crash incidence for all users, including vulnerable road users
- Decrease in crash severity for all users, including vulnerable road users
- Increase safety and comfort for pedestrians and cyclists, resulting in increased walking and biking mode share, in turn increasing safety in numbers effects for vulnerable road users and improving public health both via improved safety and increased physical activity.

While reductions in automobile speed may initially increase auto mode travel times, improving conditions for pedestrians and cyclists can lead to finer grain land use development over time, and ultimately improve destination proximity and overall access to destinations (Mondschein et al., 2015, Osman, et al., 2016).

Examples of Detriments to Safety

The following are examples of possible detriments to overall safety if not mitigated:

- An increase in VMT. More vehicle travel exposes motorists and other road users to more crash risk
- An increase in pedestrian wait times. Many studies have found that pedestrian wait times play a role in crashes. Long wait times increase the risk some pedestrians will cross against a signal, creating a vulnerable road user collision risk (FHWA-RD-03-042, 2004)
- Design elements that would create hazardous conditions for vulnerable road users
- Substantially increasing motor vehicle speeds, or increasing them to greater than 25 miles per hour where vulnerable road users are present without providing proper infrastructure for vulnerable road users (e.g. Class IV bikeways for cyclists)
- Substantially increasing intersection pedestrian crossing distances, e.g. for addition of a through or turn lane
- Signal lengths of greater than 90 seconds, which may lead to people crossing on a red signal
- Installation of large curb radii, promoting higher speed motor vehicle turning movements, particularly endangering pedestrians and cyclists
- Addition or widening of on- and off-ramps where they meet surface roadways that increases pedestrian crossing distances or times, increase pedestrian wait times, or lead to a prohibition of pedestrian crossing
- Addition or widening of off-ramps in a manner that leads to higher speeds on surface streets
- Excessively large clearance zones along shoulders
- Wider than needed travel lanes (e.g. wider than 10.8 feet on surface streets)
- Multiple turn lanes at an intersection (e.g. a double left or double right turn lane)
- Placement of driveways in locations which will lead to highly elevated collision risk
- Excessively large driveways across sidewalks
- Substantially increased distances between pedestrian and bicycle crossings
- Roadway design speed (regardless of posted speed limit) that leads to actual speeds that are unsafe for cyclists and pedestrians

Examples of Problematic Approaches to Safety

Safety issues can be mischaracterized with overly narrow perspective or traditional design guidance that has not been updated to reflect research. The following are examples of mischaracterizations of safety issues:

- Avoidance of installation of corner or mid-block crossings to avoid additional pedestrian traffic and conflict with vehicles (reduces pedestrian mode share, undoing safety in numbers)
- Providing wide (e.g. 12 foot) travel lanes on surface roadways (see discussion above)
- Avoidance of implementing sidewalk bulbs, widened sidewalks, parklets, or other curb extensions or removal of on-street parking for fear of exposing vulnerable users to vehicular traffic (these features slow traffic and improve walkability as discussed above)
- Addressing off-ramp queuing by limiting stop control on an exit ramp (this can lead to vehicles flowing unimpeded and at high speeds onto a local street, increasing risk for all road users)
- Avoidance of protected bicycle facilities adjacent to transit boarding islands to avoid conflicts between transit users and cyclists (this is safe with good design)
- Maintaining or providing parking spaces to avoid circling or other problematic traffic maneuvers. Adding parking increases VMT, which adds overall crash exposure; instead implement parking pricing

Providing infrastructure for bicyclists, pedestrians, and vulnerable road users can reduce fatality and injury rates

Image by Urban Advantage, SANDAG

Examples of Potential Transportation Safety Mitigation Measures

- Intersection improvements
  - » Visibility improvement
  - » Shortening corner radii
  - » Pedestrian safety islands
  - » Accounting for pedestrian desire lines

- Signal changes
  - Reducing signal cycle lengths to less than 90 seconds to avoid pedestrian crossings against the signal
  - Providing a leading pedestrian interval
  - Provide a “scramble” signal phase where appropriate
- Roadway improvements
  - Add curb extensions or bulb-outs
  - Add bicycle facilities (On higher speed roads, add protected bicycle facilities)
  - Reduce travel lane width below 10.8 feet (but not below 9.2 feet)
  - Add traffic calming measures
  - Add landscaping features
- Network improvements
  - Provide shorter blocks
  - Provide mid-block crossings
- Reduce VMT
  - Increase density and/or diversity of land uses
  - Provide travel demand management measures
  - Provide transit
  - Provide pedestrian facilities
  - Provide bicycle facilities

B

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C

Appendix C

New state legislation related to General Plans

AB 52 (Gatto, 2014)

Specifies that a project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource, as defined, is a project that may have a significant effect on the environment. Requires a lead agency to begin consultation with a California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project, if the tribe requested consultation to the lead agency in writing

AB 1505 (Ducheny, 1999) | Farmworker housing

Requires the housing element to identify adequate sites for farmworker housing.

Amends Sections 51238, 51238.5, 65580, 65583, and 65950 of, and adds Section 51230.2 to, the Government Code.

AB 2838 (Hertzberg, 2000) | Local agency formation commissions

Provides that a LAFCO require as a condition to annexation that a city prezone the territory to be annexed, and requires that approval of the annexation be consistent with planned and probable use based upon review of the general plan and prezoning designations. Also authorizes the LAFCO to review the consistency of a proposal within a city's general plan when a proposed action would require the extension of critical services.

Amends and adds several sections of multiple state codes.

AB 2292 (Dutra, 2002) | General plans: residential density

Prohibits a city or county from reducing the residential density for any parcel to a density that is below the density that was utilized by the Department of Housing and Community Development in determining compliance with housing element law.

Adds Section 65863 to the Government Code.

SB 1468 (Knight, 2002) | General plans: military facilities

Requires specified elements (land use, open space, and circulation) to incorporate consideration of military facilities and readiness activities. Also requires that, in counties with a military airport, the county's general plan and any applicable specific plans be consistent with safety and noise standards in the Air Installation Compatible Use Zone prepared for that military airport.

Amends Sections 65040.2, 65302, 65302.3, 65560, and 65583 of, and adds Section 65040.9 to, the Government Code, amends Section 21675 of the Public Utilities Code.

C

AB 1108 (Pavley, 2002) | Environmental quality: scoping meetings: military areas.

Requires a CEQA lead agency to submit notices to the military service if a project includes a general plan amendment and is within specific boundaries of a low-level flight path, military impact zone, or special use airport.

Amends Section 21083.9 of, and adds Sections 21098 and 21098.1 to, the Public Resources Code.

SB 18 (Burton, 2004) | Traditional tribal cultural places

Requires agencies to consult with California Native American tribes, and provide opportunities for involvement to tribes, during the preparation or amendment of the general plan.

Amends Section 815.3 of the Civil Code, amends Sections 65040.2, 65092, 65351, 65352, and 65560 of, adds Sections 65352.3, 65352.4, and 65562.5 to the Government Code.

AB 3065 (Kehoe, 2004) | General plan: safety element

See also SB 1241 (Kehoe, 2012)

Revises safety element requirements for state responsibility areas and very high fire hazard severity zones. Also requires that the safety element be submitted to the State Board of Forestry and Fire Protection and to local agencies that provide fire protection to territory in the city or county.

Amends Section 65302 of, and repeals and adds Section 65302.5 of, the Government Code, and repeals Section 4128.5 of the Public Resources Code.

SB 926 (Knight, 2004) | Economic development

Makes several changes to planning and general plan law, including changes to procedure for military consultation, and requires consultation with DOC and OES prior to preparation of safety element.

Amends and adds several sections of multiple state codes.

SB 1462 (Kuehl, 2004) | Military readiness activities: special use airspace

Requires the planning agency, during preparations to adopt or substantially amend a general plan, to refer the proposed action to branches of the US Armed Forces when the proposed action lies within 1,000 feet of a military installation, within special use airspace, or beneath a low-level flight path.

Amends Sections 65352, 65404, 65940, and 65944 of the Government Code.

AB 1268 (Wiggins, 2004) | Land use

Authorizes the text and diagrams in the land use element that address the location and extent of land uses and the zoning ordinances that implement these provisions to express community intentions regarding urban form and design.

Adds Section 65302.4 to the Government Code.

C

AB 2140 (Hancock, 2006) | General plans: safety element

Authorizes a city or county to adopt with its safety element a federally specified local hazard mitigation plan, and limits the state share for projects eligible under the CA Disaster Assistance Act unless a local jurisdiction has adopted a local hazard mitigation plan in accordance with the federal Disaster Mitigation Act as part of its safety element.

Adds Sections 8685.9 and 65302.6 to the Government Code.

AB 1019 (Blakeslee, 2007) | Land use: annexation: housing

Authorizes an agreement on a revised determination of regional housing needs if an annexation of unincorporated land to a city occurs after the council of governments, or the department for areas with no council of governments, has made its final allocation.

Amends Section 65584.07 of the Government Code.

AB 162 (Wolk, 2007) | Land use: water supply

Requires specified elements to address flood hazards and identify areas that may accommodate floodwater for purposes of groundwater recharge and stormwater management. Requires safety element to address flood hazards as specified.

Amends Sections 65302, 65303.4, 65352, 65584.04, and 65584.06 of, and adds Sections 65300.2 and 65302.7 to, the Government Code.

AB 1358 (Leno, 2008) | Planning: circulation element: transportation

Requires a city or county, upon any substantive revision of the circulation element, to modify the circulation element to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways, in a manner that is suitable to the rural, suburban, or urban context of the general plan.

Amends Sections 65040.2 and 65302 of the Government Code.

SB 375 (Steinberg, 2008) | Transportation planning: travel demand models: sustainable communities strategy: environmental review

Requires regional transportation plans to include a sustainable communities strategy. Also makes various changes to timing for review and revision of housing elements.

Amends and adds several sections of multiple state codes.

AB 45 (Blakeslee, 2009) | Distributed generation: small wind energy systems

Authorizes a county to adopt an ordinance that provides for the installation of small wind energy systems outside an urbanized area, and to establish a process for the issuance of conditional use permits for these systems.

Adds and repeals Article 2.11 (commencing with Section 65893) of, and repeals the heading of Article 2.11 (commencing with Section 65892.13) of, Chapter 4 of Division 1 of Title 7 of the Government Code.

SB 575 (Steinberg, 2009) | Local planning: housing element

Requires a local government to review its housing element as frequently as appropriate, but no less often than required by a specified schedule.

Amends Sections 65080, 65583, and 65588 of the Government Code, and amends Section 75123 of the Public Resources Code.

SB 812 (Ashburn, 2010) | Developmental services: housing

Requires a local government to include needs of individuals with a developmental disability in the housing element's analysis of special housing needs.

Amends Section 65583 of the Government Code.

SB 226 (Simitian, 2011) | Environmental quality

Limits the application of CEQA in the case of the approval of an infill project that satisfies specified standards if an EIR was certified for a planning level decision, including the enactment or amendment of a general plan, community plan, specific plan, or zoning code. Also authorizes the referral of a proposed action to adopt or substantially amend a general plan to a city or county bordering the city or county within which the project is located to be conducted concurrently with the CEQA scoping meeting.

Amends Section 65919.10 of the Government Code, and amends Sections 21083.9 and 21084 of, and adds Sections 21080.35, 21094.5, 21094.5.5, and 25500.1 to, the Public Resources Code.

SB 244 (Wolk, 2011) | Local government: land use: general plan: disadvantaged unincorporated communities.

Requires the land use element to include analysis of the presence of island, fringe, or legacy unincorporated communities. Subsequently amended by SB 1090 (2012).

Amends Sections 56375, 56425, and 56430 of, and adds Sections 53082.5, 56033.5, and 65302.10 to, the Government Code, and adds Section 13481.7 to the Water Code.

SB 1090 (Comm. On Governance and Finance, 2012) | Local government: omnibus bill

Amends statutory language added by SB 244 (2011). Requires the update of the land use element to be based on specified available data and to include identification of each island or fringe community that is a disadvantaged unincorporated community.

Amends and adds several sections of multiple state codes.

SB 1241 (Kehoe, 2012) | Land use: general plan: safety element: fire hazard impacts
See also AB 3065 (Kehoe, 2004)

Revises safety element requirements for state responsibility areas and very high fire hazard severity zones and requires the safety element to take into account specified considerations, including the most recent version of the Office of Planning and Research's "Fire Hazard Planning" document.
Amends Sections 65302 and 65302.5 of, and adds Sections 65040.20 and 66474.02 to, the Government Code, and adds Section 21083.01 to the Public Resources Code.

SB 743 (Steinberg, 2013) | Environmental Quality

Addresses several topics, including aesthetics and parking for certain infill projects. Also requires the Office of Planning and Research to update the Guidelines Implementing the California Environmental Quality Act to replace exisiting requirements for studying transportation impacts under CEQA.

SB 1462 (Comm. On Governance and Finance, 2014) | Local government: omnibus bill

Eliminates the requirement that the noise element recognize the guidelines established by the Office of Noise Control.
Amends and adds several sections of multiple state codes.

AB 1690 (Gordon, 2014) | Local planning: housing elements

Authorizes a city or county to accommodate the very low and low-income housing need on sites designated for mixed uses if those sites allow 100% residential use and require that residential use occupy 50% of the total floor area of a mixed-use project.

AB 1739 (Dickinson, 2014) | Groundwater management

Requires, prior to the adoption or any substantial amendment of a general plan, the planning agency to review and consider certain specified groundwater plans and refer a proposed action to certain specified groundwater management agencies.
Amends and adds several sections of multiple state codes.

AB 52 (Gatto, 2014) | Native Americans: California Environmental Quality Act

Specifies that a project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource, as defined, is a project that may have a significant effect on the environment. Requires a lead agency to begin consultation with a California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project, if the tribe requested consultation to the lead agency in writing.

C

AB 2501 (Bloom, 2016) | Housing: density bonuses

Requires the local government to adopt procedures and timelines for processing a density bonus application, provide a list of documents and information required to be submitted with the application in order for it to be deemed complete, and notify the applicant whether it is complete. Specifies the definition for the term "density bonus." Requires the local government to provide the requested concessions or incentives unless it finds that the concession or incentive does not result in cost reductions, to provide for affordable housing costs or rents for the targeted units, as specified. Expands the definition of housing development definition to include mixed-use housing.

Together, the following bills make several changes to housing element law:

SB 575 (Torlakson, 2005)

AB 1390 (Jones, 2005)

SB 1087 (Florez, 2005)

AB 1233 (Jones, 2005)

AB 2634 (Lieber, 2006)

SB 253 (Torlakson, 2005)

AB 2572 (Emmerson, 2006)

AB 382 (Committee on Housing and Community Development, 2007)

AB 2135 (Ting, 2014)

D

Appendix D

Noise Element Guidelines

Guidelines for the Preparation and Content of the Noise Element of the General Plan

The noise element of the general plan provides a basis for comprehensive local programs to control and abate environmental noise and to protect residents from excessive exposure. The fundamental goals of the noise element are:

- To provide sufficient information concerning the community noise environment so that noise may be effectively considered in the land use planning process. In so doing, the necessary groundwork will have been developed so that a community noise ordinance may be utilized to resolve noise complaints.
- To develop strategies for abating excessive noise exposure through cost-effective mitigating measures in combination with zoning, as appropriate, to avoid incompatible land uses.
- To protect those existing regions of the planning area whose noise environments are deemed acceptable and also those locations throughout the community deemed "noise sensitive."
- To utilize the definition of the community noise environment in the form of CNEL or Ldn noise contours as provided in the noise element for local compliance with the State Noise Insulation Standards. These standards require specified levels of outdoor to indoor noise reduction for new multifamily residential constructions in areas where the outdoor noise exposure exceeds CNEL (or Ldn) 60 dB.

The 1976 edition of the Noise Element Guidelines, prepared by the California Department of Health Services (DHS), was a result of SB 860 (Beilenson, 1975), which became effective January 1, 1976. SB 860, among other things, revised and clarified the requirements for the noise element of each city and county general plan and gave DHS the authority to issue guidelines for compliance thereto. Compliance with the 1976 version of these guidelines was mandated only for those noise elements that were not submitted to the Office of Planning and Research by the effective date of SB 860 and to subsequent revisions of previously submitted noise elements.

A comparison between the 1976 Noise Element Guidelines and this revised edition will not reveal substantial changes. The basic methodology advanced by that previous edition remains topical. Where necessary, code references have been updated and the text revised to reflect statutory changes.

D

Definitions

Decibel, dB: A unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

A-Weighted Level: The sound level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

L10: The A-weighted sound level that is exceeded ten percent of the sample time. Similarly, L50, L90, etc.

Leq: Equivalent energy level. The sound level corresponding to a steady-state sound level containing the same total energy as a time-varying signal over a given sample period. Leq is typically computed over 1-, 8-, and 24-hour sample periods.

CNEL: Community Noise Equivalent Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m.

Ldn: Day-Night Average Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after the addition of 10 decibels to sound levels in the night after 10 p.m. and before 7 a.m. (Note: CNEL and Ldn represent daily levels of noise exposure averaged on an annual or daily basis, while Leq represents the equivalent energy noise exposure for a shorter time period, typically one hour.)

Noise Contours: Lines drawn about a noise source indicating equal levels of noise exposure. CNEL and Ldn are the metrics utilized herein to describe annoyance due to noise and to establish land use planning criteria for noise.

Ambient Noise: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Intrusive Noise: That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence, and tonal or informational content as well as the prevailing noise level.

Noisiness Zones: Defined areas within a community wherein the ambient noise levels are generally similar (within a range of 5 dB, for example). Typically, all other things being equal, sites within any given noise zone will be of comparable proximity to major noise sources. Noise contours define different noisiness zones.

D

Noise Element Requirements

Government Code Section 65302(f): A noise element shall identify and appraise noise problems in the community. The noise element shall recognize the guidelines established by the Office of Noise Control in the State Department of Health Services and shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for all of the following sources:

1. Highways and freeways.
2. Primary arterials and major local streets.
3. Passenger and freight online railroad operations and ground rapid transit systems.
4. Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.
5. Local industrial plants, including, but not limited to, railroad classification yards.
6. Other ground stationary sources identified by local agencies as contributing to the community noise environment.

Noise contours shall be shown for all of these sources and stated in terms of community noise equivalent level (CNEL) or day-night average level (Ldn). The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques for the various sources identified in paragraphs (1) to (6), inclusive.

The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise.

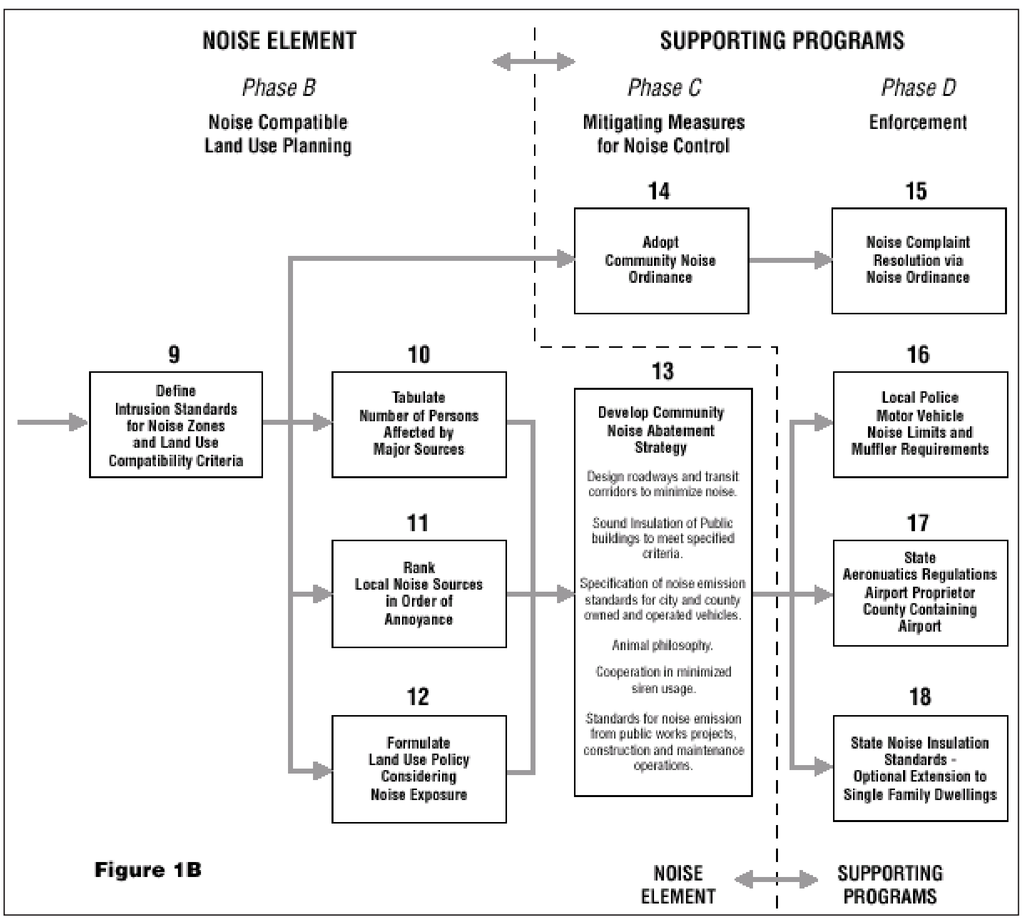


Figure 1B

The noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any. The adopted noise element shall serve as a guideline for compliance with the state's noise insulation standards.

Noise Element Development Process

The sequential steps for development of a noise element as an integral part of a community's total noise control program are illustrated in the flow diagrams of figures 1A and 1B. The concept presented herein utilizes the noise element as the central focus of the community's program and provides the groundwork for all subsequent enforcement efforts. The process may be described in terms of four phases:

Phase A: Noise Environment Definition

Phase B: Noise-Compatible Land Use Planning

Phase C: Noise Mitigation Measures

Phase D: Enforcement

These phases encompass a total of eighteen defined tasks, the first thirteen of which relate directly to the statutory requirements contained in Government Code §65302(f). The remainder relate to critical supportive programs (noise ordinances, etc.). Citations from §65302(f) are contained within quotation marks.

Phase A: Noise Environment Definition

The purpose of this phase is to adequately identify and appraise the existing and future noise environment of the community in terms of Community Noise Equivalent Level (CNEL) or Day-Night Average Level (Ldn) noise contours for each major noise source and to divide the city or county into noise zones for subsequent noise ordinance application.

Step 1:

Identify a specific individual or lead agency within the local government to be responsible for coordination of local noise control activities. This individual or agency should be responsible for coordinating all intergovernmental activities and subsequent enforcement efforts.

Step 2:

Review noise complaint files as compiled by all local agencies (police, animal control, health, airport, traffic department, etc.) in order to assess the following:

1. Location and types of major offending noise sources.
2. Noise-sensitive areas and land uses.
3. Community attitudes towards specific sources of noise pollution.
4. Degree of severity of noise problems in the community.
5. Relative significance of noise as a pollutant.

Step 3:

Specifically identify major sources of community noise based upon the review of complaint files and interagency discussion and the following statutory subjects:

1. Highways and freeways.
2. Primary arterials and major local streets.
3. Passenger and freight online railroad operations and ground rapid transit systems.
4. Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.
5. Local industrial plants, including, but not limited to, railroad classification yards.
6. Other ground stationary noise sources identified by local agencies as contributing to the community noise environment. (§65302(f))

In addition, the land uses and areas within the community that are noise sensitive should be identified at the same time.

Step 4:

Given the identification of major noise sources and an indication of the community's attitude toward noise pollution (when available), it is advisable to conduct a community noise survey. The purposes of the survey are threefold:

First and foremost, to define by measurement the current noise levels at those sites deemed noise sources and to establish noise level contours around them. The noise contours must be expressed in terms of CNEL or Ldn.

Second, the collected data will form the basis for an analysis of noise exposure from major sources.

Finally, the survey should define the existing ambient noise level throughout the community. Intrusive noises over and above this general predetermined ambient level may then be controlled through implementation of a noise ordinance.

Step 5:

Given the definition of existing ambient noise levels throughout the community, one may proceed with a classification of the community into broad regions of generally consistent land uses and similar noise environments. Because these regions will be varying distances from identified major noise sources, the relative levels of environmental noise will be different from one another. Therefore, subsequent enforcement efforts and mitigating measures may be oriented towards maintaining quiet areas and improving noisy ones.

Step 6:

Directing attention once again to the major noise sources previously identified, it is essential to gather operations and activity data in order to proceed with the analytical noise exposure prediction. This data is somewhat source-specific but generally should consist of the following information and be supplied by the owner/operator of the source:

1. Average daily level of activity (traffic volume, flights per day, hours of operation, etc.).
2. Distribution of activity over day and night time periods, days of the week, and seasonal variations.
3. Average noise level emitted by the source at various levels of activity.
4. 4. Precise source location and proximity to noise-impacted land uses.
5. 5. Composition of noise sources (percentage of trucks on highway, aircraft fleet mix, industrial machinery type, etc.).

Step 7:

In addition to collecting data on the variables affecting noise-source emission for the existing case, future values for these parameters need to be assessed. This is best accomplished by correlating the noise element with other general plan elements (i.e. land use, circulation, housing, etc.) and regional transportation plans and by coordination with other responsible agencies (Airport Land Use Commission, Caltrans, etc.).

Step 8:

Analytical noise exposure modeling techniques may be utilized to develop source-specific noise contours around major noise sources in the community.

> "The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques..." (§65302(f))

Simplified noise prediction methodologies are available through the Department of Health Services for highway and freeway noise, railroad noise, simple fixed stationary and industrial sites, and general aviation aircraft (with less than twenty percent commercial jet aircraft activity—two engine jet only). Noise contours for larger airport facilities and major industrial sites are sufficiently complex that they must be developed via sophisticated computer techniques available through recognized acoustical consulting firms. (Airport contours generally have already been developed in accordance with requirements promulgated by Caltrans' Division of Aeronautics: Noise Standards, Title 21, Section 5000, et seq., California Code of Regulations.)

Although considerable effort may go into developing noise contours that, in some instances, utilize rather sophisticated digital programming techniques, the present state of the art is such that their accuracy is usually no better than +/- 3 dB. In fact, the accuracy of the noise exposure prediction decreases with increasing distance from the noise source. In the near vicinity of the source, prediction accuracy may be within the range of +/- 1 dB, while at greater distances this may deteriorate to +/- 5 dB or more. At greater distances, meteorological and topographic effects, typically not totally accounted for in most models, may have significant influence. Thus, while dealing with the concept of noise contours, it is best not to think of them as absolute lines of demarcation on a map (such as topographical contours), but rather as bands of similar noise exposure.

In addition to assessment of the present-day noise environment, it is recommended that the noise exposure data be projected through the time horizon of the general plan. The noise element should be updated and corrected every five years, or sooner as is necessary, and, at that time, the forecasted noise exposure should be projected an additional five years.

Phase B: Noise-Compatible Land Use Planning

A noise planning policy needs to be rather flexible and dynamic to reflect not only technological advances in noise control, but also economic constraints governing application of noise-control technology and anticipated regional growth and demands of the community. In the final analysis, each community must decide the level of noise exposure its residents are willing to tolerate within a limited range of values below the known levels of health impairment.

Step 9:

Given the definition of the existing and forecasted noise environment provided by the Phase A efforts, the locality preparing the noise element must now approach the problem of defining how much noise is too much. Guidelines for noise-compatible land use are presented in Figure 2. The adjustment factors given in Table 1 may be used in order to arrive at noise-acceptability standards that reflect the noise-control goals of the community, the particular community's sensitivity to noise (as determined in Step 2), and the community's assessment of the relative importance of noise pollution.

Step 10:

As a prerequisite to establishing an effective noise-control program, it is essential to know, in quantitative terms, the extent of noise problems in the community. This is best accomplished by determining, for each major noise source around which noise contours have been developed, the number of community residents exposed and to what extent. It is also useful to identify those noise-sensitive land uses whose noise exposure exceeds the recommended standards given in Figure 2. The exposure inventory can be accomplished by using recent census data, adjusted for regional growth, and tabulating the population census blocks within given noise contours.

Step 11:

Once the noise exposure inventory is completed, the relative significance of specific noise sources in the community (in terms of population affected) will become apparent. The local agencies involved may wish to use this information to orient their noise-control and abatement efforts to achieve the most good. Clearly, control of certain major offending sources will be beyond the jurisdiction of local agencies; however, recognition of these limitations should prompt more effective land use planning strategies.

Step 12:

A major objective of the noise element is to utilize this information to ensure noise-compatible land use planning:

> "The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise." (§65302(f))

The intent of such planning is to:

1. Maintain those areas deemed acceptable in terms of noise exposure.
2. Use zoning or other land use controls in areas with excessive noise exposure to limit uses to those which are noise compatible and to restrict other, less compatible uses.

Phase C: Noise Mitigation Measures

Step 13:

Based upon the relative importance of noise sources in order of community impact and local attitudes towards these sources, "[t]he noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any" (§65302(f)).

Selection of these noise-mitigating measures should be coordinated through all local agencies in order to be most effective. Minimization of noise emissions from all local government-controlled or sanctioned activities should be a priority item. This includes low noise specifications for new city or county owned and operated vehicles (and noise reduction retrofitting where economically possible) and noise emission limits on public works projects. Local governments should insure that public buildings (especially schools) are sufficiently insulated to allow their intended function to be uninterrupted by exterior noise. Local agencies can work with state and federal bodies to minimize transportation noise, primarily through transitway design, location, or configuration modifications.

Additional measures might include such policies as limitation of siren usage by police, fire, and ambulance units within populated areas. Animal control units may be encouraged to minimize barking dog complaints through use of an improved public relations campaign termed "Animal Philosophy." This involves working with pet owners to determine why the dog barks and attempting solutions rather than just issuing citations. Local zoning and subdivision ordinances may require the use of noise-reducing building materials or the installation of sound-insulating walls along major roads in new construction and subdivisions.

In general, local noise reduction programs need to address the problems specific to each community, with the ultimate goals being the reduction of complaint frequency and the provision of a healthful noise environment for all residents of the community.

The remaining steps are beyond the scope of the noise element requirements, but pertain to coordination with other state noise-control programs and achievement of the goals set forth in the noise element through development of an active local noise-control effort.

Step 14:

While the noise element identifies problem areas and seeks to develop medium- and long-range solutions to them, a community noise ordinance is the only viable instrument for short-term or immediate solutions to intrusive noise. A model noise ordinance that can be tailored to the specific needs of a given community by simply incorporating those sections deemed most applicable has been developed by the Department of Health Services. The model ordinance also suggests a cure for non-stationary or transient types of noise events, for which noise contours are generally meaningless.

Phase D: Enforcement

To adequately carry out the programs identified in the noise element and to comply with state requirements for certain other noise-control programs, specific enforcement programs are recommended at the local level.

Step 15:

Adopt and apply a community noise ordinance for resolution of noise complaints.

FIGURE 2

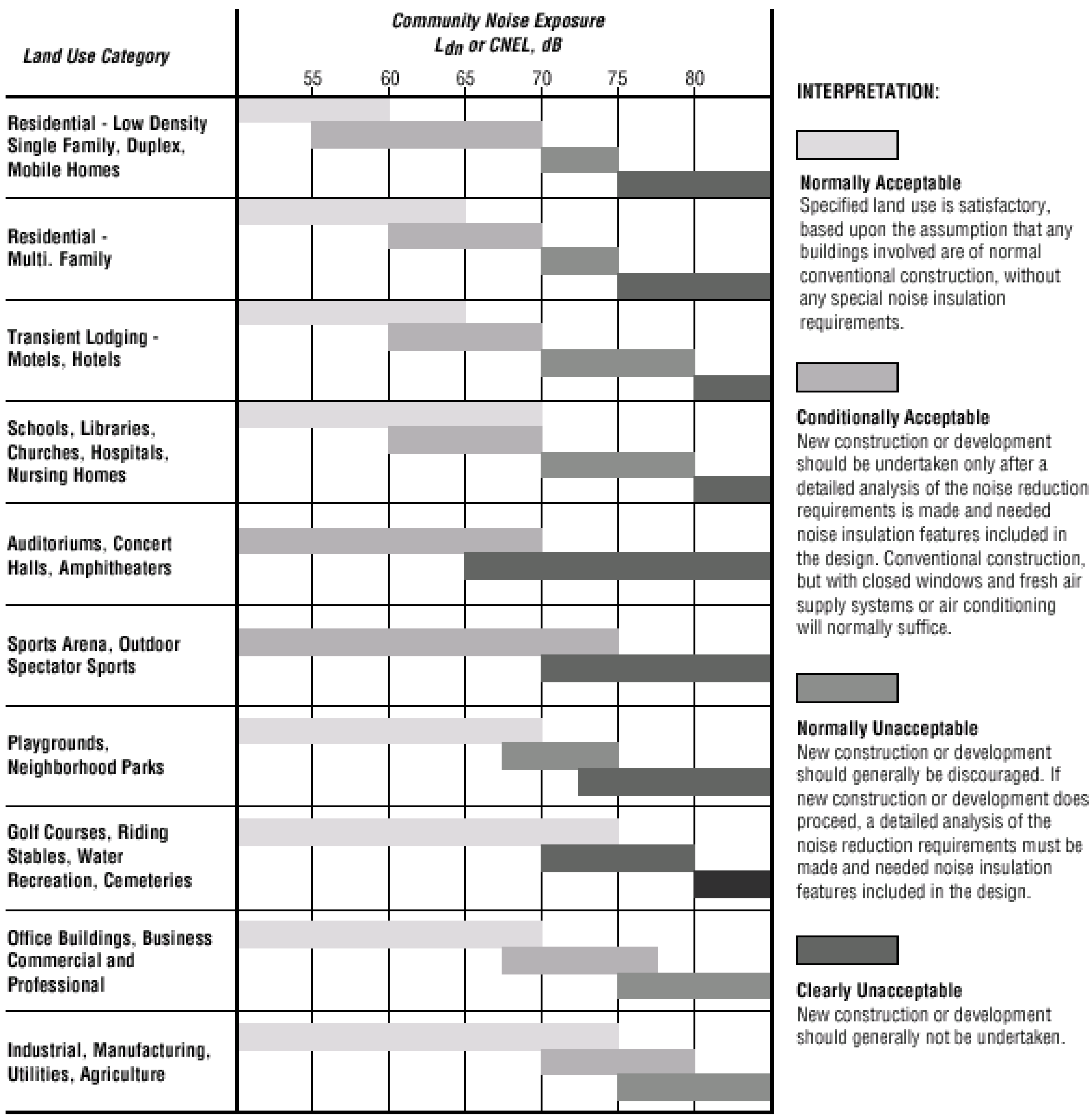


Table 1

Type of Correction	*Description*	*Amount of Correction to be Added to Measured CNEL in dB*
Seasonal Correction	Summer (or year-round operation)	**0**
	Winter only (or windows always closed)	**- 5**
Correction for Outdoor Residual Noise Level	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking).	**+ 10**
	Quiet suburban or rural community (not located near industrial activity).	**+ 5**
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas).	**0**
	Noisy urban residential community (near relatively busy roads or industrial areas.	**- 5**
	Very noisy urban residential community.	**- 10**
Correction for Previous Exposure and Community Attitudes	No prior experience with the intruding noise.	**+ 5**
	Community has had some previous exposure to intruding but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	**0**
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good.	**- 5**
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	**- 10**
Pure Tone or Impulse	No pure tone or impulsive character.	**0**
	Pure Tone or impulsive character present.	**+ 5**

Step 16:

Recent studies have shown that the most objectionable feature of traffic noise is the sound produced by vehicles equipped with illegal or faulty exhaust systems. In addition, such hot rod vehicles are often operated in a manner that causes tire squeal and excessively loud exhaust noise. There are a number of statewide vehicle noise regulations that can be enforced by local authorities as well as the California Highway Patrol. Specifically, Sections 23130, 23130.5, 27150, 27151, and 38275 of the California Vehicle Code, as well as excessive speed laws, may be applied to curtail this problem. Both the Highway Patrol and the Department of Health Services (through local health departments) are available to aid local authorities in code enforcement and training pursuant to proper vehicle sound-level measurements.

Step 17:

Commercial and public airports operating under a permit from Caltrans' Aeronautics Program are required to comply with both state aeronautics standards governing aircraft noise and all applicable legislation governing the formation and activities of a local Airport Land Use Commission (ALUC). The function of the ALUC is, among other things, to develop a plan for noise-compatible land use in the immediate proximity of the airport. The local general plan must be reviewed for compatibility with this Airport Land Use Compatibility Plan and amended if necessary (Public Utilities Code §21676). Therefore, the developers of the noise element will need to coordinate their activities with the local ALUC to ensure that compatible standards are utilized throughout the community and that the noise element develops as part of a coherent master plan, of which the ALUP forms an integral component.

Step 18:

> "The adopted noise element shall serve as a guideline for compliance with the State's noise insulation standards." (§65302(f))

Recognizing the need to provide acceptable habitation environments, state law requires noise insulation of new multifamily dwellings constructed within the 60 dB (CNEL or Ldn) noise exposure contours. It is a function of the noise element to provide noise contour information around all major sources in support of the sound transmission control standards (Appendix, Chapter 2-35, Part 2, Title 24, California Code of Regulations).

Relationship Of The Noise Element To Other General Plan Elements

The noise element is related to the land use, housing, circulation, and open-space elements. Recognition of the interrelationship of noise and these four other mandated elements is necessary in order to prepare an integrated general plan. The relationship between noise and these four elements is briefly discussed below.

- Land Use—A key objective of the noise element is to provide noise exposure information for use in the land use element. When integrated with the noise element, the land use element will show acceptable land uses in relation to existing and projected noise contours. Section 65302(f) states that: "The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise."
- Housing—The housing element considers the provision of adequate sites for new housing and standards for housing stock. Since residential land use is among the most noise sensitive, the noise exposure information provided in the noise element must be considered when planning the location of new housing. Also, state law requires special noise insulation of new multifamily dwellings constructed within the 60 dB (CNEL or Ldn) noise exposure contour. This requirement may influence the location and cost of this housing type. In some cases, the noise environment may be a constraint on housing opportunities.
- Circulation—The circulation system must be correlated with the land use element and is one of the major sources of noise. Noise exposure will thus be a decisive factor in the location and design of new transportation facilities and the possible mitigation of noise from existing facilities in relation to existing and planned land uses. The local planning agency may wish to review the circulation and land use elements simultaneously to assess their compatibility with the noise element.

- Open Space—Excessive noise can adversely affect the enjoyment of recreational pursuits in designated open space. Thus, noise exposure levels should be considered when planning for this kind of open-space use. Conversely, open space can be used to buffer sensitive land uses from noise sources through the use of setbacks and landscaping. Open-space designation can also effectively exclude other land uses from excessively noisy areas.

Selection Of The Noise Metric

The community noise metrics to be used in noise elements are either CNEL or Ldn (as specified in §65302(f)). A significant factor in the selection of these scales was compatibility with existing quantifications of noise exposure currently in use in California. CNEL is the noise metric currently specified in the State Aeronautics Code for evaluation of noise impacts at specific airports that have been declared to have a noise problem. Local compliance with state airport noise standards necessitates that community noise be specified in CNEL. The Ldn represents a logical simplification of CNEL. It divides the day into two weighted time periods (Day—7 a.m. to 10 p.m. and Night—10 p.m. to 7 a.m.) rather than the three used in the CNEL measure (Day—7 a.m. to 7 p.m., Evening—7 p.m. to 10 p.m., and Night—10 p.m. to 7 a.m.) with no significant loss in accuracy.

Criteria For Noise-Compatible Land Use

Figure 2 summarizes the suggested use of the CNEL/Ldn metrics for evaluating land use noise compatibility. Such criteria require a rather broad interpretation, as illustrated by the ranges of acceptability for a given land use within a defined range of noise exposures.

Denotation of a land use as “normally acceptable” on Figure 2 implies that the highest noise level in that band is the maximum desirable for existing or conventional construction that does not incorporate any special acoustic treatment. In general, evaluation of land use that falls into the “normally acceptable” or “normally unacceptable” noise environments should include consideration of the type of noise source, the sensitivity of the noise receptor, the noise reduction likely to be provided by structures, and the degree to which the noise source may interfere with speech, sleep, or other activities characteristic of the land use.

Figure 2 also provides an interpretation as to the suitability of various types of construction with respect to the range of outdoor noise exposure.

The objective of the noise compatibility guidelines in Figure 2 is to provide the community with a means of judging the noise environment it deems to be generally acceptable. Many efforts have been made to account for the variability in perceptions of environmental noise that exist between communities and within a given community.

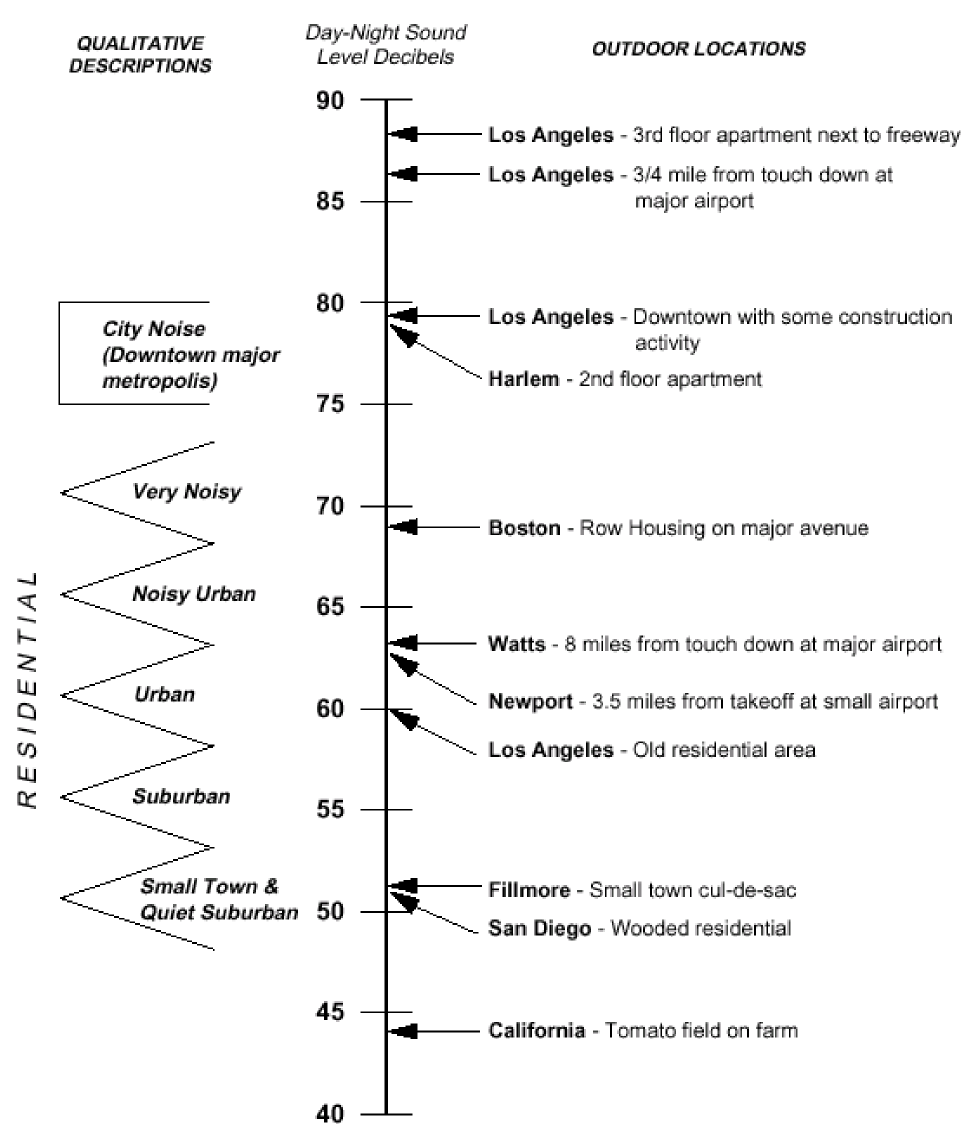
Beyond the basic CNEL or Ldn quantification of noise exposure, one can apply correction factors to the measured or calculated values of these metrics in order to account for some of the factors that may cause the noise to be more or less acceptable than the mean response. Significant among these factors are seasonal variations in noise source levels, existing outdoor ambient levels (i.e., relative intrusiveness of the source), general societal attitudes towards the noise source, prior history of the source, and tonal characteristics of the source. When it is possible to evaluate some or all of these factors, the measured or computed noise exposure values may be adjusted by means of the correction factors listed in Table 1 in order to more accurately assess local sentiments towards acceptable noise exposure.

D

In developing these acceptability recommendations, efforts were made to maintain consistency with the goals defined in the federal EPA's "Levels Document" and the State Sound Transmission Control Standards for multifamily housing. In both of these documents, an interior noise exposure of 45 dB CNEL (or Ldn) is recommended to permit normal residential activity. If one considers the typical range of noise reduction provided by residential dwellings (12 to 18 dB with windows partially open), the 60 dB outdoor value identified as "clearly acceptable" for residential land use would provide the recommended interior environment.

Figure 3 has been included in order to better explain the qualitative nature of community noise environments expressed in terms of Ldn. It is apparent that noise environments cover a broad range and that, in general, it may be observed that the quality of the environment improves as one moves further away from major transportation noise sources.

Figure 3



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E

Appendix E

Glossary

Defining the Parts of a General Plan

A general plan is made up of text describing goals and objectives, principles, standards, and plan proposals, as well as a set of maps and diagrams. Together, these constituent parts paint a picture of the community's future development. The following discussions help to clarify the meanings of these and other important terms.

Development Policy

A development policy is a general plan statement that guides action. In a broad sense, development policies include goals and objectives, principles, policies, standards, and plan proposals.

Diagram

A diagram is a graphic expression of a general plan's development policies, particularly its plan proposals. Many types of development policies lend themselves well to graphic treatment, such as the distribution of land uses, urban design, infrastructure, and geologic and other natural hazards.

A diagram must be consistent with the general plan text (Gov. code §65300.5) and should have the same long-term planning perspective as the rest of the general plan. The Attorney General has observed that "...when the Legislature has used the term 'map,' it has required preciseness, exact location, and detailed boundaries...." as in the case of the Subdivision Map Act. No such precision is required of a general plan diagram (67 Cal.Ops.Atty.Gen. 75,77).

As a general rule, a diagram or diagrams, along with the general plan's text, should be detailed enough so that the users of the plan, whether staff, elected and appointed officials, or the public, can reach the same general conclusion on the appropriate use of any parcel of land at a particular phase of a city's or county's physical development. Decision-makers should also be able to use a general plan, including its diagram or diagrams, in coordinating day-to-day land use and infrastructure decisions with the city's or county's future physical development scheme.

At the same time, given the long-term nature of a general plan, its diagram or diagrams and text should be general enough to allow a degree of flexibility in decision-making as times change. For example, a general plan may recognize the need for and desirability of a community park in a proposed residential area, but the precise location of the park may not be known when the plan is adopted. The plan would not need to pinpoint the location, but it should have a generalized diagram along with policies saying that the park site will be selected and appropriate zoning applied at the time the area is subdivided. In this sense, while zoning must be consistent with the general plan, the plan's diagram or diagrams and the zoning map are not required to be identical.

E

Goal

A goal is a general direction-setter. It is an ideal future end related to the public health, safety, or general welfare. A goal is a general expression of community values and, therefore, may be abstract in nature. Consequently, a goal is generally not quantifiable or time-dependent.

Although goals are not mentioned in the description of general plan contents in Government code section 65302, they are included here for several reasons. First, defining goals is often the initial step of a comprehensive planning process, with more specific objectives defined later, as discussed in Chapter 3. Second, goals are specifically mentioned in the statutes governing housing element contents (Gov. code §65583). Third, while the terms "goal" and "objective" are used interchangeably in some general plans, many plans differentiate between broad, unquantifiable goals and specific objectives. Either approach is allowable, as flexibility is a characteristic of the general plan.

Examples of goals:

- Quiet residential streets
- A diversified economic base for the city
- An aesthetically pleasing community
- A safe community

Goals should be expressed as ends, not actions. For instance, the first example above expresses an end, namely, "quiet residential streets." It does not say, "Establish quiet residential streets" or "To establish quiet residential streets."

Objective

An objective is a specified end, condition, or state that is an intermediate step toward attaining a goal. It should be achievable and, when possible, measurable and time-specific. An objective may pertain to one particular aspect of a goal or it may be one of several successive steps toward goal achievement. Consequently, there may be more than one objective for each goal.

Examples of objectives:

- The addition of 100 affordable housing units over the next five years
- A 25 percent increase in downtown office space by 2030
- A 50 percent reduction in the rate of farmland conversion over the next ten years
- A reduction in stormwater runoff from streets and parking lots

Principle

A principle is an assumption, fundamental rule, or doctrine guiding general plan policies, proposals, standards, and implementation measures. Principles are based on community values, generally accepted planning doctrine, current technology, and the general plan's objectives. In practice, principles underlie the process of developing the plan but seldom need to be explicitly stated in the plan itself.

Examples of principles:

- Mixed use encourages urban vitality
- The residential neighborhoods within a city should be within a convenient and safe walking distance of an elementary school
- Parks provide recreational and aesthetic benefits
- Risks from natural hazards should be identified and avoided to the extent practicable

Policy

A policy is a specific statement that guides decision-making. It indicates a commitment of the local legislative body to a particular course of action. A policy is based on and helps implement a general plan's vision.

A policy is carried out by implementation measures. For a policy to be useful as a guide to action it must be clear and unambiguous. Adopting broadly drawn and vague policies is poor practice. Clear policies are particularly important when it comes to judging whether or not zoning decisions, subdivisions, public works projects, etc., are consistent with the general plan.

When writing policies, be aware of the difference between "shall" and "should." "Shall" indicates an unequivocal directive. "Should" signifies a less rigid directive, to be honored in the absence of compelling or contravening considerations. Use of the word "should" to give the impression of more commitment than actually intended is a common but unacceptable practice. It is better to adopt no policy than to adopt a policy with no backbone.

Solid policy is based on solid information. The analysis of data collected during the planning process provides local officials with the knowledge about trends, existing conditions, and projections that they need to formulate policy. If projected community conditions are not in line with a general plan's objectives, local legislative bodies may adopt policies that will help bring about a more desirable future.

Examples of policies:

- The city shall not approve a parking ordinance variance unless the variance pertains to the rebuilding of an unintentionally destroyed non-conforming use
- The city shall not approve plans for the downtown shopping center until an independently conducted market study indicates that the center would be economically feasible
- The city shall give favorable consideration to conditional use permit proposals involving adaptive reuse of buildings that are designated as "architecturally significant" by the cultural resources element

Standards

A standard is a rule or measure establishing a level of quality or quantity that must be complied with or satisfied. Standards define the abstract terms of objectives and policies with concrete specifications.

The Government Code makes various references to general plan standards. For example, §65302(a) states in part that the land use element must "...include a statement of the standards of population density and building intensity recommended for the various districts and other territory covered by the plan." Other examples of statutory references to general plan standards include those found in §66477 (the Quimby Act) and §66479 (reservations of land within subdivisions). Of course, a local legislature may adopt any other general plan standards it deems desirable.

Examples of standards:

- High-density residential means 20 to 30 dwelling units per acre and up to 41 dwelling units per acre with a density bonus
- The first floor of all new construction shall be at least two feet above the base flood elevation

Plan Proposal

A plan proposal describes the development intended to take place in an area. Plan proposals are often expressed on the general plan diagram.

Examples of plan proposals:

- First Street and Harbor Avenue are designated as arterials
- The proposed downtown shopping center will be located within the area bound by D and G Avenues and Third and Fourth Streets
- A new parking structure shall be located in the vicinities of each of the following downtown intersections: First Street and A Avenue, and Fifth Street and D Avenue

Implementation Measure

An implementation measure is an action, procedure, program, or technique that carries out general plan policy. Each policy must have at least one corresponding implementation measure.

Examples of implementation measures:

- The city shall adopt a specific plan for the industrial park
- Areas designated by the land use element for agriculture shall be placed in the agricultural zone

Linking Objectives to Implementation

The following examples show the relationships among objectives, policies, and implementation measures. The examples are arranged according to a hierarchy from the general to the specific—from goals to implementation measures. In an actual general plan, there might be more than one policy under each objective, more than one implementation measure under each policy, etc.

Goal:

- A thriving downtown that is the center of the city's retail and service commercial activities.

Objective:

- Development of a new regional shopping center in the downtown.

Policy:

- The city shall not approve discretionary projects or building permits that could impede development of the downtown regional shopping center.

Implementation measures:

- The city shall adopt an interim zoning ordinance restricting further development in the general vicinity of the proposed downtown shopping center until a study has been completed determining its exact configuration.
- During the interim zoning period, the city shall adopt a special regional shopping center zoning classification that permits the development of the proposed downtown mall.
- Upon completion of the study, the city council shall select a site for the downtown mall and shall apply the shopping center zone to the property.

Goal:

- Affordable, decent, and sanitary housing for all members of the community.

Objective:

- 500 additional dwelling units for low-income households by 2010.

Policy:

- When a developer of housing within the high-density residential designation agrees to construct at least 30 percent of the total units of a housing development for low-income households, the city shall grant a 40 percent density bonus for the housing project.

Implementation measure:

- The city shall amend its zoning ordinance to allow for a 40 percent density bonus in the high-density residential zone.

Noise Related Definitions

Decibel, dB: A unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

A-Weighted Level: The sound level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

L10: The A-weighted sound level that is exceeded ten percent of the sample time. Similarly, L50, L90, etc.

Leq: Equivalent energy level. The sound level corresponding to a steady-state sound level containing the same total energy as a time-varying signal over a given sample period. Leq is typically computed over 1-, 8-, and 24-hour sample periods.

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CNEL: Community Noise Equivalent Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m.

Ldn: Day-Night Average Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after the addition of 10 decibels to sound levels in the night after 10 p.m. and before 7 a.m. (Note: CNEL and Ldn represent daily levels of noise exposure averaged on an annual or daily basis, while Leq represents the equivalent energy noise exposure for a shorter time period, typically one hour.)

Noise Contours: Lines drawn about a noise source indicating equal levels of noise exposure. CNEL and Ldn are the metrics utilized herein to describe annoyance due to noise and to establish land use planning criteria for noise.

Ambient Noise: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Intrusive Noise: That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence, and tonal or informational content as well as the prevailing noise level.

Noisiness Zones: Defined areas within a community wherein the ambient noise levels are generally similar (within a range of 5 dB, for example). Typically, all other things being equal, sites within any given noise zone will be of comparable proximity to major noise sources. Noise contours define different noisiness zones.

Safety Related Definitions

Alquist-Priolo Earthquake Fault Zone: A regulatory zone, delineated by the State Geologist, within which site-specific geologic studies are required to identify and avoid fault rupture hazards prior to subdivision of land and/or construction of most structures for human occupancy.

Climate Adaptation: Adjustment or preparation of natural or human systems to a new or changing environment that moderates harm or exploits beneficial opportunities.

Climate Mitigation (Greenhouse Gas Emissions Reductions): A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. Refer to Chapter 7, Climate Change, for more information.

Critical Facility: Facilities that either (1) provide emergency services or (2) house or serve many people who would be injured or killed in case of disaster damage to the facility. Examples include hospitals, fire stations, police and emergency services facilities, utility facilities, and communications facilities.

Extreme Weather Event: In most cases, extreme weather events are defined as lying in the outermost ("most unusual") ten percent of a place's history. Analyses are available at the national and regional levels.

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Fault: A fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. A fault zone is a zone of related faults which commonly are braided, but which may be branching. A fault trace is the line formed by the intersection of a fault and the earth's surface.

Active Fault: A fault that has exhibited surface displacement within Holocene time (approximately the past 11,000 years).

Potentially Active Fault: A fault that shows evidence of surface displacement during Quaternary time (the last 2 million years).

Flooding: A rise in the level of a water body or the rapid accumulation of runoff, including related mudslides and land subsidence, that results in the temporary inundation of land that is usually dry. Riverine flooding, coastal flooding, mud flows, lake flooding, alluvial fan flooding, flash flooding, levee failures, tsunamis, and fluvial stream flooding are among the many forms that flooding takes.

Ground Failure: Mudslide, landslide, liquefaction or soil compaction.

Hazardous Building: A building that may be hazardous to life in the event of an earthquake because of partial or complete collapse. Hazardous buildings may include:

1. Those constructed prior to the adoption and enforcement of local codes requiring earthquake resistant building design.
2. Those constructed of unreinforced masonry.
3. Those which exhibit any of the following characteristics:
    - exterior parapets or ornamentation which may fall on passersby
    - exterior walls that are not anchored to the floors, roof or foundation
    - sheeting on roofs or floors incapable of withstanding lateral loads
    - large openings in walls that may cause damage from torsional forces
    - lack of an effective system to resist lateral forces
    - non-ductile concrete frame construction

Hazardous Material: An injurious substance, including pesticides, herbicides, toxic metals and chemicals, liquefied natural gas, explosives, volatile chemicals, and nuclear fuels.

Hazard Mitigation: Sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects.

Landslide: A general term for a falling, sliding, or flowing mass of soil, rocks, water, and debris. Includes mudslides, debris flows, and debris torrents.

Liquefaction: A process by which water-saturated granular soils transform from a solid to a liquid state during strong ground shaking.

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Maladaptation: Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.

Natural Infrastructure: The preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.

Peakload Water Supply: The supply of water available to meet both domestic water and fire fighting needs during the particular season and time of day when domestic water demand on a water system is at its peak.

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Seiche: An earthquake-induced wave in a lake, reservoir, or harbor.

Seismic Hazard Zone: A regulatory zone, delineated by the State Geologist, within which site-specific geologic, soils, and foundation engineering studies are required to identify and avoid earthquake-caused ground-failure hazards, or selected other earthquake hazards, prior to subdivision of land and for construction of most structures for human occupancy.

Storm surge: An abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

Subsidence: The gradual, local settling or sinking of the earth's surface with little or no horizontal motion (subsidence is usually the result of gas, oil, or water extraction, hydrocompaction, or peat oxidation, and not the result of a landslide or slope failure).

Seismically Induced Surface Rupture: A break in the ground's surface and associated deformation resulting from the movement of a fault.

Tsunami: A wave, commonly called a tidal wave, caused by an underwater seismic disturbance, such as sudden faulting, landslide, or volcanic activity.

Wildland Fire: A fire occurring in a suburban or rural area that contains uncultivated lands, timber, range, watershed, brush or grasslands. This includes areas where there is a mingling of developed and undeveloped lands.

Flood Management: The overarching term that encompasses both floodwater management and floodplain management.

Floodwater Management: Floodwater management includes actions to modify the natural flow of floodwaters to reduce losses to human resources and/or to protect benefits to natural resources associated with flooding. Examples of floodwater management actions include containing flows in reservoirs, dams, and natural basins; conveying flows via levees, channels, and natural corridors; managing flows through reservoir reoperation; and managing watersheds by decreasing rainfall runoff and providing headwater stream protection.

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Floodplain Management: Floodplain management includes actions to the floodplain to reduce losses to human resources within the floodplain and/or to protect benefits to natural resources associated with flooding. Examples of floodplain management actions include minimizing impacts of flows (e.g., flood-proofing, insurance); maintaining or restoring natural floodplain processes (e.g., riparian restoration, meander corridors, etc.); removing obstacles within the floodplain voluntarily or with just compensation (e.g., relocating at-risk structures); keeping obstacles out of the floodplain (through subdivision and zoning decisions); education and emergency preparedness planning (e.g., emergency response plans, data collection, outreach, insurance requirements, etc.); and ensuring that operations of floodwater management systems are not compromised by activities in the floodplain.

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NAAQS Table

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. ***Primary standards*** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. ***Secondary standards*** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" air pollutants. Periodically, the standards are reviewed and may be revised. The current standards are listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

Pollutant [links to historical tables of NAAQS reviews]	**Primary/ Secondary**	**Averaging Time**	**Level**	**Form**
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
		primary and secondary	1 year	53 ppb [(2)]	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm [(3)]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 μg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb [(4)]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

Pollutant [links to historical tables of NAAQS reviews]	Primary/ Secondary	Averaging Time	Level	Form
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Menu of Control Measures for NAAQS Implementation

The Menu of Control Measures (MCM) provides state, local and tribal air agencies with the existing emission reduction measures as well as relevant information concerning the efficiency and cost effectiveness of the measures. State, local and tribal agencies will be able to use this information in developing emission reduction strategies, plans and programs to assure they attain and maintain the National Ambient Air Quality Standards (NAAQS). The MCM is a living document that can be updated with newly available or more current data as it becomes available.

- Menu of Control Measures

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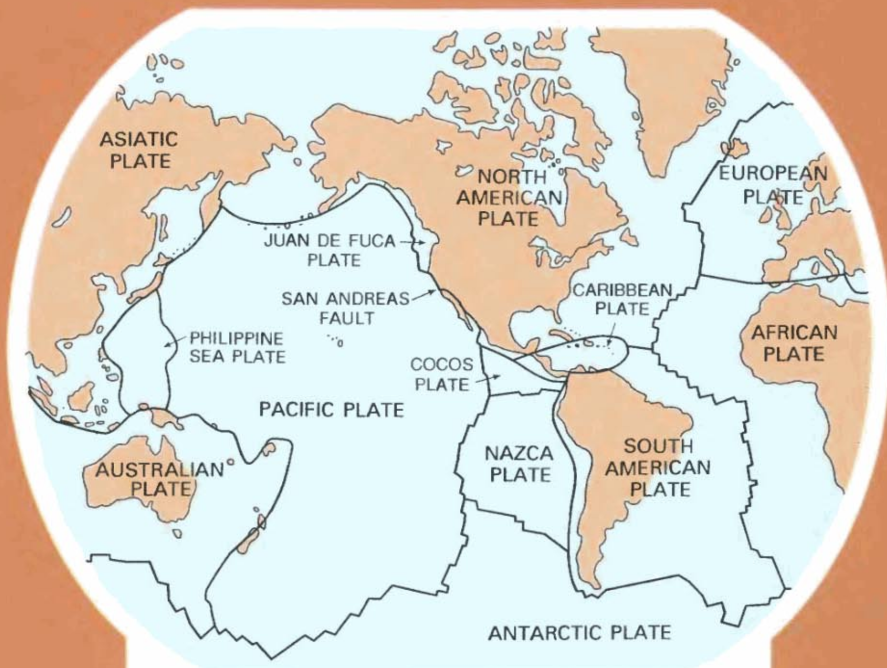
U.S. GEOLOGICAL SURVEY
PROFESSIONAL PAPER 1515



SIMPLIFIED MAP OF THE EARTH'S CRUSTAL PLATES

FRONT COVER: On the Carrizo Plain in central California, the San Andreas fault appears as a conspicuous gash across the terrain. Streams are offset and deflected at the fault. View northwestward.

MAP OF THE SAN ANDREAS FAULT SYSTEM, CALIFORNIA

Maps of northern and southern California printed on flyleaf inside front cover and on adjacent pages show faults that have had displacement within the past 2 million years. Those that have had displacement within historical time are shown in red. Bands of red tint emphasize zones of historical displacement; bands of orange tint emphasize major faults that have had Quaternary displacement before historical time. Faults are dashed where uncertain, dotted where covered by sedimentary deposits, and queried where doubtful. Arrows indicate direction of relative movement; sawteeth on upper plate of thrust fault.

These maps are reproductions, in major part, of selected plates from the "Fault Map of California," published in 1975 by the California Division of Mines and Geology at a scale of 1:750,000; the State map was compiled and data interpreted by Charles W. Jennings. New data about faults, not shown on the 1975 edition, required modest revisions, primarily additions; however, most of the map was left unchanged because the California Division of Mines and Geology is currently engaged in a major revision and update of the 1975 edition. Because of the reduced scale here, names of faults and places were redrafted or omitted. Faults added to the reduced map are not as precise as on the original State map, and the editor of this volume selected certain faults and omitted others. Principal regions for which new information was added are the region north of the San Francisco Bay area and the offshore regions.

Many people have contributed to the present map, but the editor is solely responsible for any errors and omissions. Among those contributing informally, but extensively, and the regions to which each contributed were G.A. Carver, onland region north of lat 40° N.; S.H. Clarke, offshore region north of Cape Mendocino; R.J. McLaughlin, onland region between lat 40°00' and 40°30' N. and long 123°30' and 124°30' W.; D.S. McCulloch, offshore region between lat 35° and 40° N.; J.G. Vedder, offshore region south of lat 35° N.; and D.G. Herd, southern San Francisco Bay region. The Fault Evaluation Program of the California Division of Mines and Geology, under the direction of E.W. Hart, provided much data about many faults. Unpublished material about the Bartlett Springs fault zone that was gathered by Geomatrix Consultants for the Pacific Gas and Electric Co. was very useful. In addition, selected publications that provided invaluable data include Bortugno (1982), Herd (1977), Herd and Helley (1977), Pampeyan and others (1981), and Yerkes and others (1980). Full references for these publications are listed at the end of chapter 2.

To all of the above, and to numerous others, the editor expresses his great appreciation.

SIERRA NEVADA
Redding
Red Bluff
KLAMATH MOUNTAINS
CALIFORNIA
SACRAMENTO VALLEY
GROGAN FAULT
BALD MOUNTAIN FAULT
EATON ROUGHS FAULT ZONE
BIG LAGOON F
MAD RIVER FAULT ZONE
LAKE MOUNTAIN FAULT ZONE
BARTLETT SPRINGS FAULT ZONE
WILSON FAULT
HUNTING FAULT
CLOVER VALLEY F Z
KONOCTI BAY F Z
COLLAYOMI F Z
Eureka
LITTLE SALMON FAULT
GARBERVILLE FAULT ZONE
MAACAMA FAULT ZONE
HEALDSBURG FAULT
RUSS F
CAPETOWN F
KING RANGE FAULT
BEAR HARBOR FAULT ZONE
Point Delgada
COAST RANGES
Cape Mendocino
Punta Gorda
SAN ANDREAS FAULT ZONE
Fort Ross
Point Arena
POINT REYES
MENDOCINO FRACTURE ZONE
N
PACIFIC OCEAN


SIERRA NEVADA
CALIFORNIA
SACRAMENTO
Stockton
Modesto
Merced
Fresno
SAN JOAQUIN VALLEY
San Joaquin River
SAN JOAQUIN FAULT
ORTIGALITA FAULT
Coalinga
COAST RANGES
Parkfield
GREENVILLE FAULT
LAS POSITAS FAULT
DIABLO RANGE
DIABLO RANGE
GREEN VALLEY FAULT
CONCORD FAULT
CALAVERAS FAULT
Hollister
SAN ANDREAS FAULT ZONE
RODGERS
HAYWARD FAULT
Hayward
Oakland
SAN JOSE
SARGENT FAULT
San Juan Bautista
GABILAN RANGE
RINCONADA FAULT
KING CITY FAULT
COAST RANGES
San Francisco Bay
SAN FRANCISCO
Monterey Bay
Bolinas Bay
Point Reyes
SAN GREGORIO-HOSGRI FAULT ZONE
PACIFIC OCEAN
N
0 10 20 30 40 50 KILOMETERS


OWENS VALLEY FAULT ZONE
OWENS VALLEY
SIERRA NEVADA
PANAMINT VALLEY FAULT ZONE
SIERRA NEVADA FAULT ZONE
SAN JOAQUIN VALLEY
Fresno
Tulare
CALIFORNIA
GARLOCK FAULT
TEHACHAPI MOUNTAINS
MOJAVE
COAST RANGES
Coalinga
Bakersfield
WHITE WOLF FAULT
SAN ANDREAS FAULT ZONE
Parkfield
Cholame
Palmdale
SAN ANDREAS
TEMBLOR RANGE
BUENA VISTA FAULT
PLEITO FAULT
Tejon Pass
MOJAVE SEGMENT
CLEARWATER FAULT
RANGES
RINCONADA FAULT
SAN JUAN FAULT
CARRIZO SEGMENT
CARRIZO PLAIN
SAN GABRIEL FAULT
Paso Robles
LA PANZA RANGE
MORALES FAULT
SOUTH CUYAMA FAULT
OZENA FAULT
BIG PINE FAULT
PINE MOUNTAIN FAULT
San Fernando
San Luis Obispo
EAST HUASNA FAULT
SIERRA MADRE MTS
TRANSVERSE
SAN GREGORIO-HOSGRI FAULT ZONE
SANTA YNEZ FAULT
ARROYO PARIDA FAULT
MALIBU COAST FAULT
Santa Barbara
Ventura
SANTA LUCIA BANK FAULT
Santa Cruz Island
SANTA CRUZ ISLAND FAULT
SANTA ROSA ISLAND FAULT
PACIFIC OCEAN
San Nicolas Island
N

ARIZONA
CALIFORNIA
LUDLOW FAULT
PISGAH FAULT
CALICO FAULT
WEST CALICO FAULT
CAMP ROCK FAULT
EMERSON FLT
LENWOOD FAULT
LOCKHART FAULT
HELENDALE FAULT
PINTO MOUNTAIN FAULT
BLUE CUT FAULT
Victorville
SAN BERNARDINO MTS
Desert Hot Springs
NORTH BRANCH SAN ANDREAS FAULT
SOUTH BRANCH SAN ANDREAS F
Indio
COACHELLA VALLEY
INDIO SEGMENT
Salton
Cajon Pass
FAULT ZONE
San Gorgonio Pass
Palm Springs
SAN JACINTO MOUNTAINS
IMPERIAL VALLEY
IMPERIAL FAULT
San Bernardino
Riverside
SAN JACINTO FAULT ZONE
COYOTE CREEK FAULT
SUPERSTITION HILLS FAULT
SUPERSTITION MOUNTAIN FAULT
El Centro
CHINO FAULT
WHITTIER FAULT ZONE
ELSINORE FAULT ZONE
LOS ANGELES
UNITED STATES
MEXICO
N
NEWPORT-INGLEWOOD
PALOS VERDES FAULT
ROSE CANYON FAULT ZONE
CORONADO BANK FAULT ZONE
SAN DIEGO
CALIFORNIA
BAJA CALIFORNIA
Santa Catalina Island
PACIFIC OCEAN
SAN CLEMENTE ISLAND FAULT
San Clemente Island
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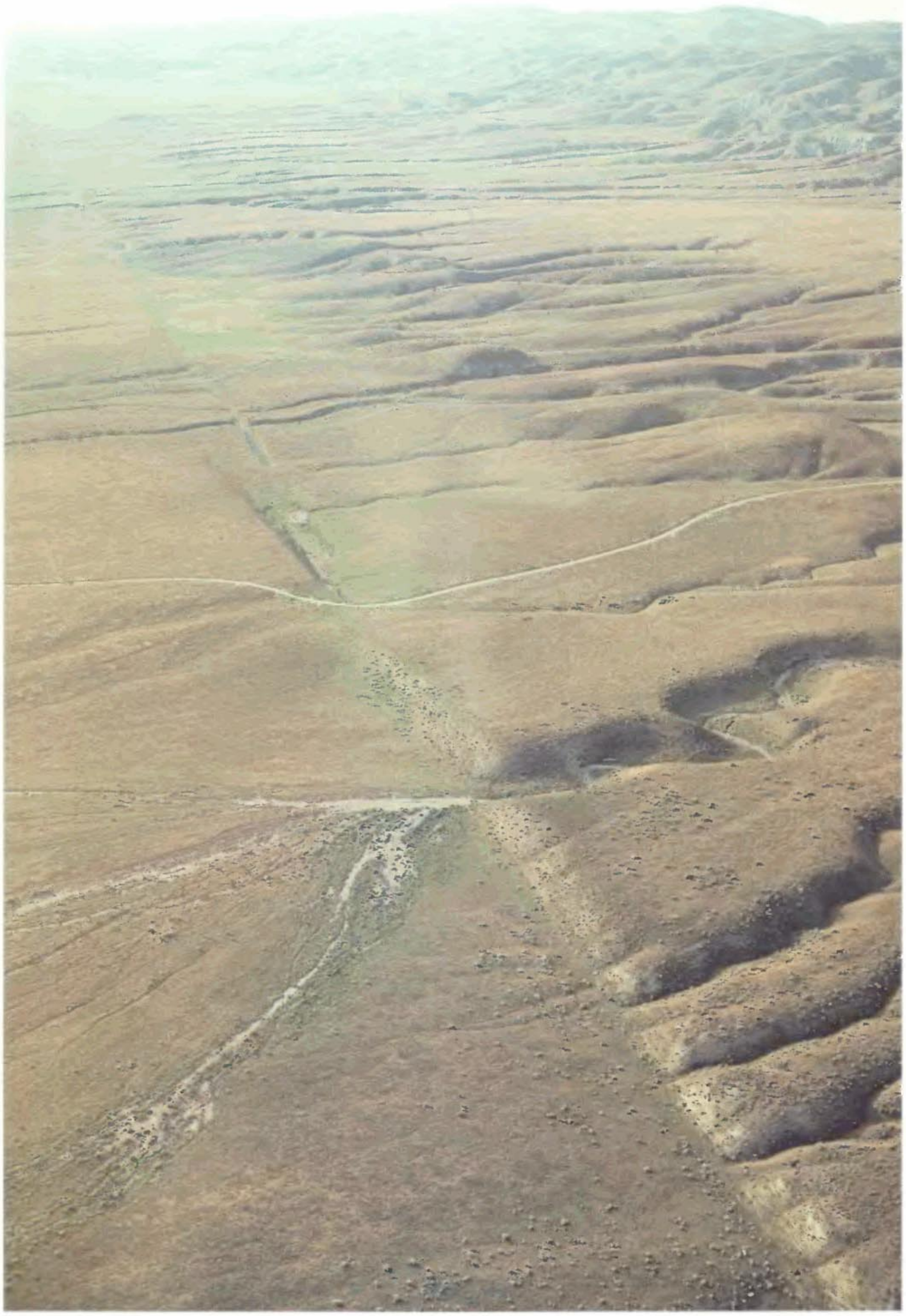
THE SAN ANDREAS FAULT SYSTEM, CALIFORNIA



The San Andreas fault in central California. Striking linearity of the trace of the fault is characteristic of strike-slip faults. Carrizo Plain to left; Temblor Range to right. View northwest.

The San Andreas Fault System, California

ROBERT E. WALLACE, *Editor*

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1515

An overview of the history, geology, geomorphology, geophysics, and seismology of the most well known plate-tectonic boundary in the world

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PREFACE

With the increasing public concern about the potential for destructive earthquakes in California since the great Alaska earthquake of 1964, and the general acceptance of the concept of plate tectonics and sea-floor spreading by earth scientists in the late 1960's, the San Andreas fault has gained wide attention. The fault has long been recognized as the source of the destructive San Francisco earthquake of 1906 and of the similarly large Fort Tejon earthquake of 1857, as well as the smaller (M=7.1), but also destructive, Loma Prieta earthquake of 1989. Many textbooks in recent decades have included photographs, maps, and descriptions of the San Andreas fault, and so among earth scientists around the world, few geologic features have greater identity than the San Andreas fault. The fault—better designated a "fault system" because of its complexities—represents an exceptional example of a plate margin that can be seen and studied on land; many other plate margins are covered by the oceans.

This volume is addressed to a varied audience, but especially to earth scientists who wish to gain a brief overview of the San Andreas fault system. We hope that the nontechnical reader also will find the volume interesting and useful. Each chapter has its own references that direct the investigator more to specific literature; suggestions for additional reading and sources of information are included at the end of the volume.

The public-safety issues of earthquake-hazard mitigation and earthquake prediction are not covered in this volume except by implication. Fundamental concepts and understanding of how the solid Earth works are essential to the development of realistic and effective procedures for hazard mitigation. Without such understanding, mitigation measures may be ineffective and wasteful of resources. Earthquake prediction requires geologic and geophysical models and data that constitute valid bases for extrapolation into the future. We believe that these concerns are well served by the reviews in this volume.

The 10 chapters that follow review geologic, geomorphic, geophysical, geodetic, and seismologic information about the San Andreas fault system. Although the material is intended to represent our current state of knowledge and understanding, many investigators will find their own specialities inadequately treated. A full discussion of the more rapidly changing and controversial ideas currently in play is impossible, given the constraints of this volume.

Manuscript approved for publication, May 4, 1990.

The need for such a volume has been recognized since the 1960's, but until recent years, data about the San Andreas fault system was so incomplete that a significant review seemed premature. Now, a general overview of many significant elements seems possible, but even so, the questions far outnumber the answers, and if history is any guide, many of the concepts put forth here will have changed markedly within the next few years. Indeed, one of the purposes of this volume is to assist and hasten the evolution of our understanding through the consolidation, under a single cover, of some of the current ideas and models.

Reference to a few of the more outstanding problems concerning the San Andreas fault system may serve to suggest how little is yet known about the fault system and how much remains to be learned. In studying the San Andreas fault system, opportunities abound for learning how the Earth works in a general sense.

A group of particularly significant problems can be collectively expressed under the question: "How does a fault system that has primarily strike slip terminate at its northwest and southeast ends, and how does it bottom out at depth?"

At the northwest end of the fault system, the Mendocino triple junction represents an intriguing structural knot where the North American, Pacific, and Gorda plates join. A fourth block at depth, made up of material below the North American plate but east of the San Andreas fault and south of the Gorda plate, also is juxtaposed with these three named plates. How are the diverse motions of these four plates or blocks accommodated where they join? Clearly, severe space problems must occur at detailed scales, even though the gross theoretical geometry of triple junctions has been fairly well described. How do these four structural blocks interact to influence the energetics of the fault system (see chap. 10)? How did the triple junction migrate over time, and how are the consequences of that migration recorded geologically?

Crustal convergence also strongly influences the fault system. Where major bends occur, as in the Transverse Ranges region, structural complexities arise. There, major left-lateral faults splay from the main San Andreas fault, and dense clusters of earthquakes extend to depths of 20 km. Elsewhere, as in the Santa Cruz Mountains, some segments of the fault dip at steep, but not vertical, angles.

Adjacent to the San Andreas fault on its east side lies the North American plate, at least in the upper few tens of kilometers; but below this plate, as indicated above, is a block of almost unknown characteristics left in the wake of the eastward-moving and subducting plate now represented by its remnants, the Gorda and Juan de Fuca plates. After pulling away from the Pacific plate in its eastward passage, did this plate leave remnants here and there under the North American plate? Did the spreading center spread continuously, or did it move eastward in one or more leaps? What sort of mantle material rose to fill in behind the stern of the eastward-moving plate? Was this newly emplaced material similar to that being generated at modern spreading centers, and to what extent did the overlying blanket of continental material alter both the geometry and thermal histories of the emplaced rocks?

Some of the models mentioned above imply decoupling between the subducting plate and the North American plate, as well as a rather significant discontinuity between the North American plate and the underlying backfill behind the stern of the eastward-moving plate. Some of the problems of this "window" behind the subducting plate are discussed in chapter 3. The San Andreas fault, indeed, may bottom in a zone of decoupling, either within the crust or below, possibly a low-angle thrust fault, as described in chapter 1, or perhaps involving gravitationally driven detachments. The characteristics of this decoupling are almost unknown. Much needs to be learned before the style of stress and strain propagation across such discontinuities can be addressed adequately.

Present-day strain is demonstrable by geodetic techniques (see chap. 7), and longer-term strain is represented geologically by the pattern of folds, faults, and magmatic intrusion into the upper crust (see chaps. 3, 4). Release of elastic strain, its timing and spatial distribution, is nicely displayed by seismicity, especially microseismicity (see chap. 5). Heat-flow measurements provide an important insight into the energetics of the San Andreas fault system (see chap. 10). Integration and comparison of these data sets, however, reveal numerous unresolved problems and apparent paradoxes. As reported in chapter 10, no sharp increase in heat flow is found directly over the San Andreas fault, even though heat would be expected to be generated in the narrow fault zone by the annual slip of several centimeters on the fault. Instead, the heat flow is distributed across a broad zone, further suggesting distributed slip on a subhorizontal plane that decouples the upper-crustal materials from those below.

The detailed characteristics of the fault zone itself are far from fully understood. Low values of stress drop that occur during seismic events have long been known (see chaps. 5, 10). The dominance of right-lateral slip along the fault, despite evidence for fault-normal compression, together with the absence of a pronounced heat-flow anomaly, attests to general weakness of the fault. How the fault zone has grown to its present 0.5- to l-km width, given this weakness, is also a puzzle. Furthermore, at many places along the fault, as in central California, the width of the fault zone is appropriately considered to be 10 km or more wide; that is the width of highly sheared and deformed rocks which lie between relatively undeformed terrane to the northeast and southwest. What is the nature of asperities, or strong points, on the fault, and how do its stronger and weaker parts interact? To what extent does plastic-behaving fault gouge move within the fault zone to change the overall geometry?

The role of water in the kinematics and dynamics of the fault system can scarcely be overemphasized, and yet almost nothing is known about the actual hydrotectonic relations. To what extent does elevated or reduced pore pressure modify the properties of the lithologic packages of rocks at different places along and across the fault? What geochemical changes in the fault zone are enhanced by the movement of fluids along the fault and through rocks adjacent to the fault? What mineralogic changes take place as a result of thermal changes related to friction, possibly accompanied by exsolution of water from minerals? Can localized, tectonically elevated pore pressure initiate slip, and once slip acceleration occurs, what role does friction play in the dynamics of slip? Why are so few volcanic rocks associated with the fault except for those related to the passing triple junction?

What are the rates of fault slip, folding, and the overall budget of deformation among various forms of strain? How do erosional rates compare with tectonic rates in changing the landscape, and to what extent do these processes deviate from linearity? How do complex geomorphic processes interact among themselves, as well as with the tectonic processes? How can the ubiquitous landforms be interpreted to illuminate the younger history of the San Andreas fault?

Strands and branches of the San Andreas fault system bound numerous exotic terranes, those aggregates of rocks which are so dissimilar that they could not have been born in their present relation to one another. The patterns of movement and distances traveled by these terranes may constitute the most significant characteristic and role of the San Andreas fault in the overall scheme of global tectonics. By whatever mechanisms these exotic blocks or terranes were transported, the western part of North America has been enlarged by the accretion of these "strangers," while at the same time other pieces of older continental material have been plucked away, eventually to join land somewhere to the northwest.

This volume represents but a small punctuation mark in the early stage of our understanding of the San Andreas fault system and the tectonics that it highlights. Most of the story has yet to be learned.

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The San Andreas fault system, a complex of faults that display predominantly large-scale strike slip, is part of an even more complex system of faults, isolated segments of the East Pacific Rise, and scraps of plates lying east of the East Pacific Rise that collectively separate the North American plate from the Pacific plate.

1. GENERAL FEATURES

By ROBERT E. WALLACE

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INTRODUCTION

This chapter briefly describes the San Andreas fault system, its setting along the Pacific Ocean margin of North America, its extent, and the patterns of faulting. Only selected characteristics are described, and many features are left for depictions on maps and figures. The other chapters in this volume elaborate on the history and evolution of the fault system, and the behavior of the Earth's crust and upper mantle within the fault system.

Because of the extent and complexity of the San Andreas fault system, it is helpful to distinguish between the broad, complex feature as seen on a map of the Western United States and the individual faults on which displacements occur to produce single earthquakes. From larger to smaller features, the terms "fault system," "fault zone," "fault," and "fault branches, splays, strands, and segments" are useful.

The term "San Andreas fault system" refers to the network of faults with predominantly right-lateral strike slip that collectively accommodate most of the relative motion between the North American and Pacific plates. The boundaries of this fault system are poorly defined, but to separate the San Andreas fault system from other tectonic provinces and systems, it is useful to limit the term to the set of faults along the Pacific rim of North America, both on land and off shore. Accordingly, at the latitude of San Francisco, the system is approximately 80 km wide, and at the latitude of San Diego approximately 150 km wide (see fig. 1 and maps at front of book).

The term "fault zone" refers to the complex zone of sheared rock that may be from 0.5 to more than 1 km wide and hundreds of kilometers long. The fault zone has developed over a period of millions of years while growing in width and complexity. The terms "fault," "fault branches," and "fault strands" refer to smaller elements and can be applied as needed. For example, surface rupture accompanying an earthquake commonly produces a complex pattern of fractures, and detailed elements can be discussed more effectively by using such terms as "fault branch, splay, or strand." The term "fault segment" recognizes that the fault is not completely continuous but is in sections or parts with poorly defined boundaries, as discussed below in the subsection entitled "Segmentation."

◀ FIGURE 1.1.—The San Andreas fault zone appears as a gash across the terrain in the Carrizo Plain area of south-central California. Streams are deflected or offset, as in foreground. Note that strata of Pleistocene age are tilted to steep angles on right (west) side of fault. View southeastward.

FIRST REFERENCES TO THE SAN ANDREAS FAULT

The San Andreas fault first came into prominence only after it was fully understood by geologists as the cause of the great San Francisco earthquake of 1906. The name had been first used only 9 years previously by A.C. Lawson (1895) for a small segment of the fault on the San Francisco peninsula, where he reported that "a remarkably straight fault * * * has conditioned the San Andreas and Crystal Springs Valley" (p. 439). Lawson applied the name "San Andreas fault" almost incidentally in a discussion of "subsequent streams that flowed in the valleys." He suggested vertical displacement on the fault but apparently was not convinced of that, inasmuch as he failed to show the fault or, with one exception, displaced strata on several cross sections in his report (for example, pl. 7). Clearly, neither the amount of displacement on the fault nor its great regional and tectonic significance was appreciated at the time of Lawson's work.

In one of the first reports about the 1906 earthquake, G.K. Gilbert (1907) accurately described the fault and its characteristic displacement, but he did not use the name "San Andreas fault." In his field notes for April 28, 1906, just 10 days after the great earthquake, Gilbert described 20 ft of right-lateral displacement of a road where it crosses the fault at the head of Tomales Bay. He had been following the surface rupture for several days, and on April 26 he recorded in his notes that along the west side of Bolinas Bay "some of the cracks were clearly secondary; others may have been primary." By the time the final report of the State Earthquake Investigation Commission was published (Lawson, 1908), the name "San Andreas" had been adopted, and its characteristics and role in causing the earthquake were clear. That report, which contains a remarkably extensive and accurate account, constitutes a major milestone in our understanding of the San Andreas fault and of strike-slip faults as a class.

EXTENT AND PATTERNS OF FAULTING

OVERVIEW OF THE PACIFIC MARGIN OF NORTH AMERICA

The San Andreas fault system is part of a complex system of faults, isolated segments of the East Pacific Rise, and scraps of plates lying east of the East Pacific Rise that collectively separate the North American plate from the Pacific plate (fig. 1.2). On a more generalized or global scale, the North American plate can be thought of as lying across and partly covering the northern part of the Pacific system of plates. In simplified terms, the Pacific system of plates includes three elements: a westward expanding plate (the Pacific plate), an eastward-expanding plate (the Juan de Fuca plate), and a spreading center (the East Pacific Rise) from which the plates expand as new material is added. To the north, the Pacific plate is underriding, or being subducted under, the North American plate along the Aleutian thrust.

Some investigators (Atwater, 1970; Atwater and Molnar, 1973) suggested that the North American plate has converged with and, indeed, slid over the Pacific system of plates, leaving only segments of the East Pacific Rise exposed, to which such names as "Juan de Fuca and Gorda Ridges" are applied. Similarly, related scraps of the eastward-expanding plate are the Juan de Fuca and Gorda plates (fig. 1.2). Absolute plate motions derived by Minster and Jordan (1980), and Jordan and Minster (1988) are shown in figure 1.2, along with the plate-motion vectors derived from the relative migration of mantle plumes or hotspots responsible for volcanic activity in Yellowstone National Park and the Hawaiian Islands.

At its north end, the San Andreas fault joins the Mendocino Fracture Zone at a high angle, and there three plates are juxtaposed: one moving relatively northwestward, the second southeastward, and the third eastward and northeastward, to form a triple junction. At its southeast end, the San Andreas fault system merges more gradually with the set of transform faults underlying the Gulf of California. Just northwest of the area of merging, however, the trend of the San Andreas fault system changes to much more westerly, whereas a set of echelon faults accompanied by volcanism less than a million years old form a north-south-trending zone that extends northward across the Mojave Desert into Owens Valley of eastern California (Hill and others, 1985). This zone may be considered the East Pacific Rise overridden, and thus modified in pattern, by the North American plate.

The San Andreas fault system may be viewed as forming the hypotenuse of a right triangle of which the northward extension of the East Pacific Rise and the eastward extension of the Mendocino Fracture Zone are the legs. The model of an overridden, subducted oceanic plate within this triangle and underlying the North American plate (Dickinson and Snyder, 1979) presents significant tectonic problems (see chap. 3).

The San Andreas fault system has rearranged an assemblage of microplates, or terranes, some of which originated tens of degrees of longitude apart. During the fault's approximately 29-m.y. existence, an extremely complex pattern of rock distribution, has thus has been created (see chap. 3).

MAJOR ELEMENTS OF THE SAN ANDREAS FAULT SYSTEM

The San Andreas fault system consists primarily of the San Andreas fault and several major branches, such as

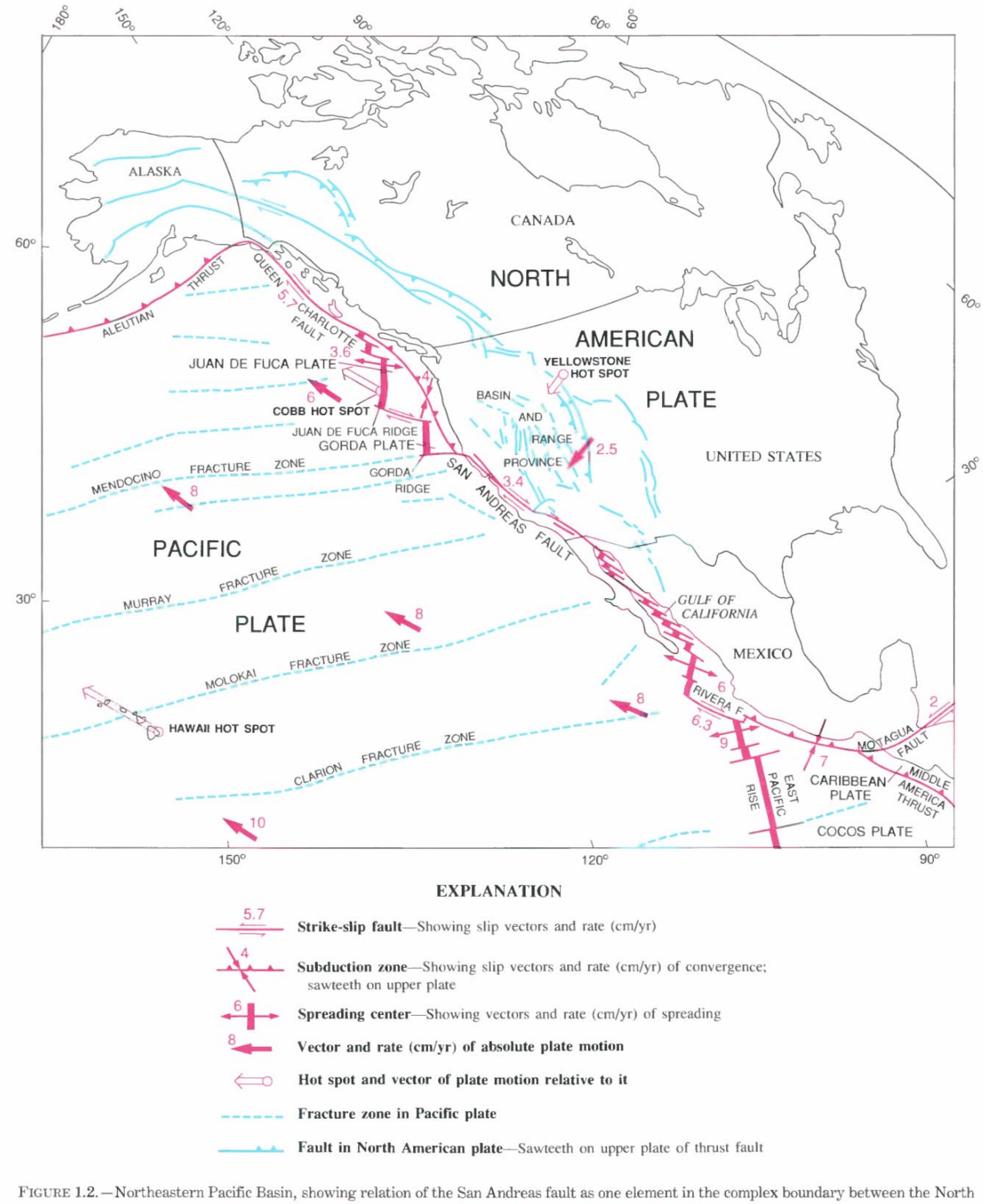


FIGURE 1.2.—Northeastern Pacific Basin, showing relation of the San Andreas fault as one element in the complex boundary between the North American and Pacific plates. Modified from Drummond (1981).

the Hayward and Calaveras faults in central California and the San Jacinto and Elsinore faults in southern California (fig. 1.3). In addition, in southern California the San Andreas fault splits into northern and southern branches in the eastern Transverse Ranges east of Los Angeles. These major faults accommodate about two-thirds of the right-slip motion between the North American and Pacific plates.

Numerous smaller branches, and extensions of segments of the fault, include in northern California such faults as the Rodgers Creek and Maacama faults, which may be considered northward extensions of the Hayward fault. The Green Valley and Bartlett Springs fault zones extend the Calaveras fault northward in a complex way (see maps at front of book). At the south end of the system, the Imperial fault represents a transition from the more continuous San Andreas fault to a more nearly echelon pattern characteristic of the faults under the Gulf of California. The Superstition Hills and Coyote Creek faults similarly represent a transition from the San Jacinto fault to a more segmented pattern to the south in Mexico.

In this volume, the San Andreas fault system is considered to lie principally within a belt about 100 km wide by 1,300 km long, but this boundary is arbitrary. Indeed, part of the relative strike-slip motion between the North American and Pacific plates seems to be taken up as far as 1,000 km east of the coastline throughout the Great Basin province (Jordan and Minster, 1988). The name "San Andreas fault system," however, should be confined to the more limited belt with the highest concentration of right-lateral strike slip.

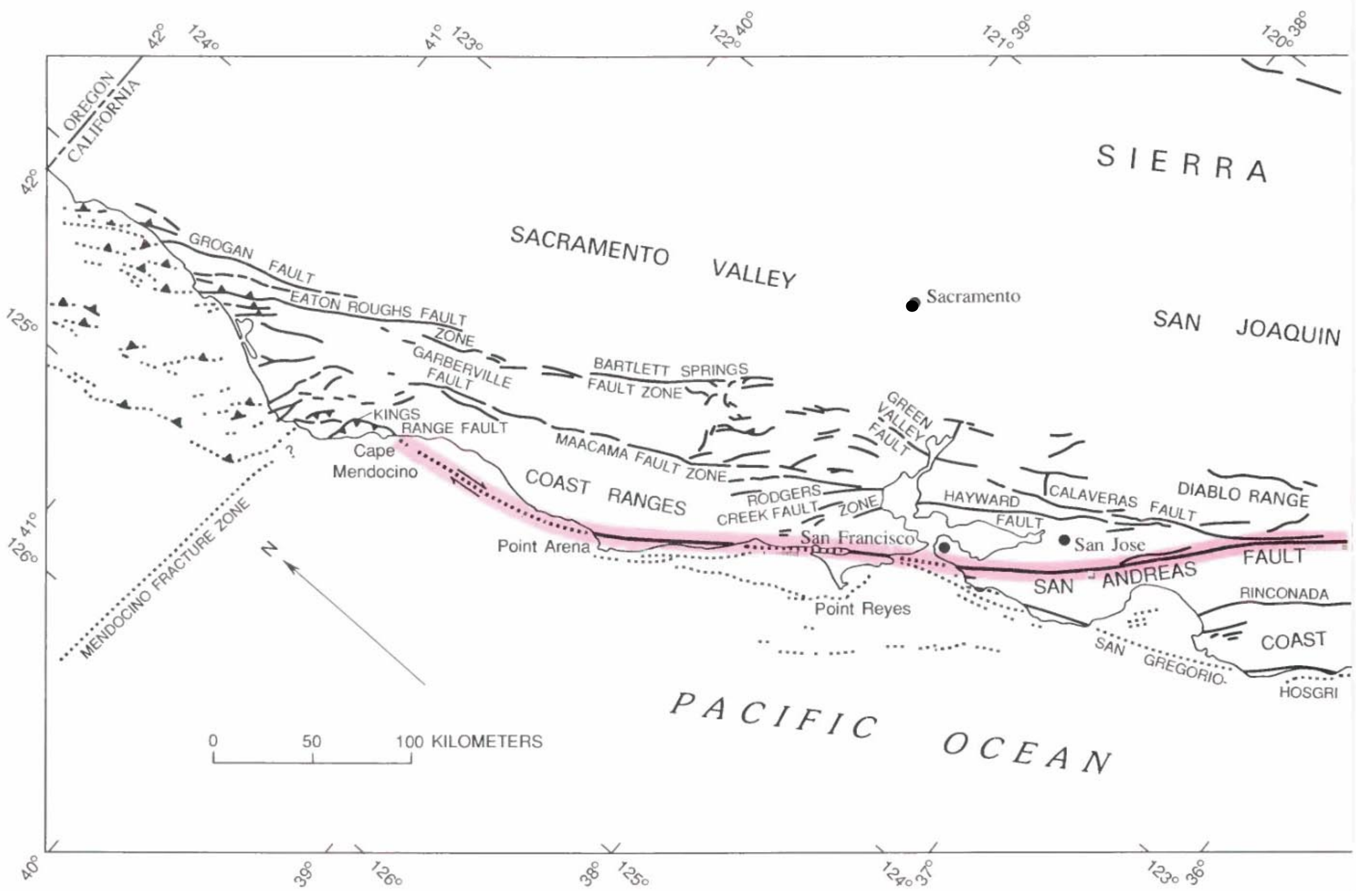


FIGURE 1.3.—The San Andreas fault system in California. Arrows on San Andreas fault (red) indicate direction of relative movement.

PRINCIPAL TRENDS

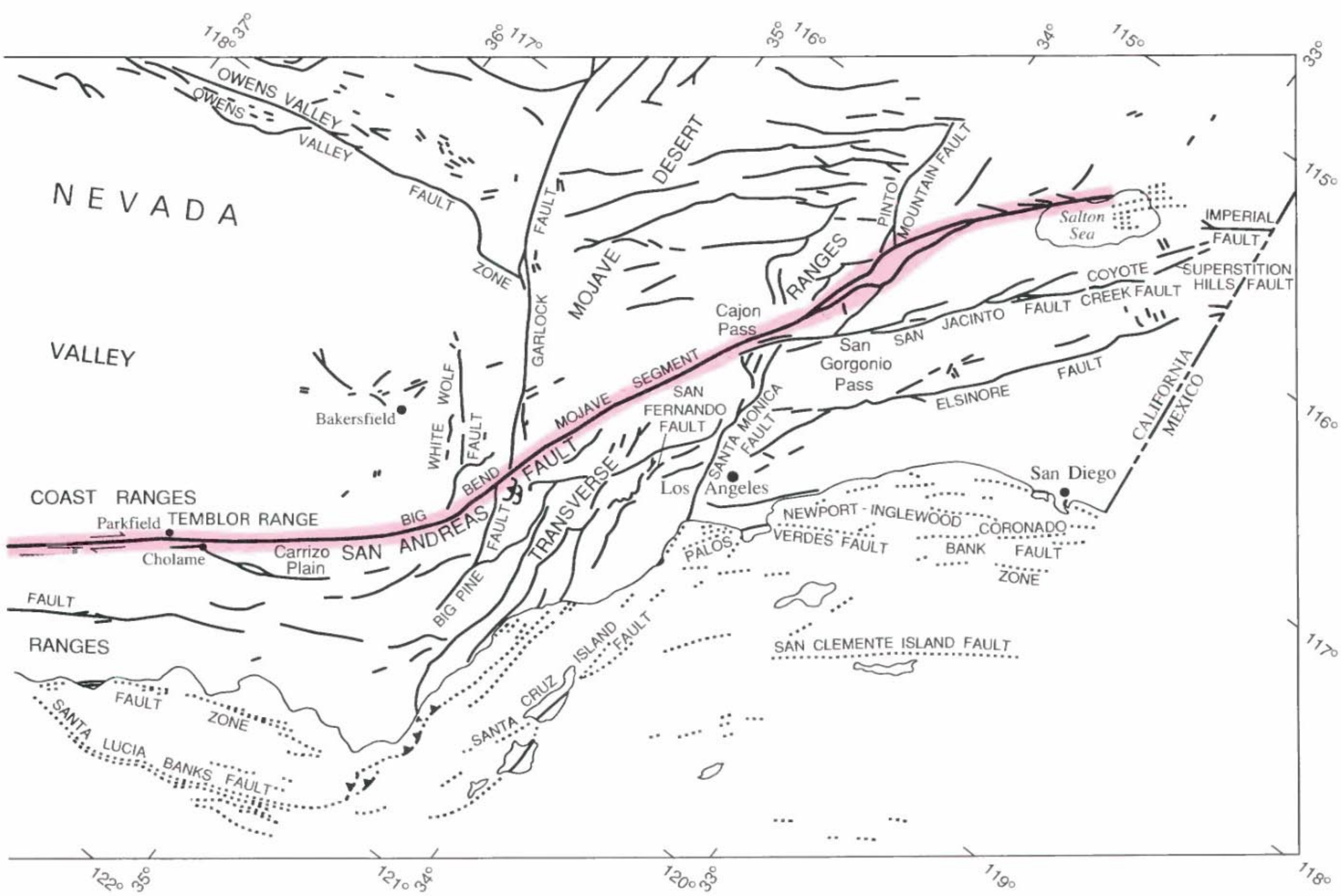
With some notable exceptions, the fault trends about N. 35°–40° W. (fig. 1.3). In its central section between the latitudes of San Jose and Bakersfield, the fault is relatively simple and straight, but farther to the south and north several branches splay from the main active trace. Near San Jose, where the fault bends about N. 50° W., the Calaveras and Hayward faults splay to the east and trend between N. 20° and 35° W. South of the latitude of Bakersfield, the main fault changes most sharply in strike, in what commonly is referred to as the Big Bend reach of the fault. For 120 km or more the fault strikes about N. 60° W., where it bounds the Mojave block on the south. This bend has significant tectonic implications (see chaps. 2 and 3, and maps at front of book).

South of the latitude of Los Angeles, the Elsinore and San Jacinto faults splay to the southeast, forming, in a general way, a reversed image of the splays in the San Francisco Bay region, although both faults trend about N. 50 W.

COMPLEXITIES OF THE FAULT SYSTEM

OTHER RELATED FAULTS

In addition to the right-lateral strike-slip faults that characterize the San Andreas fault system, faults displaying left-lateral strike slip, as well as thrust faults and reverse faults of many sizes, are present (see maps at front of book). Normal faults are less common but are present in some places, for example, in zones of extension



Faults dotted where concealed; sawteeth on upper plate of thrusts. Mendocino Fracture Zone queried where uncertain.

at the crest of folds associated with the major faults, in the bordering ranges, and at jogs in the fault where local extension is to be found.

Most conspicuous of the faults displaying left-lateral slip is the Garlock fault which intersects the San Andreas fault at about lat 35° N. and extends northeastward and eastward from there for 240 km (fig. 1.3; see maps at front of book). On the west side of the San Andreas fault, the southwest- and east-west-trending Big Pine fault joins the San Andreas fault a few kilometers northwest of the point where the Garlock fault joins the San Andreas fault.

The left-lateral Pinto Mountain fault zone joins the San Andreas fault on its east side at about lat 34° N. and extends northeastward, in a pattern not unlike that of the Garlock fault. The Blue Cut fault is another left-lateral fault in the same general area.

On a broad regional scale, thrust faults and detachments that accommodate subduction of the lower crust are significant, and various interpretations and speculations have been offered (fig. 1.4; Weldon and Humphreys, 1986; Namson and Davis, 1988). Intermediate-scale thrust faults that border the Transverse Ranges on the south side are characterized by such faults as the San Fernando fault zone (Grantz, 1971) and the Cucamonga fault zone (fig. 1.5). At the north end of the San Andreas fault system, where it joins the Mendocino Fracture Zone, such thrust faults as the Kings Range fault

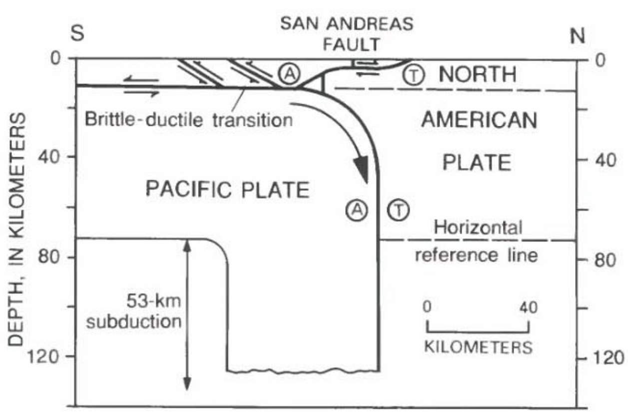


FIGURE 1.4.—Some interpretations suggest that the San Andreas fault bottoms at a detachment fault and that numerous thrust faults, as well as the San Andreas fault itself, are important elements which accommodate the relative displacements between the North American and Pacific plates (from Namson and Davis, 1988). Heavy lines, faults; arrows indicate direction of relative movement: A, away from observer; T, toward observer.

similarly accommodate crustal shortening. Smaller thrust faults that flank the San Andreas fault and dip toward it are common along many parts of the fault zone.

A range of fault types, and the complexities that typify much of the fault zone, are well illustrated near Cajon Pass and southeast of there (fig. 1.5), where the San Andreas fault zone splits into a northern and a southern branch. The strike of the San Gorgonio Pass fault zone in the east-central part of figure 1.5 changes in several places, and depending on the trend of a given segment, strike or dip slip may predominate. In this same area, the San Andreas fault, which to the northwest is relatively continuous and linear, ends as a surface feature, and the style of deformation changes from strike slip to primarily dip slip at the surface. Left-lateral slip characterizes the Pinto Mountain fault in the eastern part of figure 1.5, and small normal faults can be found throughout this area.

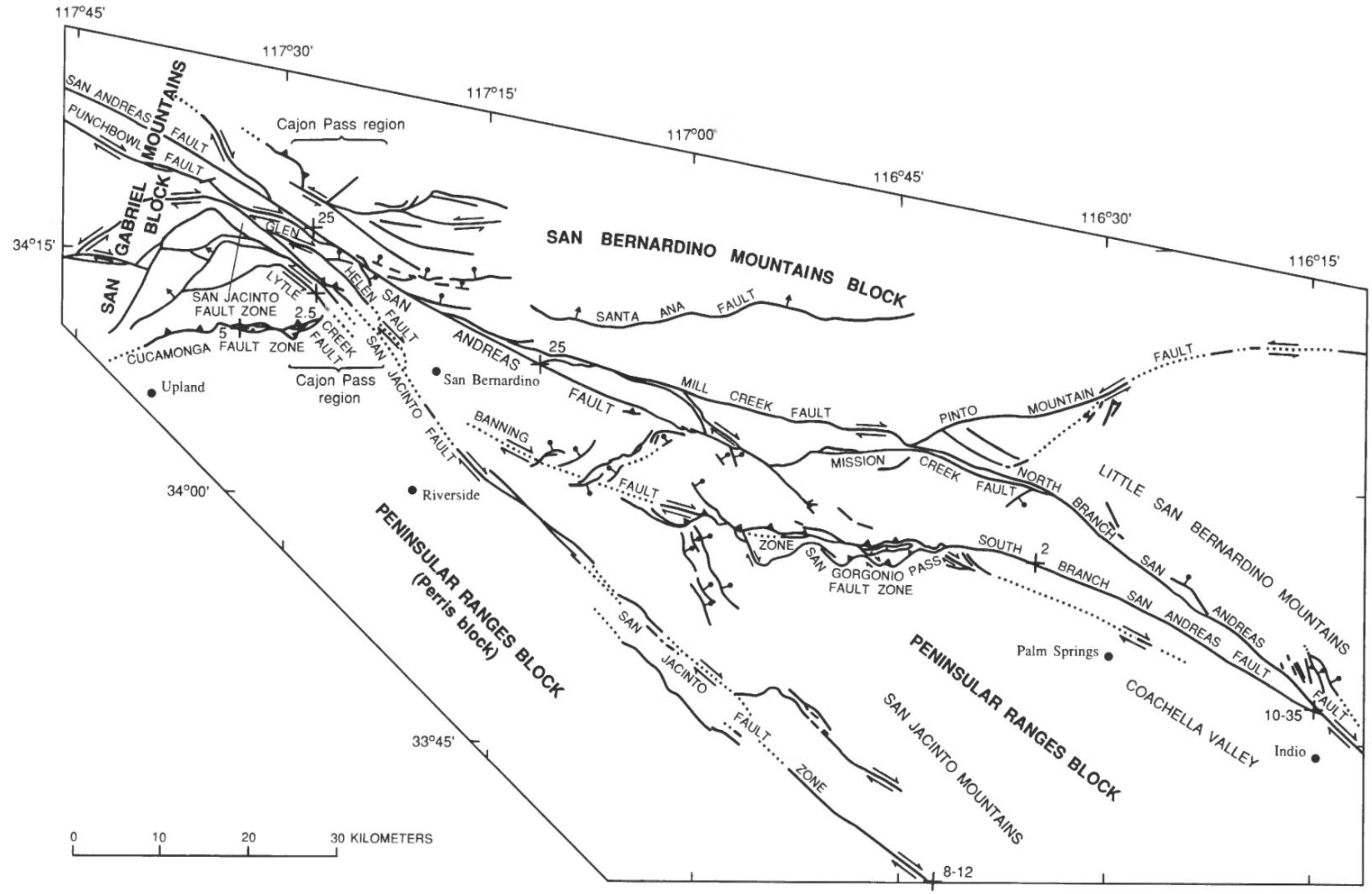
SEGMENTATION

Different behavior patterns along different parts of the fault began to be recognized when Steinbrugge and Zacher (1960) found that continuous slip or "creep" occurred along the fault in central California. Allen (1968) delineated five different regions along the San Andreas fault, three displaying seismic activity and two displaying little or no current activity. Wallace (1970) described in more detail major differences in behavior along different segments.

Large segments of the fault system that are believed to produce damaging earthquakes are illustrated in figure 1.6, which also shows an evaluation of the probabilities of earthquakes of different magnitude along these major segments of the San Andreas fault and three of its branches, the Hayward, San Jacinto, and Imperial faults. Both historical seismicity and paleoseismic evidence of large earthquakes and slip rates that characterize these different segments have been used in this assessment (Working Group on California Earthquake Probabilities, 1988).

Segmentation at a scale of a few to several kilometers is shown in figure 1.7, and a cumulative plot of the segment lengths in figure 1.8. The maximum length of these segments is about 18 km, but a more significant upper range appears to be near 10 km. These mappable segments are based on relatively fresh geomorphic features considered to be "young," that is, probably less than several thousand years old.

Both left (fig. 1.7)- and right-stepping echelon patterns are displayed, and combinations or transition zones are also present. Complex patterns are common.



EXPLANATION

Fault—Dotted where concealed; queried where uncertain. Paired arrows show relative strike slip; single arrow shows dip of fault. Bar and ball are on downdropped block

Thrust fault—Dotted where concealed. Saw-teeth on upper plate

$^{2}+$ **Location of slip-rate determination and amount (mm)**

FIGURE 1.5.—Complex branching and changes in the style of faulting characterize the eastern branch of the San Andreas fault system in southern California. Although right-lateral strike slip characterizes the main San Andreas fault and its major branches, thrust faults, normal faults, and left-lateral faults are also present (modified from Matti and others, 1985).

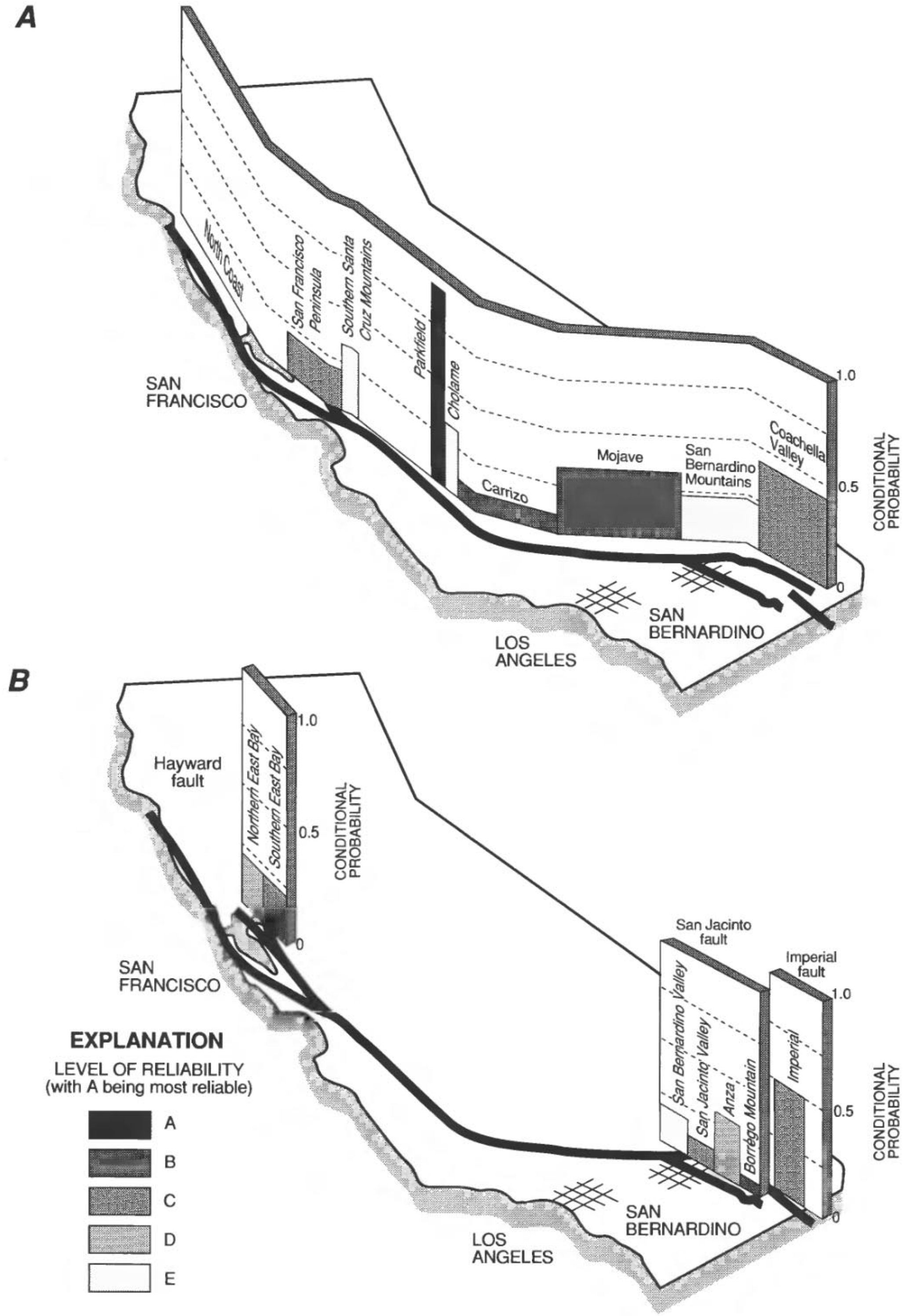


FIGURE 1.6.—Segments of the San Andreas fault system display different behavior. Here are shown conditional probabilities for the occurrence of major earthquakes along segments of the San Andreas (*A*) and the Hayward, San Jacinto, and Imperial faults (*B*) for the 30-year interval from 1988 to 2018. From Working Group on California Earthquake Probabilities (1988).

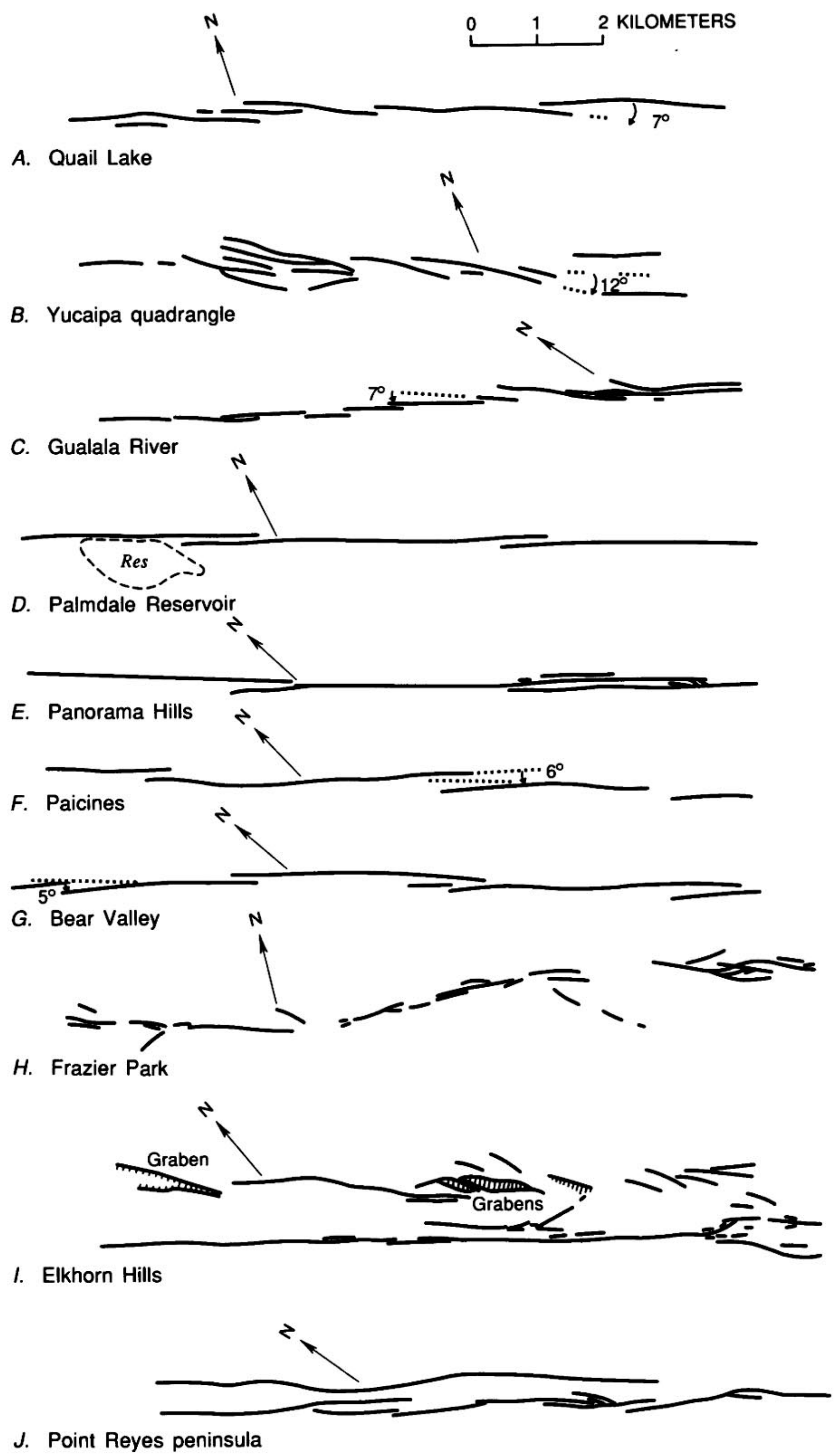


FIGURE 1.7.—Individual branches and strands of surface trace of the San Andreas fault are arranged in various patterns: *A–C*, left-stepping echelon arrangement; *D–F*, right-stepping echelon arrangement; *G*, both left- and right-stepping arrangements; *H–J*, complex arrangements of individual strands. Note that individual strands may be at an angle of as much as 12° to general trend of fault zone. Sources: *A*, *D* (Ross, 1969); *B* (Hope, 1969; see references in this chapter); *C*, *J* (Brown and Wolfe, 1972); *E*, *H*, *I* (Vedder and Wallace, 1970); *F*, *G* (Brown, 1970; see references in chap. 2).

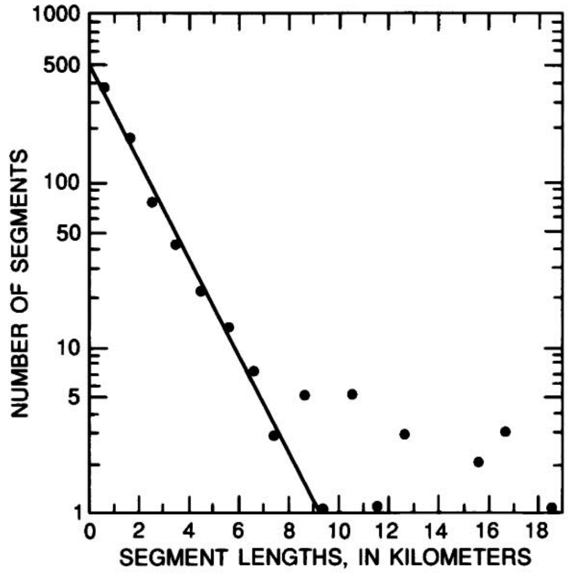


FIGURE 1.8.—Census of lengths of individual segments of the San Andreas fault. Maximum lengths are in the range 10–18 km. Line is fitted by eye to show trend of values. From Wallace (1973).

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OREGON
CALIFORNIA
Mount Shasta
KLAMATH MOUNTAINS
SAN ANDREAS FAULT
SACRAMENTO VALLEY
Reno
BASIN AND RANGE PROVINCE
Sacramento
San Francisco
SAN ANDREAS FAULT
SAN JOAQUIN VALLEY
Fresno
PACIFIC OCEAN
COAST RANGES
SAN ANDREAS FAULT
Las Vegas
Bakersfield
SAN ANDREAS FAULT
Los Angeles
EXPLANATION
ELEVATION ZONES, IN FEET
10,000
8000
6000
4000
2000
1000
0
CALIFORNIA
ARIZONA
SAN ANDREAS FAULT
San Diego
0
50
100 KILOMETERS
UNITED STATES
MEXICO

The San Andreas fault is marked in the landscape by a series of linear valleys and mountain fronts, aligned lakes and bays, elongate ridges, and disrupted or offset stream channels.

2. GEOMORPHIC EXPRESSION

By Robert E. Wallace

CONTENTS

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REGIONAL FEATURES

On maps, aerial photographs, or satellite images, at almost any scale, the San Andreas fault zone appears as a linear scar across the landscape. At scales small enough to display the entire fault length, valleys, bays, chains of lakes and ponds, linear flanks of mountain ranges, and elongate ridges bounding one side or the other of the fault are the principal features that reveal its location.

Erosion of the softer broken and sheared rocks in the several-hundred-meters- to 1-km-wide fault zone accounts for much of the valley-like expression of the fault, but differential vertical displacements also play a major role. The ratio of local horizontal to vertical displacement may be about 10 or 20 to 1. Differential erosion of the various rock types juxtaposed by faulting also influences the geomorphic expression of the fault.

The San Andreas fault separates some mountain masses from adjacent broad regions of low relief, creating pronounced linear topographic discontinuities. Considering the large lateral displacements that have occurred, juxtaposition of some mountains against flatter, lower areas probably has come about by lateral slip. Some range-size blocks bounded by the fault, however, have risen or dropped hundreds of meters to create the linear topographic features. Elongate blocks of the crust bounded by branches and subparallel strands of the fault have been created and shuffled one block against another by both upward, downward, and lateral differential displacement within the broad shear zone. Such movements are reflected in the topography as elongate ridges and depressions. Whether lateral or vertical block displacement, or warping or folding, has dominated in the development of a specific landform, and what role erosion has played, have yet to be well analyzed for most topographic features within the fault system. Evidently, a complex interaction of tectonic, erosional and depositional processes has influenced the development of each feature, and the result is a linearity of topographic features along and parallel to the San Andreas fault.

From Point Arena southeastward to the vicinity of San Jose, Calif., the trace of the San Andreas fault is topographically conspicuous on regional maps and images as a series of linear valleys (see fig. 2.1 and maps at front of book for locations). Aligned linear valleys also mark the fault trace throughout central California between San Jose and the Carrizo Plain, but along that reach another important characteristic is that the fault trace crosses mountain ranges and major ridges at a low angle. These

◀ FIGURE 2.1.—Shaded-relief map of California and western Nevada, showing the San Andreas fault as a series of linear valleys and ridges passing through a mountainous region, the Coast Ranges, the trends of which are a low angle to the fault. To the east, between the massive Sierra Nevada and the Coast Ranges, lie the broad, flat valleys of the Sacramento and San Joaquin Rivers. Farther east, in the Basin and Range province, are myriad block-faulted mountains separated by intervening basins. Synthesized from digital terrain models of a 1:250,000-scale map series originally prepared by the U.S. Defense Mapping Agency, now maintained by the U.S. Geological Survey; compiler, Ray Batson, U.S. Geological Survey. Illumination is from north at elevation of 30°.

mountain ranges and ridges, many of which are antiformal structures, trend from 5° to 10° more westerly than the strike of the fault. Thus, the altitude of the surface trace of the fault alternately rises and falls along strike.

In the Carrizo Plain-Temblor Range area, the surface trace of the fault does not lie at the base of the range but more within the Carrizo Plain, where the surface expression of the fault is narrowest, clearest, and best defined. Offset streams are especially well preserved here; individual strands of the fault reach a maximum length, from 9 to 18 km, anywhere along the fault.

In the Big Bend area at the south end of the San Joaquin Valley, the fault trace rises to a high altitude as it passes through mountainous terrain. Along the Mojave segment to the northwest and southeast of Palmdale (see maps at front of book for locations), the fault trace is again marked by a distinct narrow, linear valley. In addition, a gross contrast between the high, rugged mountain masses of the Transverse Ranges and the relatively flat Mojave Desert block is apparent (fig. 2.1). The surface of the Mojave Desert itself stands 700 m or more above sea level and above the San Joaquin Valley. Clearly, the Mojave block has been uplifted, even though the adjacent mountain masses have risen more.

To the southeast of the Mojave segment, the San Andreas fault crosses the Transverse Ranges at a low angle and separates the high San Gabriel Mountains from the San Bernardino Mountains. An extremely complex structural knot, formed by branching of the San Jacinto fault and numerous other faults (fig. 2.1; see fig. 1.5) is reflected as a complex topographic region surrounding the Cajon Pass area, through which the San Andreas fault passes.

Southwest of the Cajon Pass area, the fault divides into a northern and a southern branch and numerous other smaller faults of different tectonic style. Each fault has its own distinctive geomorphic expression.

Southeast of the zone of major branching, the fault again is less conspicuously marked by contrasts of large topographic features, but it is readily visible on aerial photographs at scales of 1:50,000 and larger (see section below entitled "A Photographic Album of Fault Features").

LOCAL GEOMORPHIC FEATURES WITHIN THE FAULT ZONE

Within the fault zone, various geomorphic features are found that have their origin in both the lateral and vertical shuffling of fault-bounded slices, as well as in the persistent, large strike slip. These features include sag depressions and sag ponds, shutter ridges and medial ridges, offset and deflected stream channels, linear benches along valley walls, aligned notches and saddles on spurs, offset marine and river terraces, scarps, fault-controlled drainage, and folds and pressure ridges (fig. 2.2).

Along its entire length, the fault zone exhibits peculiar, anomalous drainage patterns. In regions where tectonic activity is less pronounced, streams generally flow more or less perpendicular to mountain blocks and highlands, and grade more or less regularly to the lowlands; not so along an active fault like the San Andreas. When drainage flowing from highlands meets the San Andreas fault, it is diverted subparallel to the trends of the highlands or is interrupted or blocked completely. In less active areas, erosion generally is the dominant factor in carving geomorphic forms, but displacements are so rapid within the fault zone that tectonic effects overwhelm erosion, and so the geomorphic features directly express fault movement.

Movement within the network of branching and anastomosing fault strands jostles the intervening blocks, compressing some, rotating some, or causing extension across others. Because the principal slip is horizontal and lateral, the blocks tend to be elongate parallel to the trend of the fault. Blocks under compression tend to be squeezed upward to form elongate ridges, whereas blocks under extension may drop downward to form sags, and laterally displaced slices or ridge spurs create shutters across drainage channels.

The dominantly lateral slip across the fault zone and the rate of slip, from 1 cm to a few centimeters per year, make stream channels that are offset right laterally, a common and characteristic geomorphic feature. Stream channels can be completely beheaded or merely offset while maintaining continuity of flow.

In addition to the effects of lateral slip, streams are extremely sensitive to vertical slip on faults and warping of the land surface. For example, only a small upward movement of a block on the downstream side of a fault crossing a stream may divert the stream either to the left or right, thus mimicking lateral slip on the fault. Similarly, warping of the land surface over folds adjacent to the fault or on pressure ridges within the fault zone can distort the patterns of streams. Combinations of these different tectonic processes can produce many unusual features. Both the tectonic and the erosional changes at times may occur almost instantaneously, and so the dominance of one or the other process suddenly may change. Between such periods of sudden change, very little may happen for decades or even centuries. The relative rates of erosional and tectonic processes, and the timing of sudden events, are critical to the landforms created. Some of the patterns of streams found in the Carrizo Plain area are illustrated in figure 2.3, and an example is shown in figure 2.5.

The geomorphic forms created represent the results of a continuing contest between erosional changes and changes related to fault slip, folding, and warping. Where streams are large and rainfall is greater, only displacements of hundreds of meters or more are preserved for longer than a few centuries. In desert climates, however, as in the Carrizo Plain, the rate of fault slip outruns erosion, and the effects of only a few meters of fault slip may be preserved for hundreds of years, if not millennia, where small channels cross the fault (fig. 2.4).

As an example of how erosion and sedimentation interact with the faulting process, a straight channel that formerly crossed the fault at right angles is shown after having been offset by right-lateral strike slip (fig. 2.5). The strike slip partly or temporarily dams the stream, causing upstream alluviation at C. A fresh fault scarp is formed in the vicinity of A, and successive offsets expose new scarp areas to the left of A. The dam at B is eroded, and the alluvium deposited earlier at C is dissected. As offset progresses further, the channel segment along the fault trace, between B and A, continually elongates, thus lowering the channel gradient more and more. Because of this decreasing gradient, alluvium is deposited upstream from A to and beyond C, and eventually the stream, having difficulty maintaining a channel along that elongate course, spills across the fault trace and creates a new channel more nearly in alignment with the segment upstream from the fault.

After fault movement has progressed sufficiently, the downstream segments of other channels are brought into alignment, or nearly so, with the original channel. For example, in the vicinity of D in figure 2.5, drainage flowing to the right in an adjacent channel would tend to erode headward toward C, and capture of the original

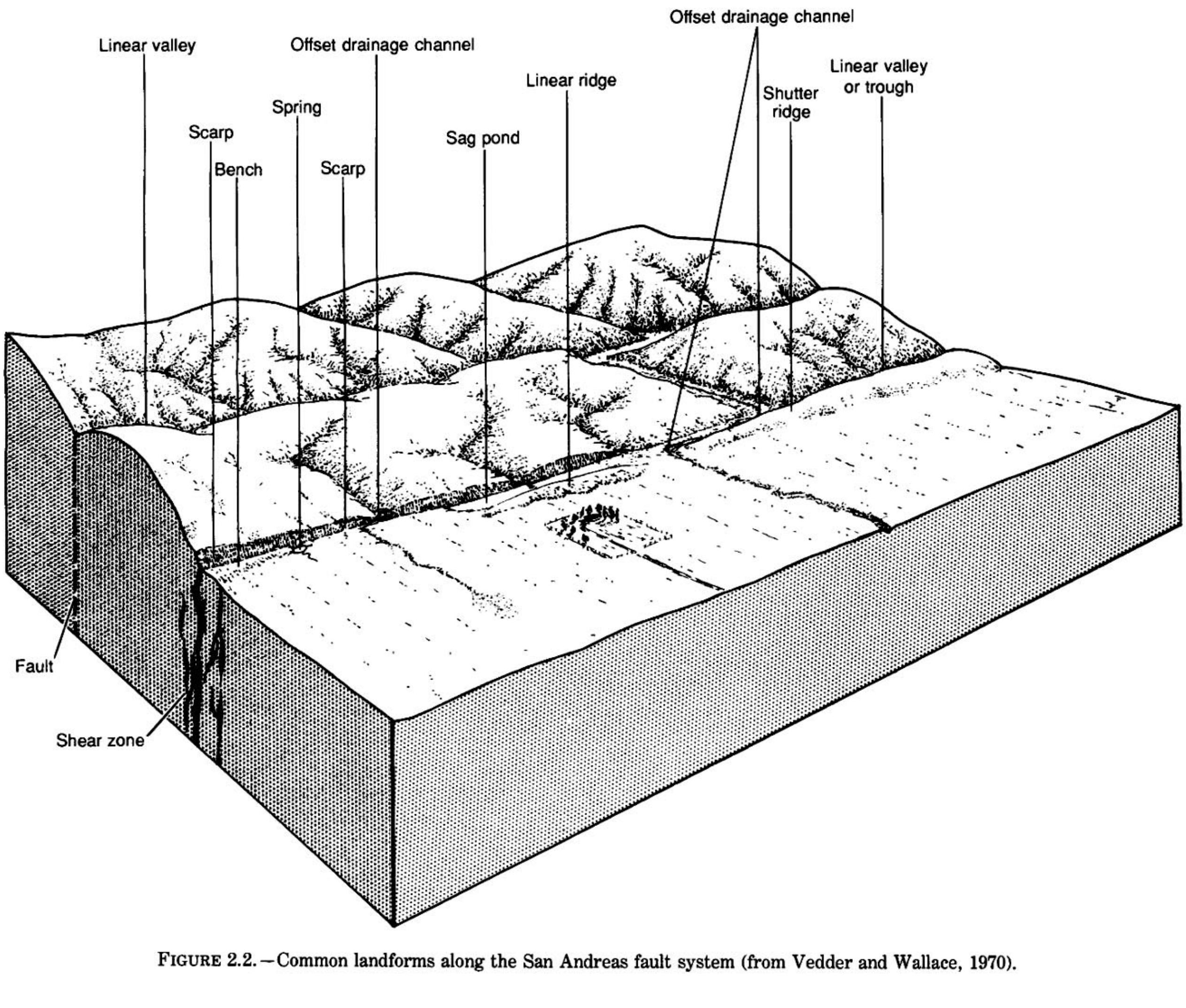
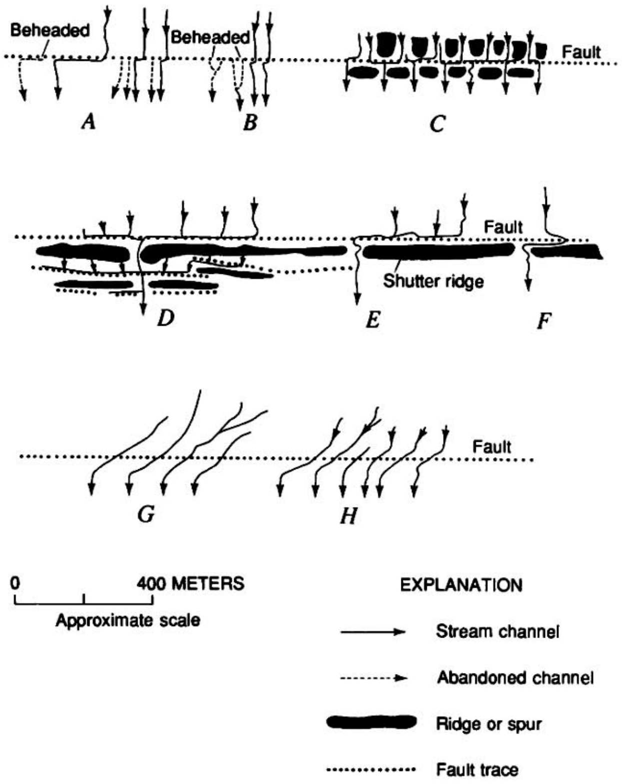


FIGURE 2.2.—Common landforms along the San Andreas fault system (from Vedder and Wallace, 1970).

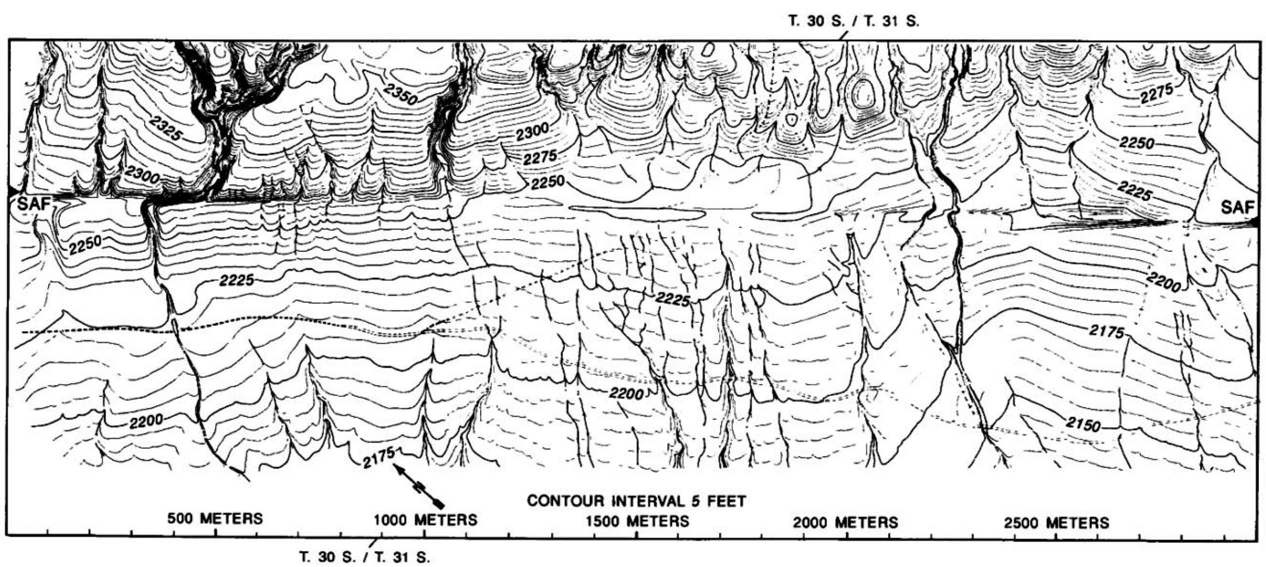


◀

FIGURE 2.3.—Diagrammatic representation of patterns of fault-related stream channels found in the Carrizo Plain area (from Wallace, 1975): *A*, misalignment of single channels directly related to amount of fault displacement and age of channel—no ridge on downslope side of fault, beheading common; *B*, paired stream channels misaligned; *C*, compound offsets of ridge spurs, and offset and deflection of channels, both right and left deflection; *D*, trellis drainage produced by multiple fault strands, sliver ridges, and shutter ridges; *E*, exaggerated or reversed apparent offset, caused by offset plus deflection by shutter ridge; *F*, "Z" pattern, caused by capture by adjacent channel followed by right-lateral slip; *G*, false offset caused by differential uplift or warping; *H*, false offset caused by echelon fractures over fault zone, followed by subsequent streamflow.

▼

FIGURE 2.4.—Topographic map of a segment of the San Andreas fault in the Carrizo Plain area, showing some characteristic small-scale geomorphic features. Markers (SAF) at the left and right margins indicate main fault trace. Between 300 and 500 m (see scale at bottom) is one of the best examples of a stream offset by right-lateral slip on the San Andreas fault (see fig. 2.20). To the northwest, between 100 and 300 m, is an abandoned channel of the same stream. To the southeast, between 600 and 700 m, small streams are offset about 10 m; a few of these streams record multiple offsets of about 8 to 10 m. The last offset presumably was during the great Fort Tejon earthquake of 1857. Between 2,150 and and 2,250 m is a pair of streams that has been offset a few tens of meters. At 2,000 m, the downstream segments of those two streams have been beheaded completely, and at 2,100 m is another possible beheaded segment of the streams (see fig. 2.21). Between 2,300 and 2,700 m is a sag depression about 7 m deep, resulting from downdrop of a narrow block into the San Andreas fault zone. From Sieh and Wallace (1987); map prepared by U.S. Geological Survey from aerial photographs taken January 13, 1966.



stream would take place. The gradient of this capturing segment, in which flow is to the right, progressively increases because right-lateral slip shortens the channel, thus accelerating erosion; at the same time, the channel flowing to the left elongates, gradient decreases, and erosion decelerates. An example of some geomorphic features that result is shown in figure 2.5.

DETAILED MAPS OF THE FAULT SYSTEM

The U.S. Geological Survey and the California Division of Mines and Geology have prepared numerous detailed maps of the faults within the San Andreas fault system. Maps prepared by the California Division of Mines and Geology address the problem of "active faults" as defined under the Alquist-Priolo Special Studies Zones Act of 1972. These maps, too numerous to list here, were indexed and described by Hart (1985); they constitute a rich data set about the San Andreas and other faults in California. Those readers interested in examining the features of the fault system in more detail or in the field are referred to the published "strip" maps and special fault maps, an index map of which is in figure 2.6.

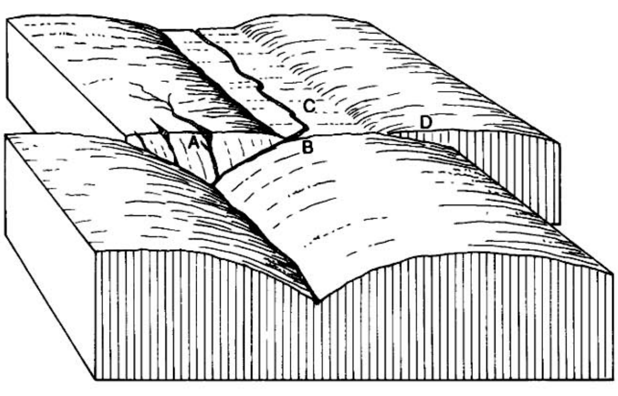


FIGURE 2.5.—General features and conditions produced where a stream channel is offset by strike slip on a fault. See text for discussion of A–D.

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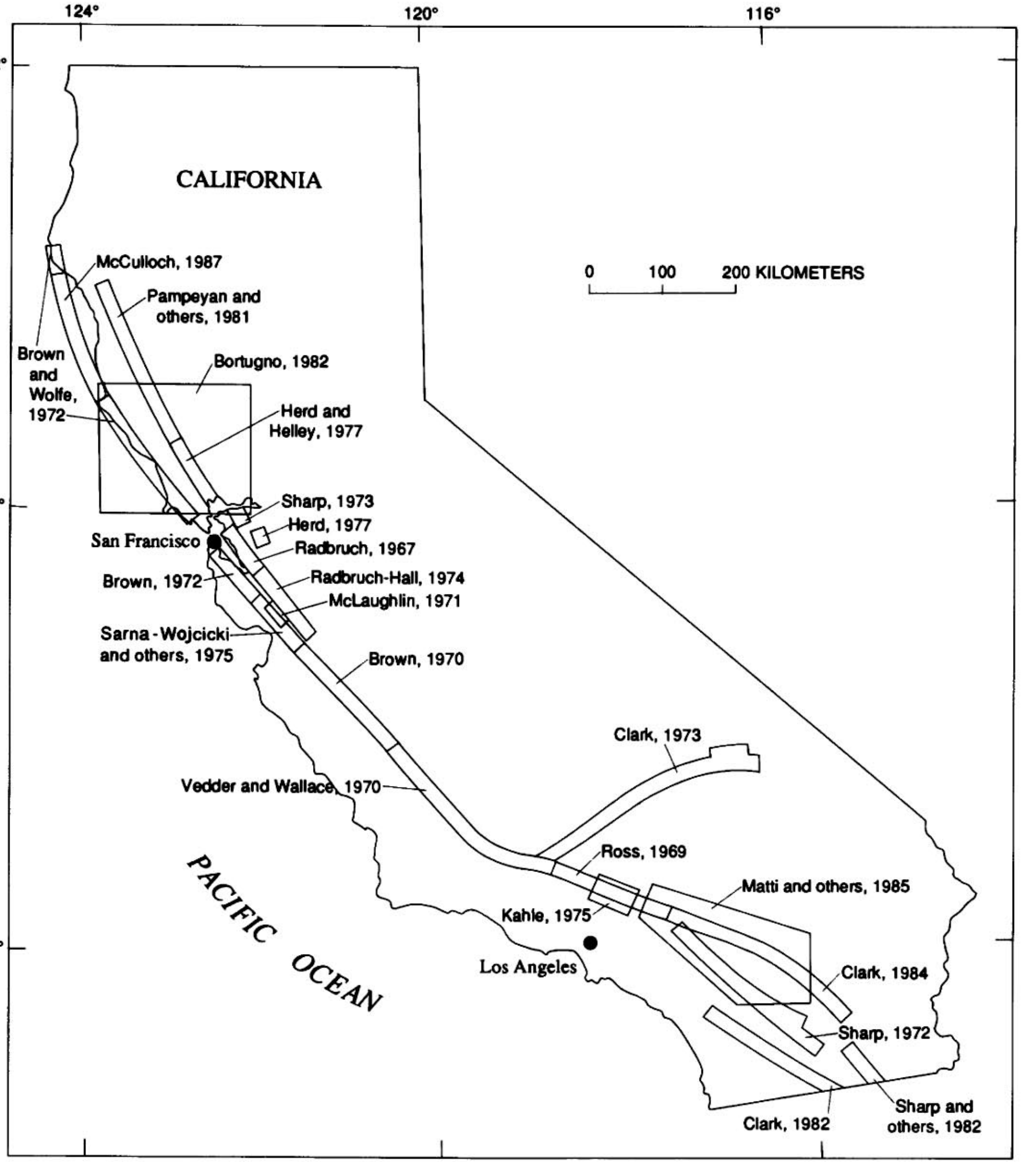

FIGURE 2.6.—Index map of California, showing locations of selected maps of surface traces of the San Andreas fault system.

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A PHOTOGRAPHIC ALBUM OF FAULT FEATURES

The characteristics of the landforms along the San Andreas fault system can be conveyed most vividly and completely by photographs, here arranged geographically from northwest to southeast (figs. 2.8–2.41). Photographs of branch faults are the last in the set. An accompanying map (fig. 2.7) shows the locations of the photographs. All photographs are my own except as otherwise credited in the captions.

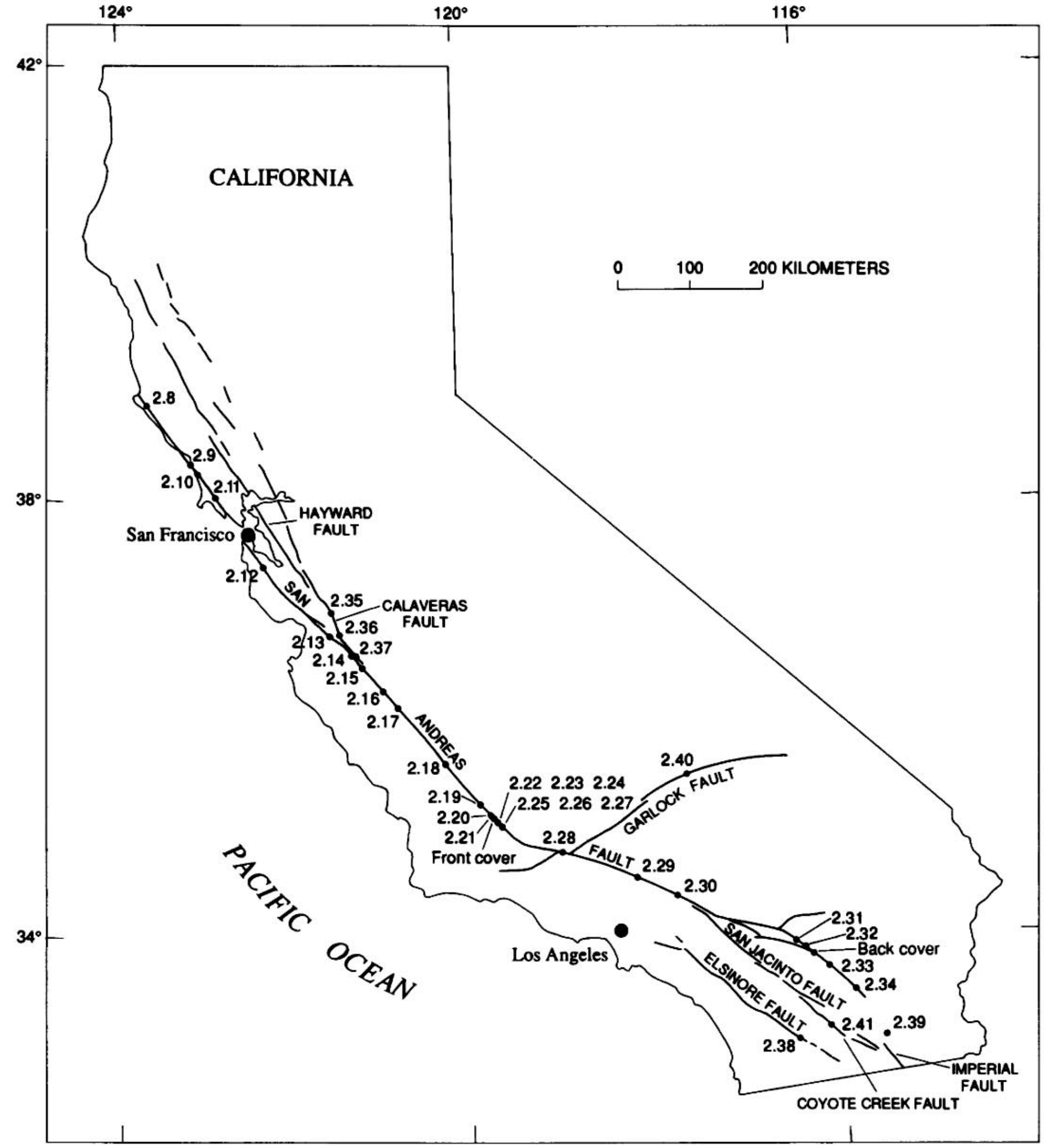


FIGURE 2.7.—Index map of the San Andreas fault system, showing locations of photographs in "photographic album" and locations of cover photographs.

FIGURE 2.8.—Valley of Garcia Creek follows trace of the San Andreas fault near Point Arena. Most recently active trace lies on west (left) valley flank in foreground. View northwestward, with the Pacific Ocean in background.

FIGURE 2.9.—A scarp facing the Pacific Ocean, with marine terraces above, marks trace of the San Andreas fault at Bodega Bay, 70 km north of San Francisco. View northwestward.

FIGURE 2.10.—Tomales Bay lies in an elongate depression along the San Andreas fault. In 1906, a maximum strike slip of 6 m on the fault was reported at the head of Tomales Bay, mid-distance in view; however, some of this slip may have been related to shifting of marshy sediment. The Point Reyes peninsula is to right (west); Mount Tamalpais is high-point in skyline at top left. View southeastward toward San Francisco, 55 km away.

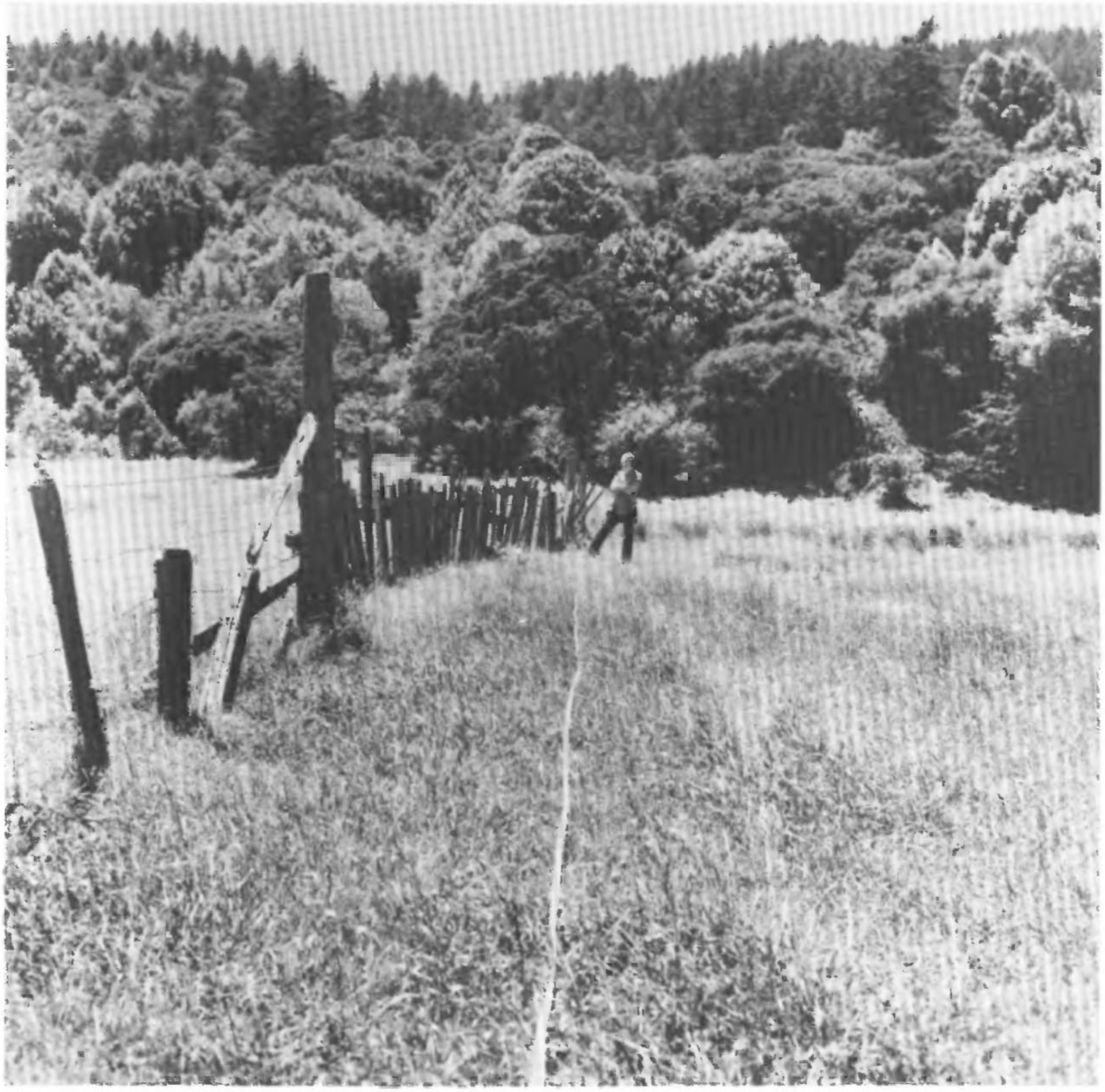


FIGURE 2.11.—A broad valley marks trace of the San Andreas fault on the Point Reyes peninsula. During the great San Francisco earthquake of 1906 , slip on one strand of the fault offset a fence about 2.5 m. Fence beyond break (west side) is relatively straight and aligned with line of view and with tape in foreground; fence on near (east) side bows gradually to meet the fault. View southwestward along fence in southern part of the Strain Ranch (Lawson, 1908, p. 70–71; Brown and Wolfe, 1972).

FIGURE 2.12.—Along the San Andreas fault zone near San Francisco. Displacement in 1906 was along linear trace on left (west) side of the Crystal Springs Reservoir (foreground). To northwest, active trace of fault bends to east side of the San Andreas Reservoir, which lies just beyond the Crystal Springs Reservoir. View northwestward.

FIGURE 2.13.—The San Andreas fault at San Juan Bautista. In 1906, southeast end of surface rupture was just north of here. Northwest limit of creeping segment of fault is now at about the same point. Active trace of fault lies along scarp at northeast (right) edge of town, which is located on a tectonic upwarp along the fault. View northwestward.

FIGURE 2.14.—Fault creep on the San Andreas fault was first reported at the Paicines Winery south of San Juan Bautista in 1960 by Steinbrugge and Zacher (1960). Fault trace (between arrows) passes under winery building, and walls of building are continually being displaced. View northwestward.

FIGURE 2.15.—The San Andreas fault about 40 km south of San Juan Bautista. Here, the Calaveras and San Andreas faults join. The Gabilan Range is on left; the San Benito River meanders across fault zone. View northwestward.

FIGURE 2.16.—The San Andreas fault about 70 km south of San Juan Bautista. The Diablo Range is on right (east); the Gabilan Range, displaying a broad, arched upland surface, is on skyline at upper left. View northwestward.

FIGURE 2.17.—From 65 to 80 km northwest of Cholame, trace of the San Andreas fault follows crest of a ridge. Fault trace is marked by a series of sag ponds, in seemingly anomalous position near crest of a major elongate topographic high. View southeastward from California Highway 198.

FIGURE 2.18.—Trace of the San Andreas fault in the Palo Prieta Pass, about 13 km southeast of Cholame. A sag pond is in foreground. View southeastward.

FIGURE 2.19.—A graben locally marks trace of the San Andreas fault near north end of the Carrizo Plain. The Caliente Range is on horizon in upper right. View southeastward.

FIGURE 2.20. — Stream offsets are well displayed along the Carrizo Plain reach of the San Andreas fault. Here, Wallace Creek, center (named by Sieh and Jahns, 1984), is offset about 130 m. To right (southeast) of the creek, small gulches are offset about 9.5 m as a result of fault slip accompanying the great Fort Tejon earthquake of 1857. See figure 2.4 for a detailed topographic map of this reach of the fault.

FIGURE 2.21.—A pair of streams that has been offset by right-lateral slip on the San Andreas fault (lineament extending from left to right edge of photograph). View northeastward across fault toward the Temblor Range. Photograph by Sandra Schultz Burford, U.S. Geological Survey.

FIGURE 2.22.—Stream channel offset by the San Andreas fault. Southwest (far) side is raised along a fault sliver, which tends to preserve incised position of stream. Mound topography is believed to be ancient modified ground-squirrel burrows. View southwestward toward the Carrizo Plain.

FIGURE 2.23.—A sigmoidal pattern of stream channel results from right-lateral offset, followed by stream capture producing left deflection, followed by further right-lateral offset. Fault extends from right to left; stream flows from bottom to top. View southwestward toward the Carrizo Plain.

FIGURE 2.24.—Multiple fault strands are common along the San Andreas fault. Four parallel strands are reflected geomorphically here in the Carrizo Plain area. Nearest, most recently active strand (latest displacement in 1857) displays deflection of streams both to right and left. Although right-lateral slip causes displacement, either stream capture, surface warping, or uplift of downstream side can deflect drainage to either right or left. View southwestward.

FIGURE 2.25.—Linear scar marks trace of the San Andreas fault in the Carrizo Plain area. Large stream entering fault zone from left has been displaced by movement on fault to debouch on right (southwest) side into the Carrizo Plain, thus displaying right-lateral slip. View southeastward.

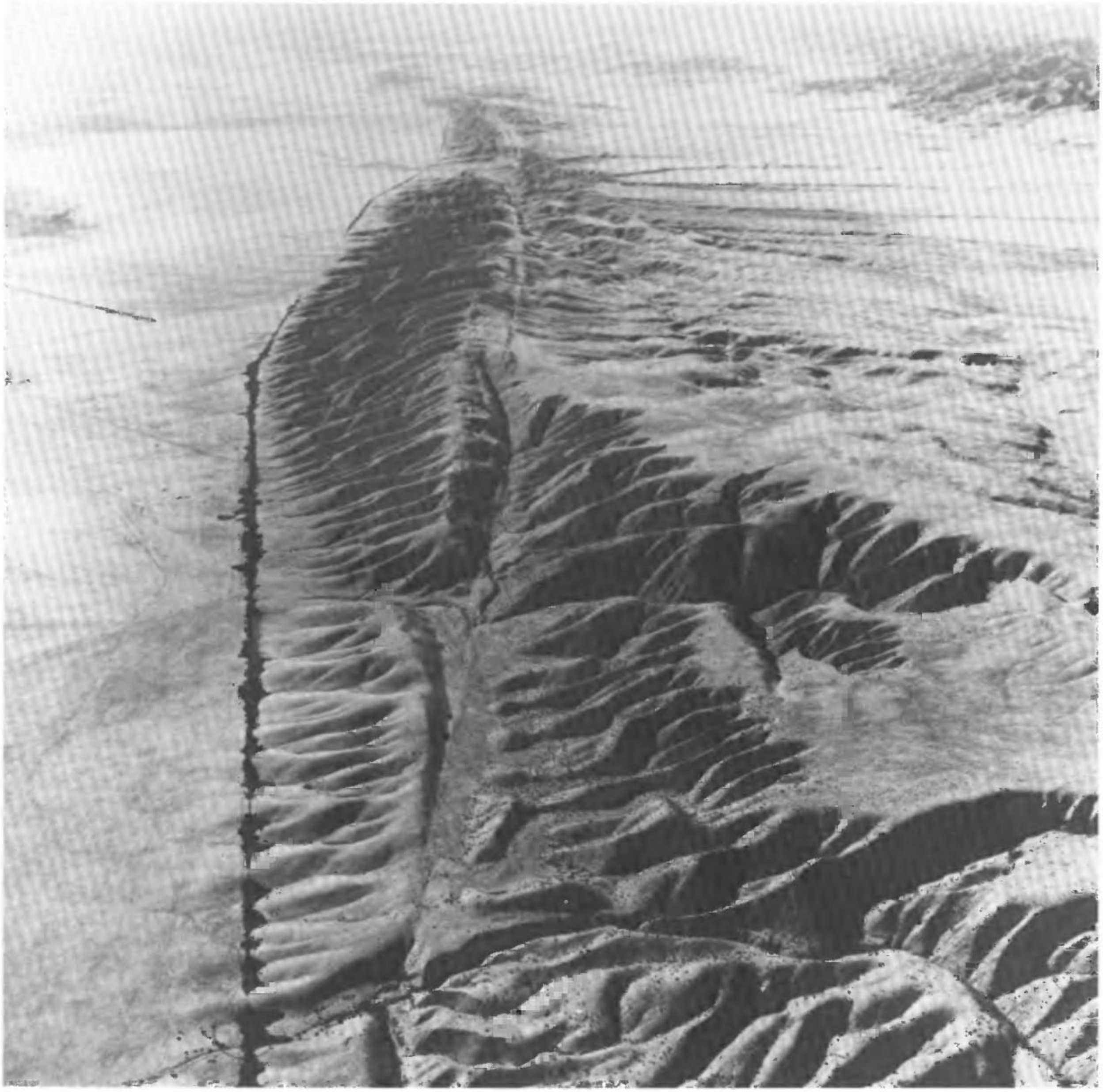


FIGURE 2.26.—The San Andreas fault on east edge of the Carrizo Plain. Rugged, dissected terrain west (left) of fault trace is the Elkhorn scarp. The Elkhorn Plain is to right in distance (see Vedder and Wallace, 1970).

FIGURE 2.27.—A complex expression of the San Andreas fault forms west flank of the Elkhorn Hills. Upwarping of hills, in combination with echelon fractures along the San Andreas fault zone, helped control drainage. View southeastward.

FIGURE 2.28.—In the Big Bend region of the San Andreas fault, the Garlock fault, which has left-lateral slip, branches eastward. Junction of these two great faults is near center (circle); trace of the Garlock fault extends to left (east), and that of the San Andreas fault (between arrows) extends east-southeastward from lower right to upper left corner of photograph. Light-colored mountain just west of fault junction is Fraser Mountain, an isolated thrust block placed there by compression across the Big Bend. U.S. Air Force photograph, taken November 27, 1967.

FIGURE 2.29.—The Palmdale Reservoir lies along the San Andreas fault north of the San Gabriel Mountains. The Mojave Desert is to northeast (right), and a series of ridges lies between the fault and the desert basin. View northwestward.

FIGURE 2.30.—The San Andreas fault on northeast flank of the San Gabriel Mountains. View northwestward from Jackson Lake (foreground) toward Palmdale.

FIGURE 2.31.—Northern branch of the San Andreas fault in northern Coachella Valley. The San Gorgonio Pass is at left horizon, and the San Bernardino Mountains are at center of horizon. View northwestward.

FIGURE 2.32.—The San Andreas fault (between arrows) in northern Coachella Valley, disrupts drainage, offsetting and beheading many channels. Mount San Jacinto is in center distance; the San Gorgonio Pass, a fault-controlled pass, is at right in the distance. View westward; U.S. Geological Survey photograph, taken November 15, 1956.

FIGURE 2.33.—The San Andreas fault in badlands of the Mecca Hills, Coachella Valley. Sympathetic slip of as much as 1+ cm occurred here during the Borrego Mountain and Imperial Valley earthquakes of 1968 and 1979, respectively.

FIGURE 2.34.—The San Andreas fault near the Salton Sea, Imperial Valley. Salt Creek is in foreground; Bat Cave Buttes are dark hills at left, and the Salton Sea is in distance. View southeastward.

FIGURE 2.35.—The Coyote Lake Reservoir lies in a topographic trough along the Calaveras fault a few kilometers east of Morgan Hill, Calif. View eastward across fault.

FIGURE 2.36.—Creep of about 1 cm/yr on the Calaveras fault in Hollister, Calif., has bowed walls, sidewalks, streets, and houses. View eastward at Sixth Street.

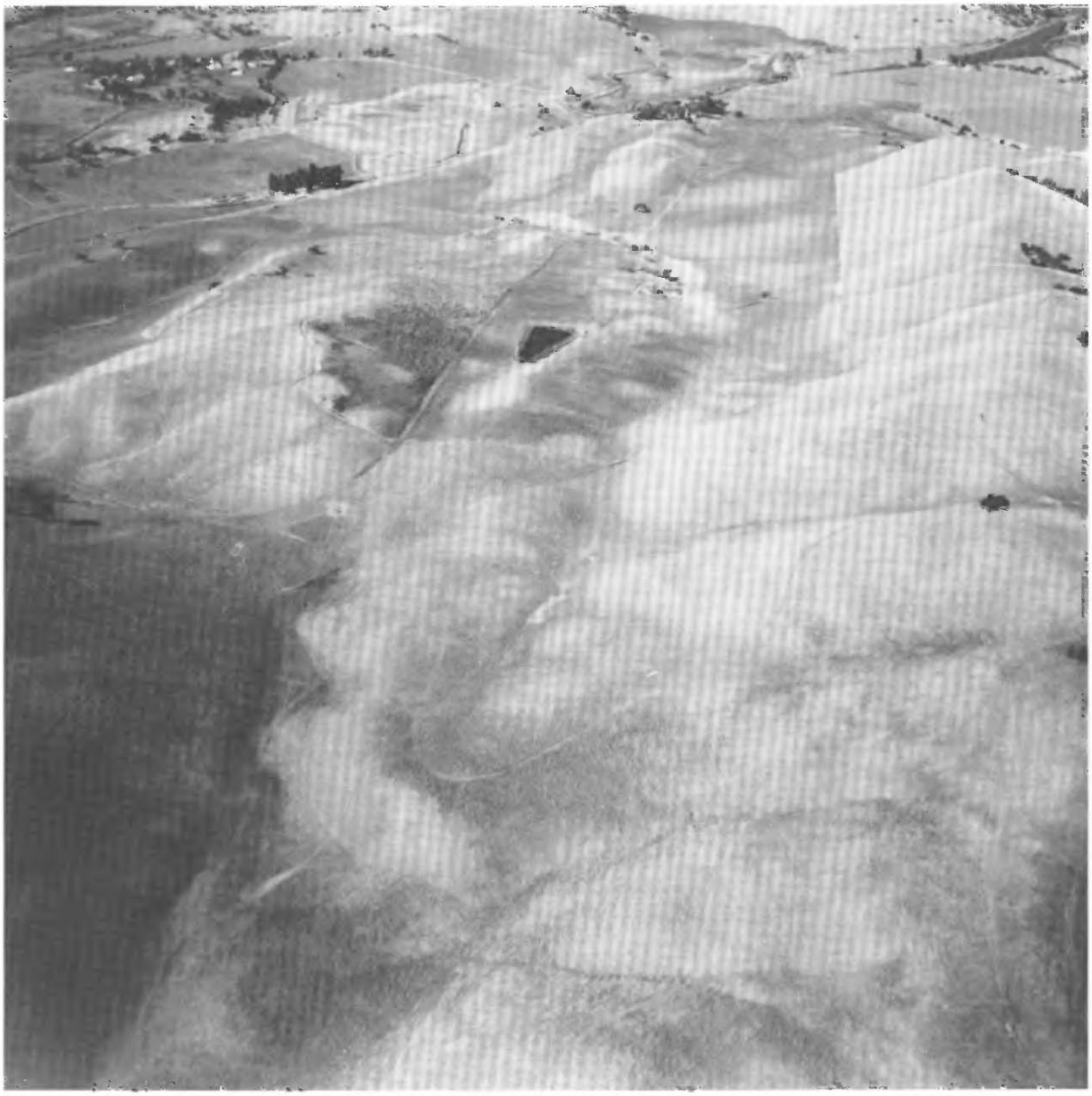


FIGURE 2.37.—Valleys and ponds mark trace of the Calaveras fault (first referred to at this location as the Paicines fault). View northwestward toward village of Paicines (top).

FIGURE 2.38.—The Elsinore fault just north of the United States-Mexican border is not as conspicuously displayed as the San Andreas and San Jacinto faults; however, this fault markedly influences the topography. Here, a major valley is eroded in the general fault zone, but traces of late Quaternary displacement are not as obvious as farther northwest along fault. U.S. Geological Survey photograph, taken October 13, 1956.

FIGURE 2.39.—Imperial fault south of the Salton Sea, southern California. During the Imperial Valley earthquake of October 15, 1979, surface rupture occurred along fault trace (black-and-white line). Bull's-eye denotes epicenter. From U.S. Geological Survey (1982, cover). U.S. Air Force photograph, taken July 17, 1968.

FIGURE 2.40.—Linear ridges and undrained sags mark trace of the Garlock fault along north edge of the Mojave Desert. Note left-lateral offset of gulches. View southwestward.

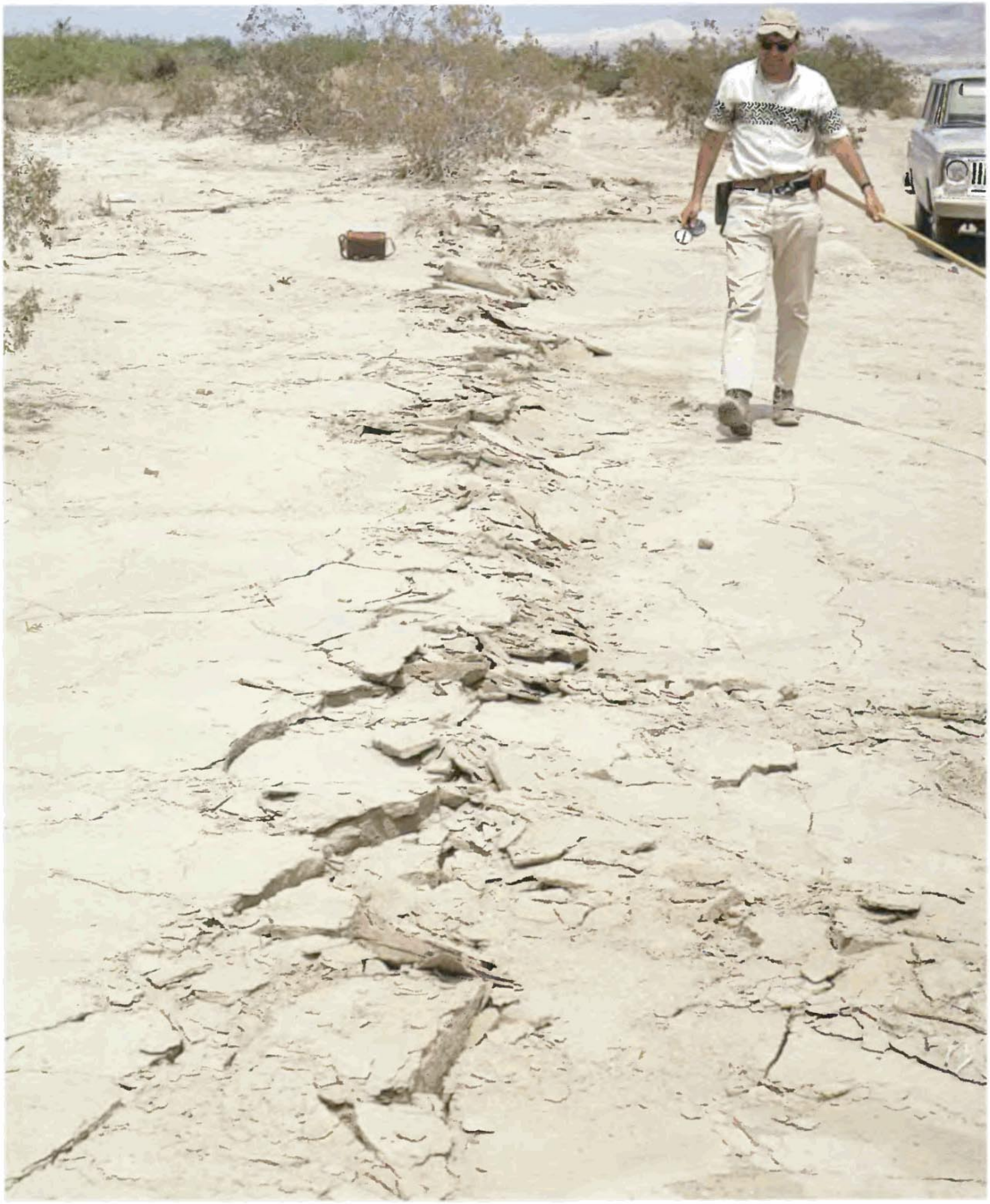
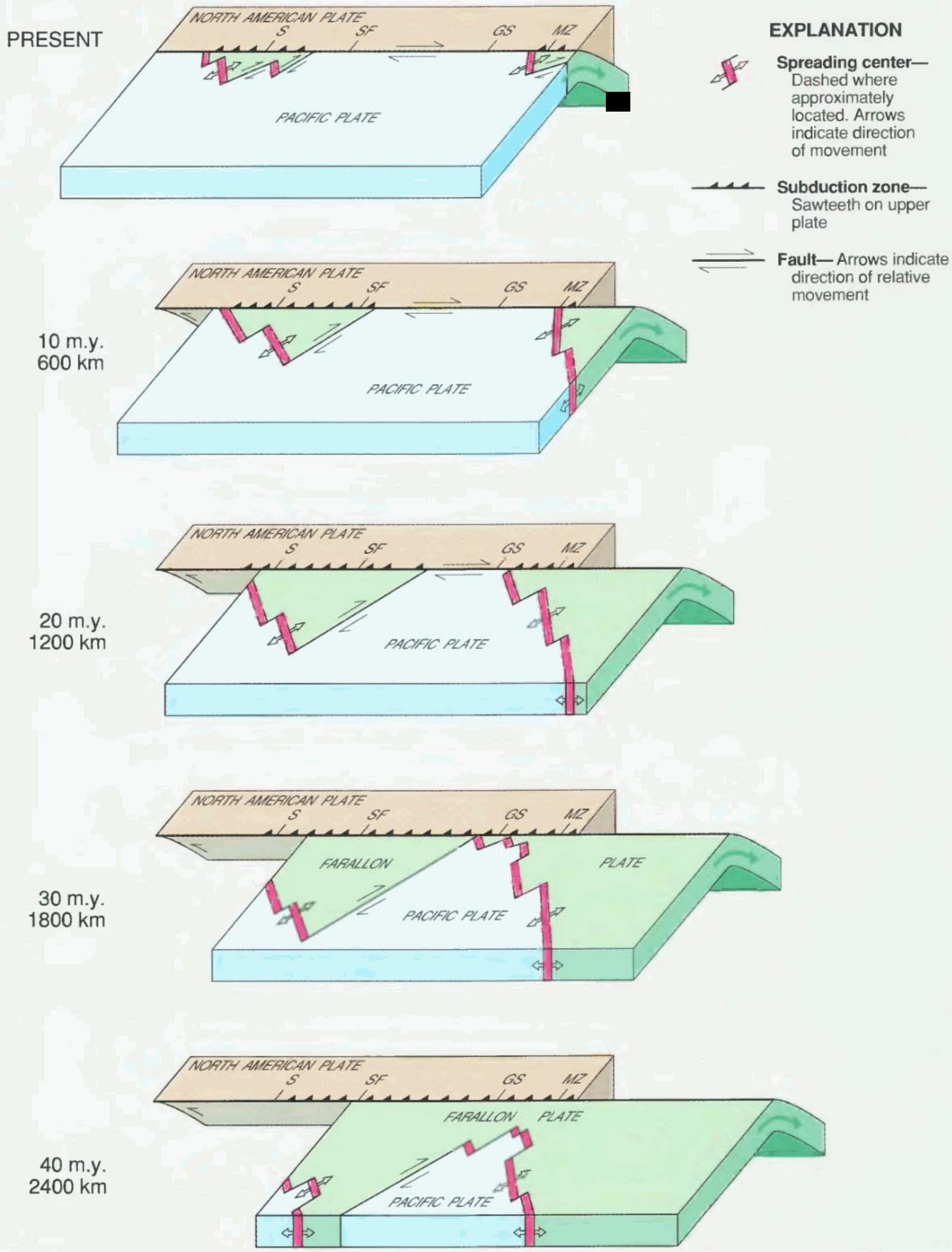


FIGURE 2.41.—Right-lateral slip accompanying an earthquake creates characteristic echelon fractures and zones of compression that produce a "mole track." This mole track formed along the Coyote Creek fault during the Borrego Mountain earthquake of 1968.


PRESENT
NORTH AMERICAN PLATE
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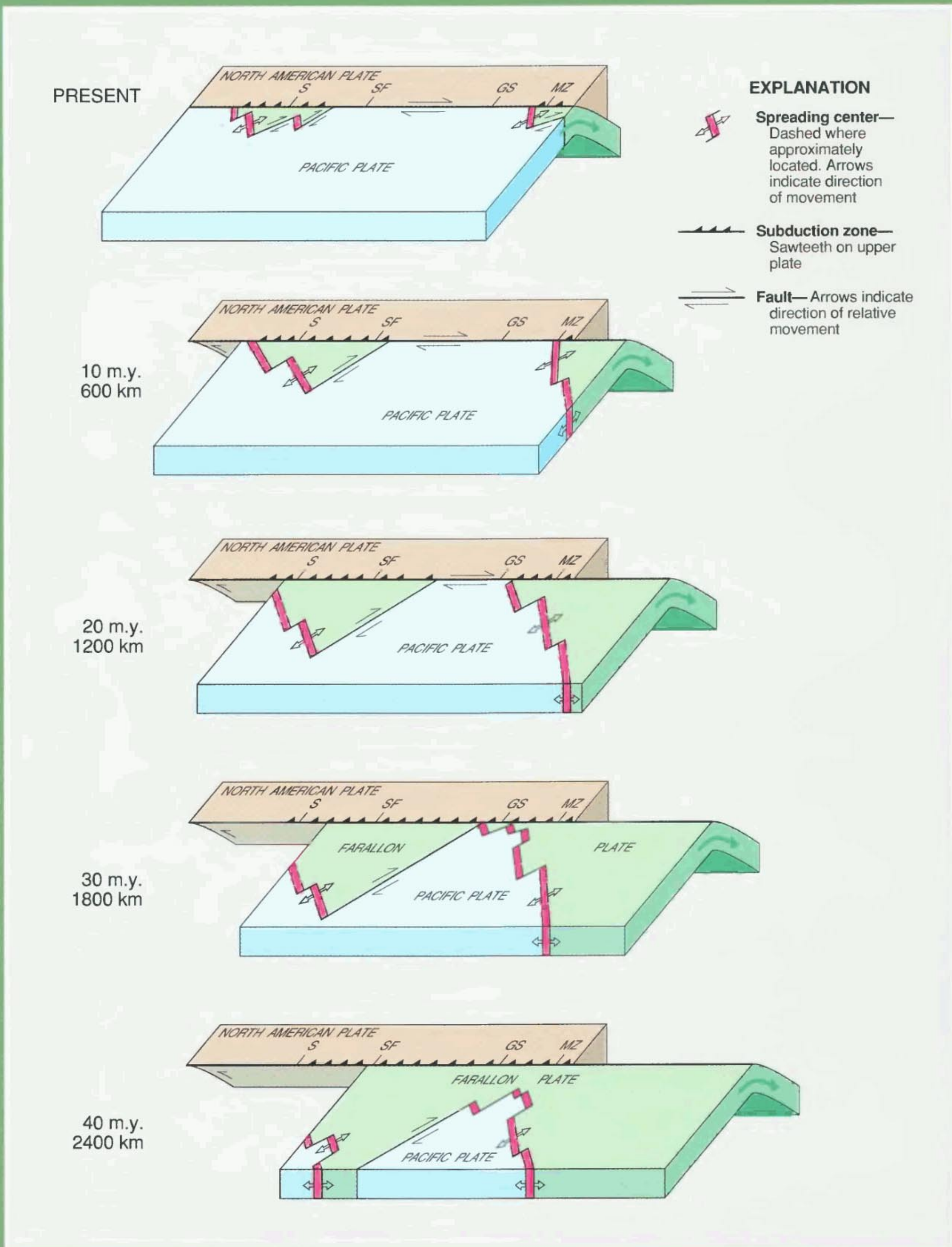
PACIFIC PLATE
10 m.y.
600 km
20 m.y.
1200 km
30 m.y.
1800 km
FARALLON
PLATE
40 m.y.
2400 km
FARALLON PLATE
EXPLANATION
Spreading center—
Dashed where approximately located. Arrows indicate direction of movement
Subduction zone—
Sawteeth on upper plate
Fault— Arrows indicate direction of relative movement


PRESENT
NORTH AMERICAN PLATE
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PACIFIC PLATE
EXPLANATION
Spreading center— Dashed where approximately located. Arrows indicate direction of movement
Subduction zone— Sawteeth on upper plate
Fault— Arrows indicate direction of relative movement
10 m.y.
600 km
NORTH AMERICAN PLATE
S
SF
GS
MZ
PACIFIC PLATE
20 m.y.
1200 km
NORTH AMERICAN PLATE
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PACIFIC PLATE
30 m.y.
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FARALLON
PLATE
PACIFIC PLATE
40 m.y.
2400 km
NORTH AMERICAN PLATE
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FARALLON PLATE
PACIFIC PLATE

The San Andreas fault is a transform fault along the boundary between the Pacific and North American plates. Bedrock along the fault includes various lithologic units that range in age from Precambrian to Tertiary and younger. Some bedrock units that can be matched across the fault suggest strike-slip displacement of as much as 560 km.

3. GEOLOGY AND PLATE-TECTONIC DEVELOPMENT

By William P. Irwin

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INTRODUCTION

The great scar across the land of California, extending from the Gulf of California to Point Arena on the north coast, was recognized as a major fault during early geologic study of the San Francisco peninsula; it was named for San Andreas Valley, which lies a few kilometers south of San Francisco. Interest in the San Andreas fault was heightened as a result of movement on the fault, in some places as much as 5 m of strike-slip displacement, that occurred during the great San Francisco earthquake of 1906. Because of this earthquake, a concerted study was carried out by several leading geologists of that time (Lawson, 1908) that dramatically increased our knowledge of the regional extent and general features of the fault. Much controversy ensued during the following decades as to the time of origin of the fault, the magnitude of cumulative displacement along it, and, indeed, even whether the displacement might be principally dip slip rather than strike slip. An early proponent of substantial lateral movement on the San Andreas fault was Levi Noble (1927) of the U.S. Geological Survey, who suggested a 38-km right-lateral displacement based on the similarity of Tertiary strata on opposite sides of the San Andreas fault at Cajon Pass and Rock Creek (lat 34°26' N., long 117°50' W.). Substantial lateral offset of Quaternary terraces along the Mojave segment of the fault was recognized by R.E. Wallace (1949) while working on his Ph.D. thesis at the California Institute of Technology. He estimated a slip rate of 0.4 cm/yr, which he extrapolated to 120 km of right-lateral slip since mid-Tertiary time (approx 30 Ma). In 1953, a benchmark

◀ Figure 3.1.—Sequential diagrams showing interactions between the North American, Farallon, and Pacific plates, assuming a constant relative motion of 6 cm/yr parallel to the San Andreas fault (modified from Atwater, 1970). Position of the North American plate in each time frame is relative to those of the Farallon and Pacific plates rather than to outlines of diagram. Lengthening interface between the North American and Pacific plates, shown in three upper diagrams, represents the San Andreas transform fault. Captions for each step indicate amount of time and lateral movement necessary for the North American plate to reach its present position relative to the Pacific plate. GS, Guaymas; MZ, Mazatlán; S, Seattle; SF, San Francisco.

paper by M.L. Hill and T.W. Dibblee, Jr., of the Richfield Oil Corp. cited various evidence for great right-lateral offset along the San Andreas fault and speculated that the total offset amounts to 560 km or more since Jurassic time.

During middle and late 1960's, a time of great ferment of concepts regarding the plate-tectonic development of the planet Earth, the foundation was laid for much of the present view of the tectonics of California and the San Andreas fault. A highly significant breakthrough to our understanding of the development of the fault system was the brilliantly simple construction by J. Tuzo Wilson (1965, fig. 9), who showed the San Andreas fault as a transform fault connecting two spreading oceanic ridges (figs. 3.1, 3.2). This view was soon modified by McKenzie and Morgan (1969) and Atwater (1970) to account for the effects of migrating triple junctions and for the timing, rates, and vectors of plate movement. Their plate-tectonic analysis of the San Andreas fault was based on calculations of plate motions between North America, Africa, India, Antarctica, and the Pacific, and many land-based geologists of the time would have agreed that it seemed "outrageous" to be "studying the San Andreas fault by using data that is no closer to California than 7,000 km" (Atwater and Molnar, 1973).

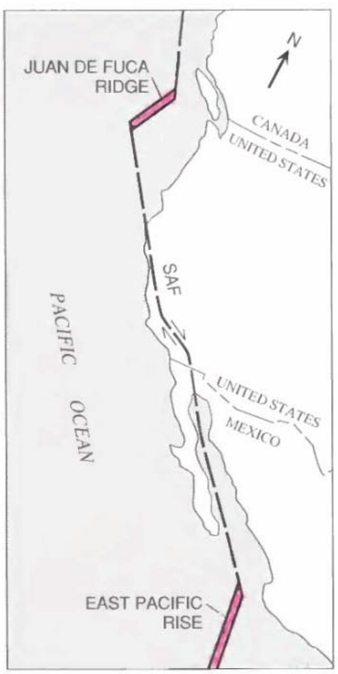


FIGURE 3.2.—Sketch map of part of the Pacific coast of North America, showing J. Tuzo Wilson's early idea of the San Andreas fault (SAF) as a right-lateral (arrows) transform fault connecting the termination of two spreading centers represented by the East Pacific Rise and the Juan de Fuca Ridge (modified from Wilson, 1965).

GEOLOGIC FORMATIONS

On its path through nearly the length of California, the San Andreas fault separates major crustal blocks (fig. 3.3). In much of northern and central California, the fault is a southeast-trending boundary between the Salinian block of granitic and metamorphic rocks on the west and the Franciscan assemblage and overlying strata of the Great Valley sequence on the east. In its southerly course the fault abruptly curves eastward to cut diagonally across the Transverse Ranges, and then splays into several auxiliary faults before the main strand terminates near the Gulf of California. In southern California the basement rocks cut by the San Andreas fault are mostly Precambrian and younger metamorphic and plutonic rocks, and the crustal blocks on either side of the fault generally do not show the distinctive lithologic contrast that is so striking in central and northern California.

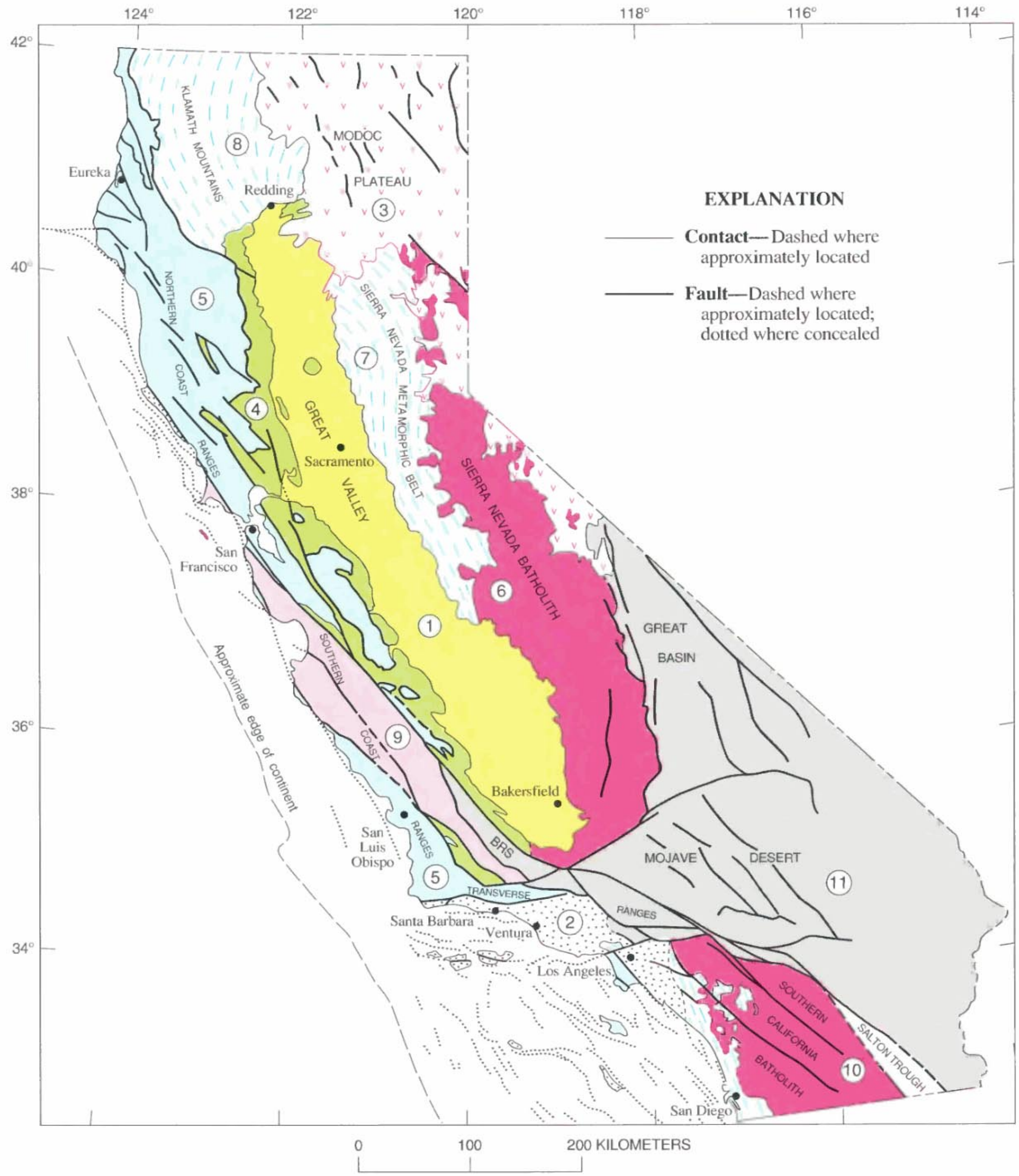
▶

FIGURE 3.3.—Geologic sketch map of California, showing distribution of principal basement rocks. Cenozoic cover not shown except for the Modoc Plateau, northeastern Sierra Nevada, Great Valley, and Santa Barbara-Ventura Basin. Based on U.S. Geological Survey (1966), Jennings and others (1977), and Ross (1984). Units: 1, Quaternary alluvium—shown only in Great Valley; 2, basement rocks concealed by thick Upper Cretaceous and Tertiary deposits in the Santa Barbara, Ventura, and Los Angeles Basins; 3, Cenozoic volcanic rocks of the Modoc Plateau; 4, Great Valley sequence—Lower Jurassic to Upper Cretaceous strata, including Coast Range ophiolite at base; 5, Franciscan assemblage of Lower Jurassic to Tertiary oceanic rocks; 6, Sierra Nevada batholith—dominantly Cretaceous granitic rocks; 7, Sierra Nevada metamorphic belt—early Paleozoic to Late Jurassic rocks, including fragments of ophiolites, island arcs, and melanges, intruded by Mesozoic plutons; 8, Klamath Mountains—early Paleozoic to Late Jurassic ophiolites, island arcs, and melanges, intruded by early Paleozoic to Cretaceous plutons; 9, Salinian block—dominantly Cretaceous plutons intruding metamorphic rocks of questionable age (Barrett Ridge slice [BRS], commonly shown as part of the Salinian block, is here shown as part of unit 11); 10, southern California batholith—dominantly Cretaceous plutons intruding sedimentary and volcanic rocks of Jurassic age and metamorphic rocks of mostly unknown age; 11, mainly Precambrian metamorphic and plutonic rocks, in part overlain by Paleozoic continental shelf deposits and intruded by Mesozoic plutons, locally underthrust in southwestern part of region by schist (similar in lithology to the Pelona Schist) of probable Cretaceous age.

NORTHERN AND CENTRAL CALIFORNIA

FRANCISCAN ROCKS

Franciscan rocks form the east wall of the San Andreas fault for virtually its entire course through the Coast Ranges of central and northern California, although the Franciscan is concealed along some reaches of the fault by overlying rocks. The Franciscan is a heterogeneous assemblage that consists largely of dismembered sequences of graywacke, shale, and lesser amounts of mafic volcanic rocks, thin-bedded chert, and rare limestone.



These rocks also occur with serpentinite and tectonic pods of blueschist in melange zones that are the locus of much shearing within the Franciscan and that generally separate blocks of the more coherent sequences. The sedimentary and volcanic Franciscan rocks were formed in a marine environment, as attested by the abundance of foraminifers in the limestone and by radiolarians in the chert. Most of these rocks are probably Late Jurassic and Cretaceous in age (Bailey and others, 1964), but some of the chert and associated volcanic rocks are as old as Early Jurassic (Pliensbachian) (Irwin and others, 1977; Blome and Irwin, 1983). In the northern Coast Ranges, some of the rocks assigned to the coastal belt of the Franciscan assemblage are as young as late Tertiary and are thought to have accreted to North America during post-middle Miocene time (McLaughlin and others, 1982). The age and origin of Franciscan melange is problematic. Mid-Cretaceous limestone in melange near Laytonville in the northern Coast Ranges, 225 km northwest of San Francisco, has a paleomagnetic inclination that indicates an origin several thousand kilometers to the south (Alvarez and others, 1980). Similarly, Franciscan pillow basalt about 45 km northwest of San Francisco is thought to have moved northward 19° of latitude (approx 2,000 km) from its site of origin (Grommé, 1984). These and other features indicate that some, possibly much, of the Franciscan has been transported great distances northward along the Pacific margin relative to a stable North America.

The Franciscan rocks are locally overlain structurally by the Coast Range ophiolite and the Great Valley sequence, and are separated from them by the Coast Range thrust (Bailey and others, 1970). The original extent of the Coast Range thrust is not clearly known because most of the ophiolite and Great Valley sequence that formed the upper plate of the thrust has been removed from the top of the Franciscan except in the general area of the Diablo antiform, which is marked by a line of windows from Mount Diablo to Parkfield, and along the west edge of the Great Valley (figs. 3.3, 3.4). A few small outliers of upper-plate rocks are present elsewhere east of the San Andreas fault as far north as Pillsbury Lake, 35 km east of Willits, and the Camp Meeker area, 17 km northeast of Bodega Head, and at several localities west of the Salinian block as far south as the Santa Ynez fault in the Transverse Ranges (see maps at front of book). Much of the serpentinite in Franciscan melange may well be sheared-in fragments of dismembered Coast Range ophiolite.

COAST RANGE OPHIOLITE

The Coast Range ophiolite represents oceanic crust on which much of the sedimentary rock of the Great Valley sequence was deposited. A complete ophiolite sequence consists of serpentinized harzburgite tectonite at the base, overlain by cumulate ultramafic and gabbroic rocks, passing upward into noncumulate gabbroic and related plutonic rocks, then into diabase dikes, and finally into pillow lavas. The Coast Range ophiolite, however, generally is highly sheared, dismembered, thinned, and locally missing, presumably as a result of faulting, at many places along the fault contact between Franciscan and Great Valley rocks. Only in a few places is a nearly complete lithologic sequence of Coast Range ophiolite preserved, and there the total stratigraphic thickness of the ophiolite is about 3 to 5 km (Hopson and others, 1981). Isotopic ages ranging from about 165 to 153 Ma (Hopson and others, 1981) indicate that the Coast Range ophiolite is Middle and Late Jurassic in age. Paleontologic and paleomagnetic evidence suggests that the Coast Range ophiolite formed in an equatorial setting and was transported great distances northward before being accreted to North America and overlain by the Great Valley sequence (Pessagno and others, 1984; Hopson and others, 1986; McLaughlin and others, 1988).

GREAT VALLEY SEQUENCE

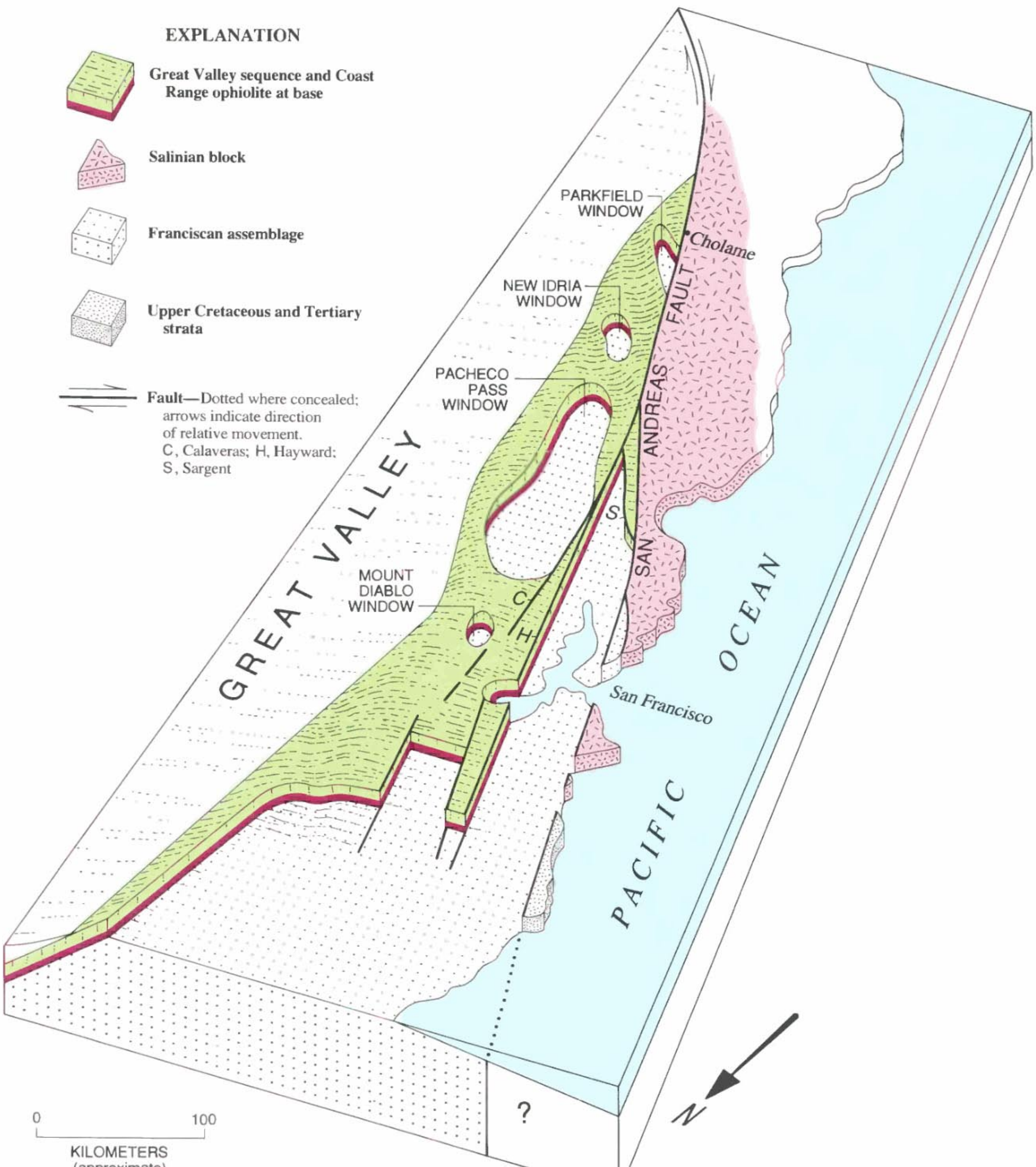
The Great Valley sequence consists of interbedded marine mudstone, sandstone, and conglomerate that range from Late Jurassic to Cretaceous in age (Bailey and others, 1964). It crops out as thick, monotonously bedded sections of strata that generally are markedly less deformed and more coherent than sedimentary sections of the Franciscan and also have greater lateral continuity. Where most fully developed, such as along the west side of the northern Great Valley, the aggregate stratigraphic thickness of Great Valley sequence is at least 12 km. The strata normally lie depositionally on Coast Range ophiolite except where disrupted by faults, but at the north end and along the east side of the Great Valley they onlap the Nevadan and older basement terranes of the Klamath Mountains and Sierra Nevada. This enormous thickness of clastic detrital material probably represents submarine fans and turbidity deposits that formed as a result of rapid erosion of the ancestral Klamath Mountains and Sierra Nevada.

▶

FIGURE 3.4.—Schematic block diagram of part of the Coast Ranges of California, showing gross structural relations between principal lithotectonic units cut by the San Andreas fault (modified from Irwin, 1977). The Coast Range ophiolite lies at base of the Great Valley sequence and is separated from underlying Franciscan rocks by the Coast Range thrust. Blueschist-facies metasedimentary and metavolcanic rocks that form border zone in the Franciscan immediately below the thrust are not shown. View southeastward along the San Andreas fault.

COAST RANGE THRUST

The upper plate of the Coast Range thrust, consisting of Great Valley sequence with Coast Range ophiolite at the base, is cut by the San Andreas fault only along the west side of the Diablo Range in central California. There, the upper plate of the Coast Range thrust forms a broad blanket over the Franciscan rocks except in



several places along the length of the Diablo Range where windows, or piercement structures, in the upper plate expose Franciscan rocks of the lower plate (fig. 3.4): at Mount Diablo, Pacheco Pass, New Idria, and Parkfield. This deformed antiformal structure (Bailey and others, 1964) is truncated on the west by the Hayward and Calaveras faults in its northern part and by the San Andreas fault in its southern part, and narrows to the southeast as the San Andreas fault converges with the south end of the Great Valley. The ophiolitic rocks are generally thinned and highly discontinuous along the faults that bound the windows except for the New Idria window, which is occupied mostly by serpentinite. South of the Pacheco Pass window, the structure is complicated by a series of west-northwest-trending synforms that cross the axis of the Diablo Range antiform at a low angle, and by multiple strands of the San Andreas fault. In the Parkfield area, the western part of the antiform has been virtually destroyed by its proximity to the San Andreas fault. The Franciscan rocks of the Parkfield window, and the associated serpentinite and Great Valley sequence of the highly dissected upper plate, now are mostly elongate fault slices that form part of the San Andreas fault zone (see Dibblee, 1980).

Most of the serpentinite of the Coast Ranges of California is related to the ultramafic parts of the Coast Range ophiolite. Serpentinite is strikingly absent along the San Andreas fault north of San Francisco, a situation that reflects the absence of the upper plate of the Coast Range thrust in that area. Although many elongate fault-bounded bodies of serpentinized ultramafic rocks in the Coast Ranges traditionally have been mapped and described as part of the Franciscan, most are probably dismembered and dislocated parts of the Coast Range ophiolite or equivalent. Recognition that the ultramafic rocks in most places belong to the Coast Range ophiolite rather than to the Franciscan assemblage is important to a tectonic analysis of the region. The common presence and possible seismotectonic significance of serpentinite along creeping segments of the San Andreas and related faults were described by Allen (1968) and Irwin and Barnes (1975).

SALINIAN BLOCK

The west wall of the San Andreas fault consists mainly of rocks of the Salinian block from the Transverse Ranges northward to Bodega Head. At the latitude of the San Francisco peninsula, the Salinian block is separated from the San Andreas fault by a narrow fault slice of Franciscan rocks (fig. 3.3). Northward, from just beyond Bodega Head to Point Arena, the rocks that crop out along the fault are chiefly Upper Cretaceous and Tertiary sedimentary strata, but because of the presence of a relatively small exposure of spilitic volcanic rocks that may be Franciscan, it is questionable whether these sedimentary rocks overlie granitic and metamorphic rocks of the Salinian block or whether they are separated from the Salinian block by another fault just off shore (Wentworth, 1968). The north end of the Salinian block off shore is thought to be at about the latitude of Point Arena (see McCulloch, 1987). At Point Delgada (see maps at front of book), which many workers consider to be the location of the northernmost onland trace of the San Andreas fault, the rocks on both sides of the fault are Franciscan.

The Salinian block is composite, consisting of central, western, and northern belts, and commonly is considered to include the Barrett Ridge slice (fig. 3.3; Ross, 1984). The basement rocks of the Barrett Ridge slice, though poorly exposed, are thought likely to be a northward continuation of the rocks of the San Gabriel Mountain area because they include similar-appearing metamorphic and granitic rocks, as well as schist similar to the Pelona Schist, along a possible exposure of the Vincent(?) thrust (Ross, 1984). The principal formations of these central, western, and northern belts are granitic and metamorphic rocks, locally overlain by Upper Cretaceous and younger strata. The metamorphic rocks, which commonly are moderate- to high-grade gneiss, granofels, impure quartzite, and minor schist and marble, probably represent a metamorphosed thin-bedded sequence of siltstone and sandstone, with lesser amounts of shaly, marly, and calcareous strata (Ross, 1978). The metamorphic rocks of the western belt are higher in metamorphic grade than those of the central and northern belts. The stratigraphic age of the protoliths of the metamorphic rocks is not known. The plutonic rocks are mostly granite and tonalite, but they range in composition to gabbro. U-Pb-isotopic measurements on zircon in the plutonic rocks indicate that plutonic activity began about 120–105 Ma in the northwestern part of the Salinian block and migrated southeastward over a period of 40 m.y., with the youngest plutons intruding the Barrett Ridge slice about 80–75 Ma (Mattinson and James, 1985).

The basement rocks of much of the Salinian block do not clearly differ from those of the Sierra Nevada, and so many workers have speculated that the Salinian block may be a displaced part of the Sierra Nevada (for example King, 1959; Page, 1981). According to Ross (1984), who compared the two terranes in considerable detail, the similarities are so great that strong data would be required to support an alternative origin. Paleomagnetic data, however, indicate that the Salinian block may have been displaced 2,500 km northward since Cretaceous time (Champion and others, 1984) and that it may have originated near the latitude of Central America or Mexico in the axial part of the Cordilleran Cretaceous plutonic arc (Page, 1982).

DISPLACEMENT OF PRE-QUATERNARY ROCKS BY THE SAN ANDREAS FAULT

The largest offset on the San Andreas fault postulated by Hill and Dibblee (1953) is 560 km, on the basis of the speculation that a contact between Sierran basement and Franciscan rocks near the south end of the Great Valley was cut by the fault and that the contact on the west side of the fault was offset northward to a point at sea north of Point Arena. This concept, however, is questionable not only because of the uncertain correlation of the Salinian block with rocks of the Sierra Nevada but also because the northernmost exposure of granitic rocks along the west side of the fault is at Bodega Head, about 90 km southeast of Point Arena, and neither the presence nor the type of a contact between Sierran-type basement and Franciscan rocks is known off shore north of Point Arena (see McCulloch, 1987). Nor is the significance clearly known of the possibly substantial lateral offset along the San Gregorio fault, which intersects the San Andreas at a low angle just west of the entrance to the San Francisco Bay. However, Upper Cretaceous strata that crop out near Gualala, on the west side of the San Andreas fault between Bodega Head and Point Arena, were thought by Ross and others (1973) also to have been offset 560 km, consistent with Hill and Dibblee's concept. The strata near Gualala include quartz-plagioclase arkose and a conglomerate characterized by unusual quartz-bearing mafic clasts, including volcanic rocks, diabase, and diorite to gabbro. Paleocurrent features indicate a source to the east of the fault. The source of the unusual gabbroic clasts is thought to be the Eagle Rest Peak area in the San Emigdio Mountains, just east of the San Andreas fault in the Transverse Ranges (fig. 3.5). This area may also be the source of relatively small fault slivers of similar mafic rocks that now lie 160 km northwest along the San Andreas fault at Gold Hill and 320 km northwest at Logan (Ross and others, 1973).

Other features that suggested substantial right-lateral offset to Hill and Dibblee (1953) include (1) the south limit of Cretaceous strata near Fort Ross, offset 512 km from

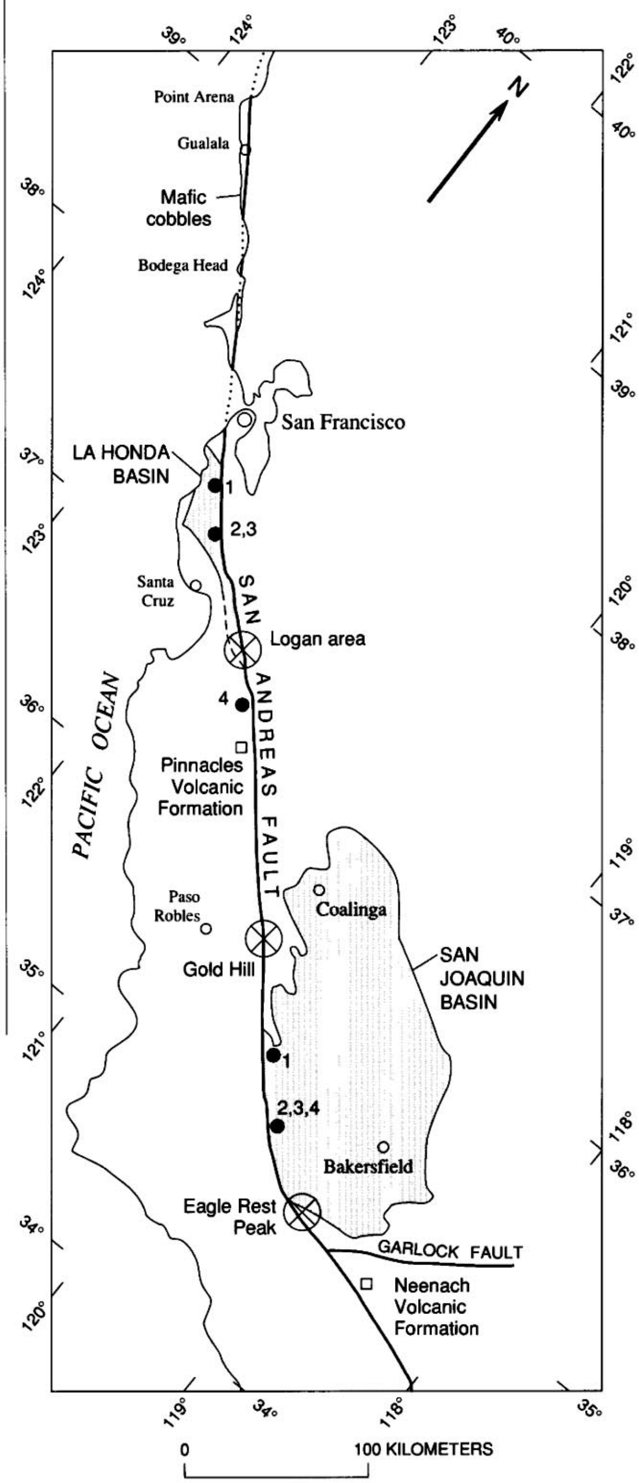


FIGURE 3.5.—Locations of some pre-Quaternary features offset by the San Andreas fault in the California Coast Ranges. The La Honda Basin is an offset segment of the San Joaquin sedimentary basin (Stanley, 1987); boundary dashed where approximately located. Circled x's, bedrock exposures of unusual quartz-bearing mafic rocks at Logan, Gold Hill, and Eagle Rest Peak (Ross and others, 1973); squares, locations of the Pinnacles and Neenach Volcanic Formations (see fig. 3.6) (Matthews, 1976). Numbered dots: 1, Butano Sandstone and Point of Rocks Sandstone Member (of Kreyenhagen Formation), representing offset parts of an Eocene deep-sea fan (Clarke and Nilsen, 1973); 2, steeply southwest-dipping slopes of the San Joaquin and La Honda Basins during late Zemorrian time (Stanley, 1987); 3, deepest parts of the San Joaquin and La Honda Basins adjacent to the San Andreas fault during Saucesian time (Stanley, 1987); 4, unusual clasts in upper Miocene conglomerate in the Temblor Range east of fault and their postulated source area in the Gabilan Range west of fault (Huffman, 1972).

their south limit in the Temblor Range; (2) Eocene formations in the Santa Cruz Mountains, offset 360 km from lithologically and faunally similar formations in the Temblor-San Emigdio Mountains; (3) sequences of lower Miocene volcanic rocks, red beds, and Oligocene and lower Miocene marine deposits of the Gabilan Range, offset 280 km from similar sequences in the San Emigdio Mountains; (4) a facies transition from marine to continental middle and upper Miocene beds of the Carrizo Plain, offset 104 km from a similar transition projected from the south end of the Great Valley; and (5) 16 km of offset based on the juxtaposition of two facies of Pleistocene gravel south of the Temblor Range.

Offset of the Eocene formations was described in more detail by Clarke and Nilsen (1973), who considered the lower to upper Eocene sedimentary sequences to represent parts of a single deep-sea fan that have been offset 305 km along the San Andreas fault. These sequences are (1) the Twobar Shale Member of the San Lorenzo Formation and the Butano Sandstone, exposed in the Santa Cruz Mountains on the west side of the fault; and (2) the shale member and Point of Rocks Sandstone Member of the Kreyenhagen Formation, exposed along the southwest boundary of the Great Valley on the east side of the fault (fig. 3.5). Both sandstone units, which consist chiefly of detritus from the Salinian block, are thought to have been deposited as a submarine fan on the west side of a deep, northwest-trending offshore basin. The Eocene fan deposits on the east side of the fault are in a structurally complex area at the south end of the Diablo antiform. If they overlie Franciscan basement there and Salinian basement on the west side of the fault, they indicate that the Franciscan and Salinian basements had already been juxtaposed by Eocene time when the fan was deposited, as noted by Page and Engebretson (1984).

The strongest evidence for measuring the large amount of right-lateral displacement along the trace of the San Andreas fault through the Coast Ranges may be the correlation of the Pinnacles and Neenach Volcanic Formations (Matthews, 1976), which are exposed on opposite sides of the fault about 315 km apart (fig. 3.5). The Pinnacles Volcanic Formation is in the central Coast Ranges, on the west side of the Chalone fault, a parallel strand that is several kilometers west of the San Andreas. The Neenach Volcanic Formation is in the Mojave Desert, adjacent to the San Andreas fault on the northeast side, about 20 km southeast of its intersection with the Garlock fault. The volcanic rocks at both exposures rest on granitic basement rocks that are petrographically and chemically similar (Ross, 1984). As described by Matthews (1976), the volcanic rocks form stratigraphic sections that are remarkably similar in composition, lithologic sequence, and age; they consist of calc-alkaline andesite, dacite, and rhyolite flows interbedded with pyroclastic and volcaniclastic rocks (fig. 3.6). K-Ar-isotopic analyses of the volcanic rocks indicate an early Miocene age (23.5 Ma; Turner, 1970). The similarity of the 315-km offset of the volcanic formations and the 305-km offset ascribed to the previously mentioned Eocene fan deposits suggests that little movement occurred along that section of the San Andreas fault during intervening Oligocene time (Clarke and Nilsen, 1973).

Paleobathymetric contour maps of middle Tertiary (late Oligocene to early Miocene) topographic features of the San Joaquin sedimentary basin match similar features across the fault in the La Honda Basin (fig. 3.5), according to Stanley (1987). The paleobathymetry is based on studies of the distribution of fossil foraminifers. In both basins, (1) the southwestern margins were bounded by shelf areas and steep north-facing slopes, (2) maximum water depth was about 2,000 m, (3) the deepest part was truncated by the San Andreas fault, and (4) the paleobathymetric contours generally trend at large angles to the fault and are truncated by it. These features indicate a post-late Zemorrian (late Oligocene to early Miocene) displacement of 325 to 330 km and a post-Saucesian (early Miocene) displacement of 320 to 325 km.

Large offset along the San Andreas fault is also indicated by an anomalous distribution of upper Miocene sedimentary deposits that occur on both sides of the fault for more than 300 km in the central Coast Ranges. According to Huffman (1972), the clast composition of upper Miocene sedimentary rocks of the Temblor Range lying east of the fault in the southern Coast Ranges indicates that they were deposited adjacent to the Gabilan Range, which lies to the northwest on the opposite side of the fault, and that they subsequently have been displaced approximately 240 km (fig. 3.5).

The various aforementioned features that have been used to measure lateral offsets along the San Andreas fault are all situated near the present-day trace of the fault. They do not measure the substantial displacements that probably occurred along presently inactive older faults of the system, nor do they measure the large lateral movement (described below) that is thought to have occurred along the interface between continental and oceanic crust during the early plate-tectonic development of the fault system.

RELATION OF GEOLOGIC STRUCTURE TO SEISMIC BEHAVIOR

From the preceding descriptions, the San Andreas fault evidently cuts through many different types of rocks and regional structures along its traverse from the Transverse Ranges to the Mendocino triple junction, and the patterns of seismicity differ strikingly along various segments of the fault. These differences in seismic behavior coincide so closely with certain geologic situations along the San Andreas fault in central California as to suggest a causal relation.

Certain segments of the San Andreas fault in central California are characterized by frequent small-magnitude earthquakes and aseismic slippage (creep); creep also occurs along the San Andreas fault in Coachella Valley, the Imperial fault, and the Superstition Hills fault. Other segments, said to be "locked," are characterized by infrequent earthquakes, some of which have been historically of large magnitude, and by an absence of creep. The occurrence of creep has been described by Allen (1968), Wallace (1970), Nason and Tocher (1970), and Thatcher (see chap. 7), among others. The creep is mainly on faults along the west side of the Diablo antiform. The creeping segment of the San Andreas fault extends from Cholame to near San Juan Bautista. Other faults known to creep include segments of the Calaveras, Hayward, Concord, Green Valley, and Sargent faults (fig. 3.7). The locked segments of the San Andreas fault in central California extend northward from near San Juan Bautista and southward from Cholame. Though of no recognized significance, the creeping segment of the San Andreas fault terminates near the north end of the Barrett Ridge slice of the Salinian block.

The creeping segments in central California occur where the faults regionally cut the upper plate of the Coast Range thrust (figs. 3.4, 3.7; Irwin and Barnes, 1975). This position accounts for the common presence of serpentinite along the creeping segments of the San Andreas fault, because the serpentiniferous Coast Range ophiolite in the upper plate of the thrust is at the fault interface along these segments. The lower-plate Franciscan rocks form a geochemical province characterized by carbon dioxide-rich springs. Where the upper plate of the thrust is present, it may act as a hydraulic cap that helps to maintain high pore pressure caused by carbon dioxide in the underlying Franciscan rocks, and to direct fluid flow into the fault (Irwin and Barnes, 1975). The importance of pore pressure in relation to creep is its ability to reduce the frictional strength of rocks by lowering the effective confining pressure, as demonstrated by Byerlee and Brace (1972). The tectonic relations between carbon dioxide springs and seismicity were described by Irwin and Barnes (1980).

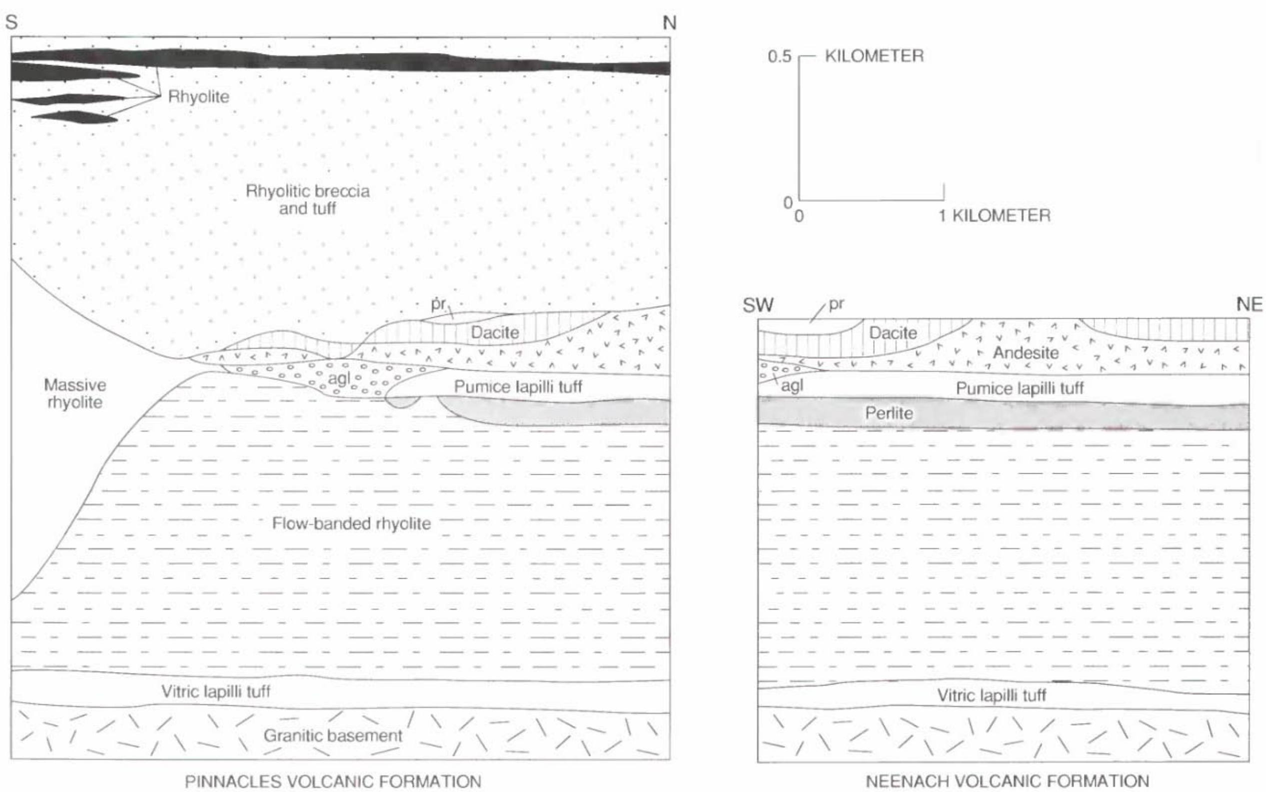


FIGURE 3.6.—Idealized cross sections showing stratigraphic and lithologic similarity of the Neenach Volcanic Formation, on northeast side of the San Andreas fault in southern California, to lower half of northern part of the Pinnacles Volcanic Formation several kilometers west of fault in central California (modified from Matthews, 1976) (see fig. 3.5 for locations). agl, agglomerate; pr, porphyritic rhyolite.

SOUTHERN CALIFORNIA

TRANSVERSE RANGES AND THE SALTON TROUGH

Where the San Andreas fault bends eastward, near the south end of the Great Valley, it forms the boundary between the southern "tail" of the Sierra Nevada and rocks of the Transverse Ranges (fig. 3.3). Continuing southeastward along the Transverse Ranges, the fault trends along the north slope of the San Gabriel Mountains and the edge of the Mojave Desert for about 100 km, and then cuts diagonally between the San Gabriel and San Bernardino Mountains, where a major strand (San Jacinto fault) splits off to the south. The rocks traversed by the San Andreas fault in the Transverse Ranges are mainly Mesozoic plutons and their Precambrian metamorphic and plutonic host rocks.

South of the Transverse Ranges, the bedrock along the fault is concealed by Quaternary deposits of the Salton Trough for a length of more than 200 km. The Salton Trough, which includes the Coachella and Imperial Valleys, widens toward the southeast, and the number of faults and complexity of the zone increase. The east wall of the trough is at the San Andreas fault, where it consists of Precambrian rocks and Mesozoic plutons and of schists like those exposed in the Orocopia and Chocolate Mountains (fig. 3.8). The west wall consists of Cretaceous plutonic rocks of the Southern California batholith and their metamorphic host rocks, similar to rocks exposed in the nearby San Jacinto Mountains. As shown by Fuis and others (1982), the trough is a gap in the crystalline basement that is filled with Quaternary and older Cenozoic sedimentary rocks. The gap increases irregularly in width from 20 km at the north end of the Salton Sea to 60 km at the United States-Mexican border. The enormous thickness of the sedimentary fill is indicated by a drill hole that bottoms in Pleistocene(?) sedimentary rocks at a depth of about 4 km (Muffler and Doe, 1968). Seismic-refraction studies show an interface with "basement" rocks at a depth of 5 to 6 km, and the "basement" rocks below the 5- to 6-km-deep interface are thought actually to be metamorphosed Cenozoic fill (Fuis and others, 1982). Near the south end of the Salton Sea, the San Andreas appears to terminate as a transform fault at a spreading center, or pullapart zone, that is the most northerly in a series of spreading centers distributed along the length of the Gulf of California which form part of the East Pacific Rift. The proximity of this pullapart zone accounts for the abundant young volcanic and geothermal features in the area (Elders and others, 1972).

The Precambrian rocks and associated Mesozoic plutons that constitute much of the crystalline basement cut by the San Andreas in southern California are locally seen to lie in thrust-fault contact on relatively younger metamorphic rocks. In the San Gabriel Mountains, on the southwest side of the San Andreas fault, the principal country rocks are divided into two plates by the Vincent thrust (lat 34°19' N., long 117°45' W.). As described by Ehlig (1981), the upper plate of this thrust is a Precambrian gneiss-amphibolite-granite complex (U-Pb age, approx 1,700 Ma; Silver, 1966) intruded by a Precambrian anorthosite-syenite-gabbro complex (U-Pb age, 1,220 Ma; Silver, 1971), all of which are intruded by the Late Triassic Lowe Granodiorite (U-Pb age, 220 Ma; Silver, 1971), by mid-Mesozoic rhyolitic to basaltic dikes, and, finally, by granitic plutons of probable Late Cretaceous age (U-Pb age, 80 Ma; Carter and Silver, 1971). The oldest rocks in the upper plate are thought to be a remnant of a Precambrian craton. Northeast of the fault, in the Mojave Desert and San Bernardino Mountains, some Precambrian rocks are unconformably overlain by lower Paleozoic miogeoclinal strata that are thought to represent an essentially autochthonous part of the North American craton (Burchfiel and Davis, 1981; Ehlig, 1981).

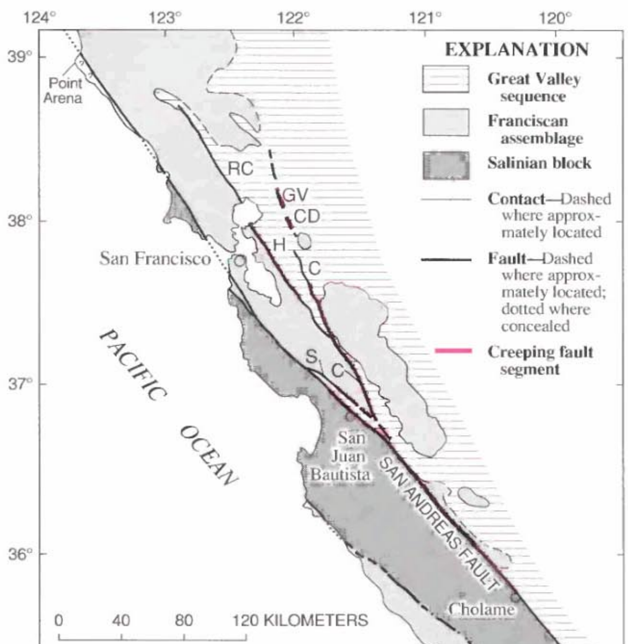


FIGURE 3.7.—Known creeping segments of the San Andreas and related faults in central and northern California. Data from Nason (1973), Frizzell and Brown (1976), Prescott and Burford (1976), Burford and Sharp (1982), and Harsh and Burford (1982). Faults: C, Calaveras; CD, Concord; GV, Green Valley; H, Hayward; RC, Rodgers Creek; S, Sargent. Compare creeping segments with concentrations of small earthquakes shown in figures 5.4 and 5.5.

The lower plate of the Vincent thrust consists of the Pelona Schist, which is largely a sedimentary section of arkosic sandstone, siltstone, and shale that has been metamorphosed to white mica-quartz-albite schist and locally includes metavolcanic rocks, metachert, marble, and serpentinite (Ehlig, 1981). The section in the San Gabriel Mountains has an exposed thickness of 3.5 km. The metamorphism decreases downward, away from the fault, and so sedimentary structures, including graded bedding, are well preserved in the lowest 1 km of section. This "upside down" metamorphism and other features indicate that the metamorphism of the lower-plate rocks occurred during thrusting. Pelona-type schist also occurs beneath Precambrian rocks of the Barrett Ridge slice west of the Tejon Pass and crops out in places along the Garlock fault (fig. 3.9). On the northeast side of the San Andreas fault in the Orocopia-Chocolate Mountains area, just east of the Salton Sea, the schist, there known as the Orocopia Schist, lies below the Orocopia thrust. Scattered exposures of Pelona-type schist and the Vincent-Orocopia thrust continue into southwesternmost Arizona (Haxel and Dillon, 1978).

The protoliths of the Pelona-type schist are thought to be deep-marine sedimentary rocks deposited on oceanic crust, possibly representing mostly the distal parts of turbidite fans. They probably were Jurassic or Cretaceous in age and are thought to have been metamorphosed by the thrusting that probably occurred no later than Late Cretaceous time (Haxel and others, 1985). The tectonics of the Pelona and Orocopia Schists is controversial. The Vincent-Orocopia thrust may have dipped southwest, and the Precambrian and other rocks of the upper plate been thrust northeastward over backarc-basin protoliths of the Pelona and Orocopia Schists (Haxel and Dillon, 1978). Conversely, the thrust relation may represent a gently north-northeast dipping subduction zone in which the protoliths of the schists were trench deposits similar to the Franciscan rocks and were thrust north-northeastward under the sialic North American plate (Burchfiel and Davis, 1981; Crowell, 1981). The Pelona-type schist is reminiscent of the Franciscan-derived South Fork Mountain Schist and related semischists of northern California that form a narrow, virtually continuous selvage for hundreds of kilometers along the west edge of the Klamath Mountains and the west side of the Great Valley, where they form the lower plate of the Coast Range thrust (Blake and others, 1967).

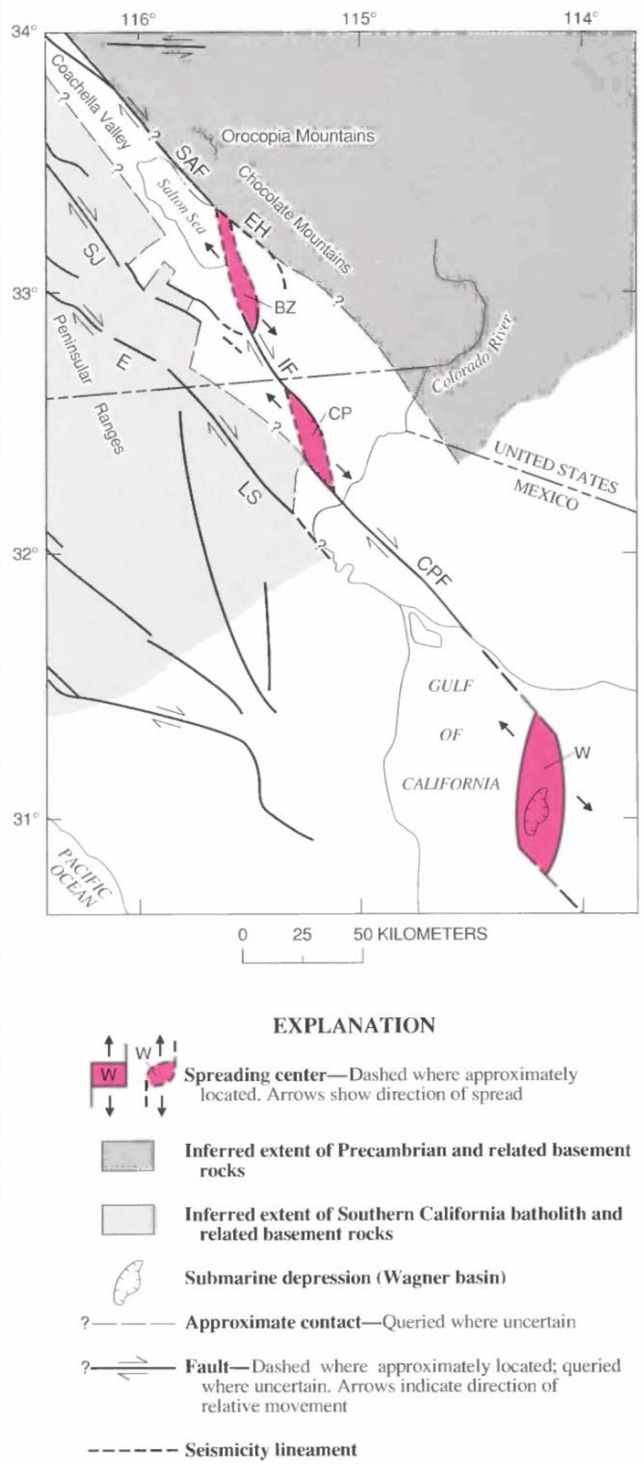


FIGURE 3.8.—Salton Trough and north end of the Gulf of California, showing major spreading centers and termination of the San Andreas fault (modified from Fuis and others, 1982). Spreading centers: BZ, Brawley seismic zone; CP, Cerro Prieto geothermal area; W, Wagner Basin. Major transform faults: CPF, Cerro Prieto; IF, Imperial; SAF, San Andreas. Other major faults: E, Elsinore; EH, East Highland Canal seismicity lineament; LS, Laguna Salada; SJ, San Jacinto.

DISPLACEMENT OF BASEMENT ROCKS BY THE SAN ANDREAS FAULT

The distribution of the Pelona-type schist (fig. 3.9) has played an important role in many attempts to measure the slip on the San Andreas fault in southern California. In their classic report, Hill and Dibblee (1953) recognized the similarity of the Pelona Schist of the San Gabriel Mountains area to the Orocopia Schist east of the Salton Sea and postulated that these schists are offset 257 km from one another by the San Andreas fault. Crowell (1962) noted that the Precambrian rocks and Pelona-type schist of the Tejon area are separated from those of the San Gabriel Mountains area by the San Gabriel fault and that the Tejon, San Gabriel Mountains (Soledad), and Orocopia Mountains areas contain not only similar Precambrian rocks and Pelona-type schist but also similar Oligocene and other Tertiary strata. The similar lithologies and geologic histories of the rocks of these three areas indicated to him that these rocks once formed an east-west-trending belt which has been segmented and displaced by right-lateral slip of approximately 50 km on the San Gabriel fault and 210 km on the San Andreas fault. However, the validity of the concept that the Tertiary rocks of the San Gabriel (Soledad) and Orocopia Mountains areas once were parts of a single basin was questioned by Spittler and Arthur (1973), who believed that the Tertiary strata of these two areas were deposited in separate basins, consist of distinctly different flow rocks, and are dissimilar in age.

More recent schemes for measuring offset along the San Andreas fault in southern California have been proposed. Among them, Powell (1981) postulated that all major exposures of the Pelona-type schist are in the core of an antiformal fold and that they once formed a nearly continuous structure which subsequently has been disrupted by Cenozoic strike-slip faults (fig. 3.10). An important part of Powell's palinspastic reconstruction of the antiform is an old east-west-trending fault that is a composite of the San Francisquito, Fenner, and Clemens Well faults. This fault is thought to have had 80 km of right-lateral slip, cutting the antiform, and later was cut diagonally by the San Andreas fault. The axis of the antiformal structure is a linear feature that can be used as a "piercing point" in measuring offset where the axis appears on opposite sides of a fault. On this basis, the axis in the San Gabriel Mountains (Sierra Pelona) area is offset 220 km along the San Andreas fault from the axis in the Orocopia Mountains area (Powell, 1981). The Transverse Ranges segment of the San Andreas fault was described by Matti and others (1985) as consisting of several old strands (Wilson Creek, Mission Creek, and

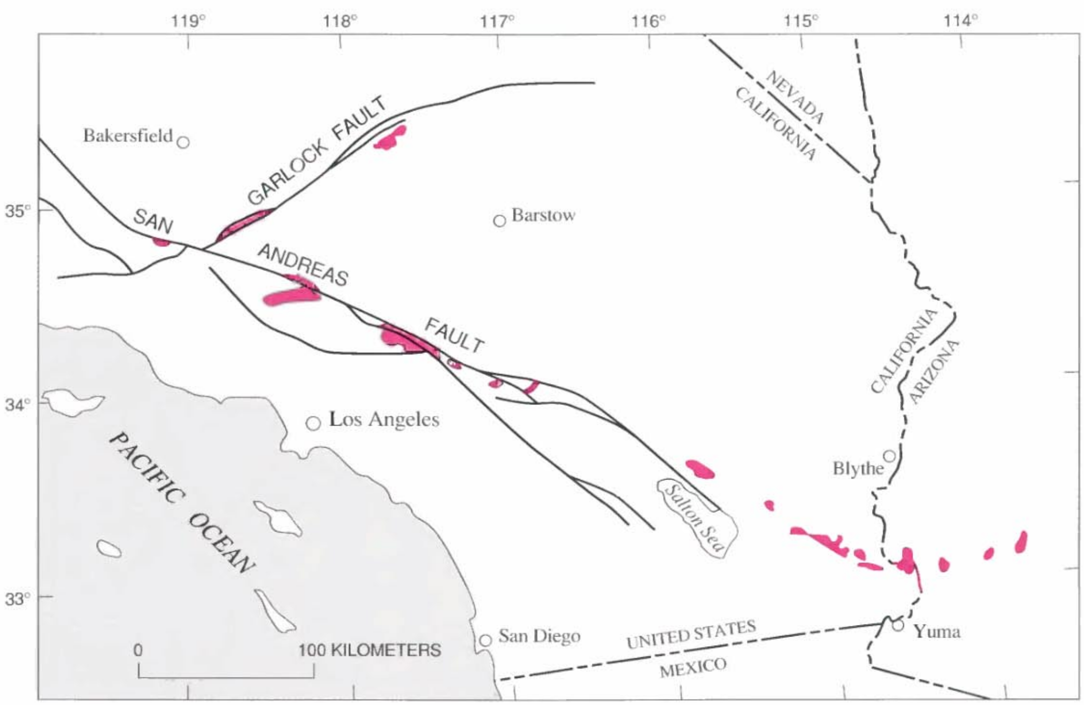


FIGURE 3.9.—Distribution of the Pelona Schist and lithologically similar schists in southern California and southwestern Arizona (modified from Haxel and Dillon, 1978). Northernmost occurrence along the San Andreas fault is in Barrett Ridge slice of the Salinian block.

Mill Creek faults) and a young strand (San Bernardino strand). The total displacement across all of these strands is thought to be 160±10 km (Matti and others, 1986), on the basis of exposures of a distinctive Triassic megaphyric monzogranite. The exposures of this monzogranite, which are on the northeast side of the San Andreas fault in the San Bernardino Mountains but on the opposite side of the fault in Liebre Mountain (lat 34°43' N., long 118°40' W.), are thought to represent displaced parts of the same pluton.

PLATE-TECTONIC DEVELOPMENT OF THE SAN ANDREAS FAULT

The Pacific coast of North America is a highly mobile zone of tectonic interaction between continental crust on the east and oceanic crust on the west. At some times and places, the relative movements of these contrasting crustal domains have been sufficiently convergent that the oceanic crust has underthrust the continental crust and swept island arcs and other crustal materials into the zone of interaction (Hamilton, 1969). However, much of the movement along this zone of interaction seems to have been oblique or lateral in an overall northwest-southeast direction, and so as the two types of crust moved past one another, fragments of all sizes were sliced or pulled from them and carried various distances away from their source. By these processes of convergence and lateral translation, large crustal fragments referred to as "terranes" (Irwin, 1972; Coney and others, 1980; Schermer and others, 1984) are juxtaposed against others that may differ strikingly in lithology, age, genetic environment, stratigraphy, metamorphic facies, plutonism, and mineral deposits.

The general directions and rates of movement of the major crustal domains that converged along the western margin of North America are amenable to explanation by the theory of global plate tectonics as far back in time to

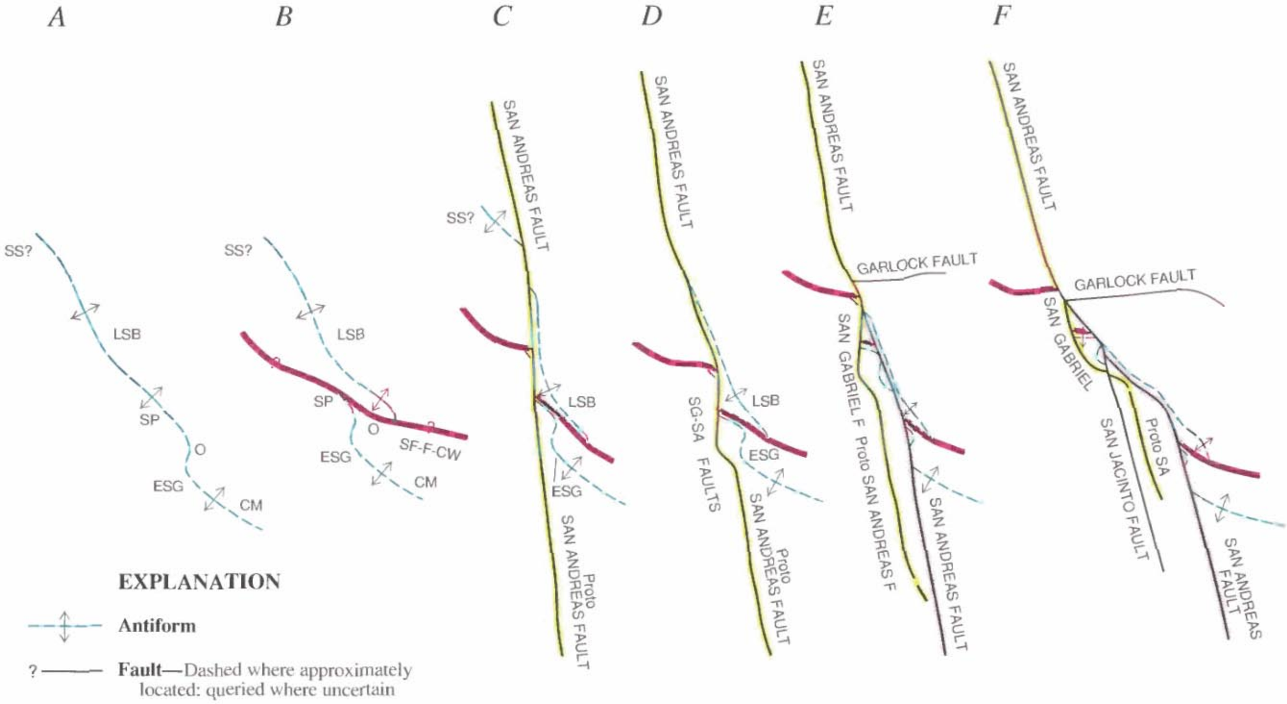


FIGURE 3.10.—Sequential diagrams showing evolution of the San Andreas fault system in southern California as proposed by Powell (1981). *A*, Approximately 30–15 Ma—formation of regional antiform cored by schist lithologically similar to the Pelona Schist. *B*, Approximately 20–10 Ma—displacement of antiform by the San Francisquito-Fenner-Clemens Well fault. *C*, Approximately 10–2 Ma—inception of San Andreas-San Gabriel strand of the San Andreas fault, displaying approximately 60 km of right-lateral displacement. *D*, Approximately 5–0 Ma—left-lateral bending of San Gabriel segment and possible inception of the Garlock fault. *E*, Approximately 2–0 Ma—inception of modern southern-California segment of the San Andreas fault, displaying 220 km of right-lateral displacement. *F*, Approximately 2–0 Ma—left-lateral bending of Transverse Ranges segment of the San Andreas fault and development of the San Jacinto fault. Faults: CW, Clemens Well; F, Fenner; SA, San Andreas; SF, San Francisquito; SG, San Gabriel. Antiform segments: CM, Chocolate Mountains; ESG, Eastern San Gabriel Mountains; LSB, Little San Bernardino Mountains; O, Orocopia Mountains; SP, Sierra Pelona; SS, Sierra de Salinas.

at least the Mesozoic (Engebretson and others, 1985). According to this theory, the crust of Earth is a mosaic of interacting rigid plates. Boundaries between the plates are spreading ridges where the plates pull apart, oceanic trenches above subduction zones where the plates converge, and transform faults where the plates slide laterally past one another. These boundaries are the loci of seismic activity. The corollaries of the theory of global plate tectonics have been enormously valuable as an aid in recognizing the genetic environments of the various terranes, whether oceanic or continental crust, volcanic island arc, or oceanic trench. The presence of multiple ophiolite and blueschist belts along parts of the western margin of North America (Irwin, 1977) indicates that some of these terranes were subduction related during Paleozoic and Mesozoic time. Although much has been learned of the relative motions between the oceanic and continental rocks for the past 180 m.y. (for example, Engebretson and others, 1985), the tectonics of the zone of allochthonous terranes is so complex, and the sites of origin of the various terranes generally so obscure, that much painstaking research remains to be done before the Paleozoic and Mesozoic margins of western North America can be palinspastically reassembled.

The tectonic setting of the continental margin during late Mesozoic time, before development of the San Andreas fault, is highly controversial. Some geologists (for example Dickinson, 1981) favor a model of highly convergent plate interaction to develop a continental margin of the Andean type (fig. 3.11). Others, however, interpret certain paleontologic and paleomagnetic evidence to indicate that some late Mesozoic rocks of the Coast Ranges were translated great distances northward from equatorial sites of origin during Late Jurassic time, before accretion to North America and deposition of the Great Valley sequence (Hopson and others, 1986). This movement is thought to have been followed in Late

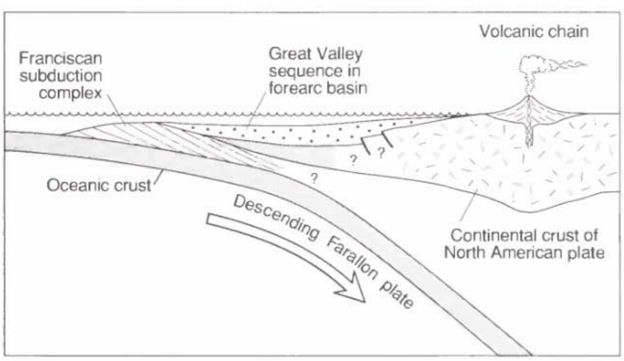


FIGURE 3.11.—Schematic diagram showing California as an Andean-type continental margin during late Mesozoic time (modified from Dickinson, 1981).

Cretaceous and early Tertiary time by a second episode of dextral translation during which part of the Franciscan assemblage was accreted and parts of the Coast Range ophiolite and overlying Great Valley sequence moved northward for distances as great as 1,120 km (McLaughlin and others, 1988).

The rates and relative directions of motion of the principal tectonic plates are based mainly on patterns of magnetic anomalies in the oceanic crust. These patterns indicate that a subduction-related trench lay offshore of western North America during early Tertiary time because of the convergence of the Farallon plate (see fig. 3.1), and that strike-slip movement on faults of the San Andreas system began no earlier than approximately 30 Ma (late Oligocene), when the Pacific plate first impinged on the North American plate (McKenzie and Morgan, 1969; Atwater, 1970). Triple junctions formed at the point of contact of the Pacific plate with the North American plate and migrated to the northwest and southeast as subduction of the Farallon plate continued. These triple junctions are now approximately 2,500 km apart: The Mendocino triple junction is off the coast of northern California, and the Rivera triple junction is at the mouth of the Gulf of California. The relative motion along the transform fault that formed the lengthening boundary between the Pacific and North American plates was right lateral. This early transform movement probably was not along the modern trace of the San Andreas fault but must have been along other faults of the system that now lie mostly to the west and at the edge of the continent (fig. 3.12). The modern San Andreas fault apparently did not come into being in southern California until the opening of the Gulf of California during Pliocene time, about 4 Ma, since which time Baja California has moved 260 km away from mainland Mexico (Larson and others, 1968). The San Andreas fault is commonly referred to as the boundary between the Pacific and North American plates, which is true in the sense that the rocks on the west side of the fault are moving somewhat in concert with the Pacific plate, although those rocks actually are displaced fragments that once were part of the North American plate (fig. 3.13).

During the early development of the San Andreas fault system, the principal movement must have been along a transform fault that formed the boundary between rocks of the North American plate and newly formed oceanic crust of the Pacific plate as the triple junction migrated southward. At some point during southward migration of this triple junction, the transform apparently jumped eastward one or more times to positions within the North American plate, to become the northern section of the modern San Andreas fault. The modern trace of the San Andreas fault in central California probably had only minor slip until about 12.5–10 Ma and probably was not

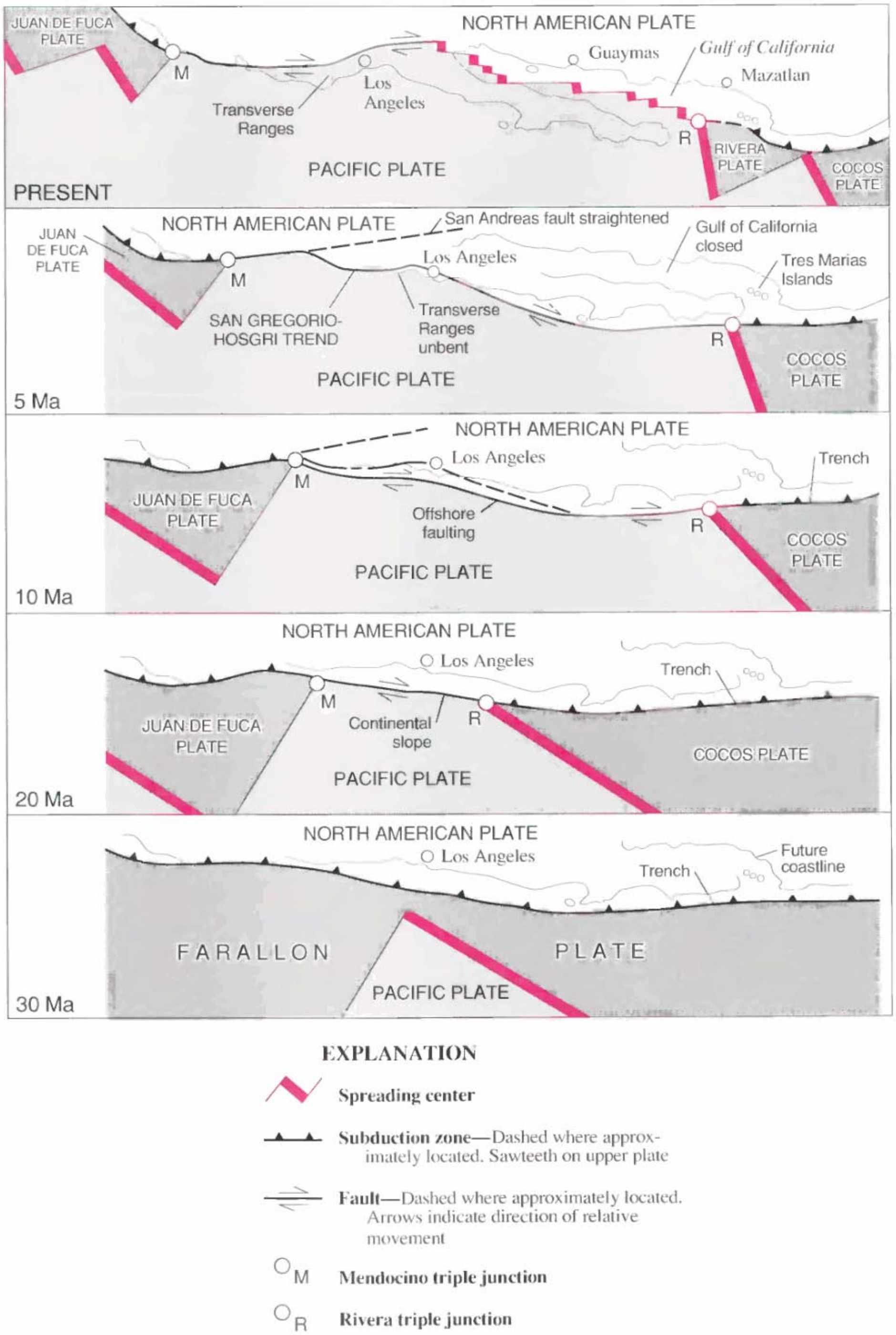
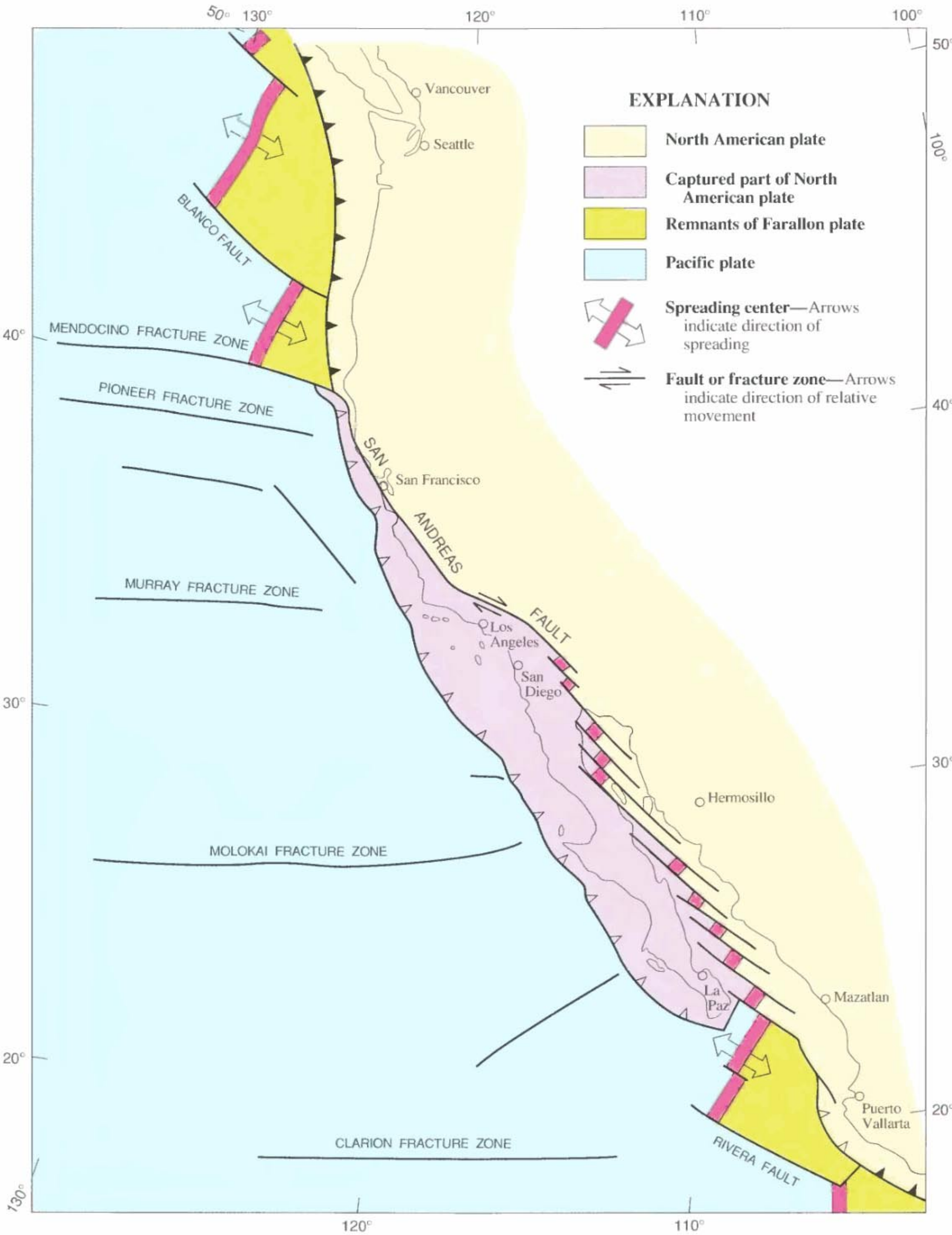


FIGURE 3.12.—Sequential diagrams showing plate-tectonic evolution of the San Andreas transform fault system (modified from Dickinson, 1981). Note that early transform faulting was west of the present-day San Andreas fault and presumably separated young oceanic rocks of the Pacific plate from rocks of the North American plate. Over time, the transform faulting has stepped eastward, and so virtually all the presently most active element, the present-day San Andreas fault, is now in rocks of North American plate aspect. In earlier diagrams, partial outline of the Gulf of California, which did not exist before 5 Ma, is shown for reference only.

the strand of dominant slip before 7.5–5 Ma (Dickinson and Snyder, 1979). The southern section of the modern San Andreas fault was formed by similar eastward jumps of the transform fault, resulting in opening of the Gulf of



California. Some of the major faults that lie between the San Andreas fault and the continental margin may represent these earlier positions of the transform, and some of these faults are still active. Possible candidates for such early intermediate faults include, among others, the San Gregorio-Hosgri fault in central and northern California and the Elsinore and offshore faults in southern California. With our present state of knowledge, however, it is unclear which of the many faults in the Coast Ranges are early faults of the San Andreas system and which may have formed before mid-Tertiary initiation of the San Andreas system.

The models of McKenzie and Morgan (1969) and Atwater (1970) have been widely used in relating Pacific plate interactions to the tectonics and geology of California and other parts of western North America (fig. 3.1). A more actualistic developmental sequence of diagrams was drawn by Dickinson (1981), in which the position of an early San Andreas fault is shown before the opening of the Gulf of California (fig. 3.12). In figures 3.1 and 3.12, the boundary between the Pacific and North American plates is shown as a transform fault that was formed by the passage of migrating triple junctions. However, marine geologic studies offshore of California between Point Conception and Cape Mendocino indicate that this old interface between the Pacific and North American plates is an inactive east-dipping low-angle fault which is interpreted to be a fossil subduction zone (McCulloch, 1987). There, magnetic stripes of the oceanic (Pacific) plate can be traced some distance eastward—locally as much as 30 km—beneath the leading edge of the upper (North American) plate, and both plates are covered along the suture by a thin veneer of undeformed Miocene strata. The presence of a Miocene or older subduction zone rather than a transform fault at the ocean-continent interface is difficult to reconcile with a strict interpretation of McKenzie and Morgan's (1969) and related models, although it is interpreted to indicate that the transform motion was accompanied by oblique convergence (McCulloch, 1987).

The present overall rate of relative movement between the Pacific and North American plates, earlier thought to be about 6 cm/yr (Atwater, 1970) or 5.6 cm/yr (Minster and Jordan, 1978), is now thought to be more likely about 4.8 cm/yr (DeMets and others, 1987). This rate probably has varied over time (Atwater and Molnar, 1973); however, the rate of relative motion between the two plates is substantially greater than the slip rates based on measured offsets of geologic features along the San Andreas fault. For example, the 315-km offset of the lower Miocene Pinnacles and Neenach Volcanic Formations indicates a minimum overall slip rate of 1.3 to 1.4 cm/yr (Matthews, 1976), and the offset of the channel of Wallace Creek by the San Andreas fault in central California indicates a slip rate of about 3.4 cm/yr for the past 3,700 yr and of 3.6 cm/yr for the past 13,250 yr (Sieh and Jahns, 1984). Geodetic-survey measurements indicate that slip rates during the past 90 yr in central California average 2.9 cm/yr for the upper 15 km of crust but 3.7 cm/yr below 15 km (Thatcher, 1977). The discrepancy between the rate of relative motion between the Pacific and North American plates and the much smaller slip rate on the San Andreas fault has been noted by many workers (for example, Atwater, 1970; Minster and Jordan, 1978; Weldon and Humphreys, 1986). Part of the total slip along the boundary between the Pacific and North American plates probably is occurring in small increments along other faults in a broad zone of interaction that may extend from the continental margin eastward even as far as the Basin and Range province.

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FIGURE 3.13.—Western margin of North America, showing tectonic capture of part of the North American plate by the Pacific plate (plate-tectonic base modified from Moore, 1981). Captured part of the North American plate is now moving northwesterly with the Pacific plate and is commonly considered to be part of the Pacific plate. West boundary of captured part of the North American plate is inactive early transform fault with component of subduction (open sawteeth; see text); interfaces of the North American plate with remnants of the Farallon plate are active subduction zones (solid sawteeth).

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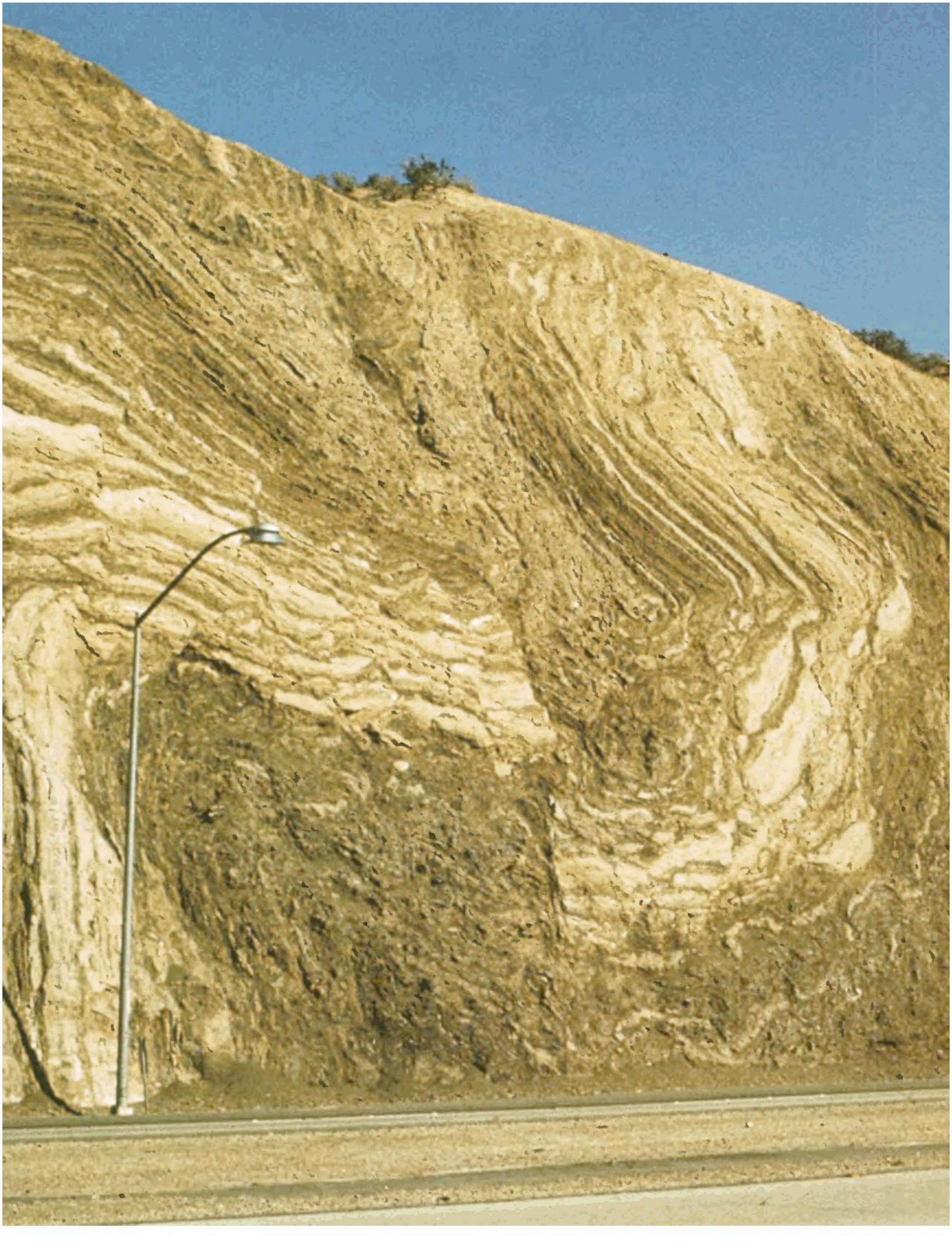

Displaced or deformed rock units and landforms record the past 2 m.y. of faulting, folding, uplift, and subsidence in California. Properly interpreted, such evidence provides a quantitative basis for predicting future earthquake activity and for relating many diverse structures and landforms to the 5 cm/yr of horizontal motion at the boundary between the North American and Pacific plates.

4. QUATERNARY DEFORMATION

By ROBERT D. BROWN, JR.

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INTRODUCTION

Modern techniques of geologic dating and expanded research on earthquake hazards have greatly improved our knowledge of the San Andreas fault system. Much of this new knowledge has been gained since 1965, and that part which concerns crustal deformation during the past 2 m.y. is briefly summarized here.

In emphasizing recent work, I cite only a few of those earlier investigators who first recorded the extent and timing of deformation in upper Cenozoic deposits. Their contributions deserve a more complete accounting, and in several works cited herein such credit is given, most thoroughly by Wahrhaftig and Birman (1965). Also especially important in understanding the framework of the fault system are the 1:250,000-scale, 1° by 2° sheets of the "Geologic Atlas of California" published by the California Division of Mines and Geology, the 1:750,000-scale "Geologic Map of California" (Jennings, 1977), and the 1:750,000-scale "Fault Map of California" (Jennings, 1975).

The Quaternary deformation processes—chiefly faulting, folding, and uplift—represent crustal changes that in many places continue today but at barely perceptible rates. The perspective of 2 m.y. of geologic time permits us to detect and measure these processes, and where historical deformation is evident—as shown by seismology, geodetic studies, or geologic investigations of recent earthquakes—the Quaternary record provides an independent check on the reliability of our observations and measurements. More importantly, we also use the Quaternary viewpoint to sketch the outlines of the currently active fault system, its intact crustal elements and major active faults, and how these faults propagate and change over time. From such evidence we can better understand

◀ FIGURE 4.1.—Strata within a few hundred meters of the San Andreas fault are highly deformed. Here, folded and faulted beds of Pliocene age on the north side of the San Andreas fault are exposed in a roadcut along California Highway 14 just south of Palmdale along the southern margin of the Mojave Desert. Photograph by R.E. Wallace, U.S. Geological Survey.

the pre-Quaternary history of the system and build the predictive kinematic models needed for earthquake hazard assessment.

Evidence of Quaternary deformation comes chiefly from the observed displacement of strata or geomorphic features (fig. 4.1). Where this displacement can be dated or, at least, bracketed in time, the age of deformation can be established, and its rate—generally an average—can be determined. In this report, most deformation rates are converted to units of centimeters per year, in part to facilitate comparison of different data sets but also because the dominant process, strike slip on major faults, is conveniently expressed in such units. Both the amount of displacement and the materials used to determine the age of displaced geologic markers require careful geologic analysis to ensure that field relations are unequivocal and correctly interpreted; the most reliable deformation rates depend on highly detailed analyses of local stratigraphy, which provide multiple measures of displacement over broad timespans, typically thousands to tens of thousands of years.

Deposits of Quaternary age can be dated by several methods, most of which ultimately depend on geochemical analyses that require highly sophisticated laboratory practices and expertise, as well as carefully chosen samples. The principal methods of dating Pleistocene and Holocene deposits within the San Andreas fault system (fig. 4.2) include radiocarbon, soil chronostratigraphy, correlation with standard sea-level stages (chiefly used for uplifted marine terraces), tephrochronology, and mammalian and invertebrate paleontology; supplementary techniques include paleomagnetism, uranium-series analysis, and amino-acid racemization. The underlying theory and limitations of these methods (for example, Pierce, 1986) are beyond the scope of this review. Each method, however, differs in resolving power, the timespan over which it is effective, and applicability to different rock types.

Difficulties in dating deformed Quaternary deposits are not the only deterrent to reconstructing the history of faulting. Large areas within the fault system are nearly devoid of Quaternary deposits; others are masked by landslide deposits, which conceal Quaternary folds and faults. Few published geologic maps differentiate between faults with Quaternary movement and those that have long been inactive, and for even the best known faults our knowledge of Quaternary faulting is still incomplete. Quaternary reverse and thrust faults, more difficult to identify and map than their strike-slip counterparts, are surely underrepresented on published geologic maps and in the literature.

Our knowledge of Quaternary deformation is thus incomplete and biased. We have learned much, and are rapidly learning more, about the Holocene and latest Pleistocene, but the view much beyond the past 100 ka is still poorly resolved. Despite the problems, the results of the past 2 decades of Quaternary research have brought

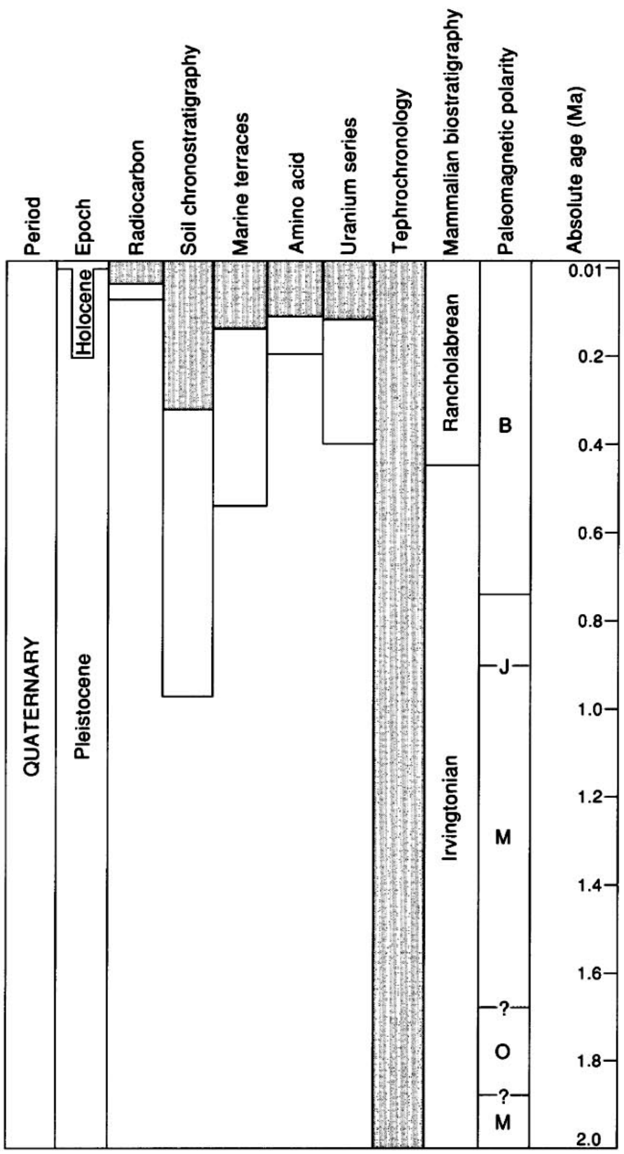


FIGURE 4.2.—Dating methods used in studies of the Quaternary deposits of the San Andreas fault system. Shading shows principal methods and timespans over which they have been most effectively used; open bars indicate potential range of the methods. Other available methods of Quaternary dating, some of which are not shown, either are little used or have produced few or no reported data on Quaternary deformation within the fault system. Paleomagnetic polarities: B, Brunhes Normal-Polarity Chron; J, Jaramillo Normal-Polarity Subchron; M, Matuyama Reversed-Polarity Chron; O, Olduvai Normal-Polarity Subchron.

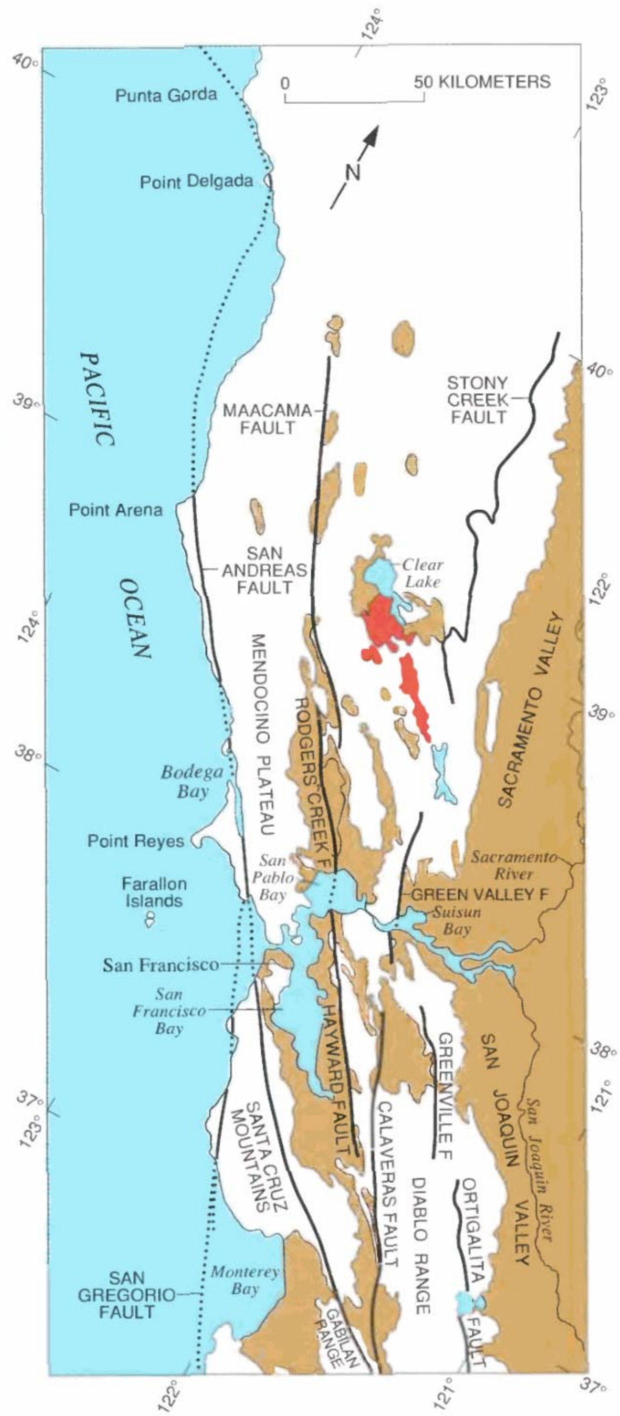
new insights into the mechanics of the fault system and the promise of more discoveries yet to come.

NORTHERN SECTION OF THE SAN ANDREAS FAULT SYSTEM

SAN ANDREAS FAULT

The northern section of the San Andreas fault system, as defined here, extends from Punta Gorda, 40 km southeast of the Mendocino triple junction, to the northern Gabilan Range (fig. 4.3). This belt of Quaternary—and earlier—faulting and folding, about 120 km wide by 500 km long, includes the San Andreas, at least four major related faults, and several smaller faults, 5 to 20 km long. All of these faults displace Quaternary deposits or landforms, and all are seismically active. From west to east, major faults within the system are the San Gregorio, San Andreas, Hayward (and its northern, right-stepping extensions, the Rodgers Creek-Healdsburg and Maacama faults), Calaveras (and its northern, right-stepping extensions, the Concord and Green Valley faults), and an ill-defined, possibly discontinuous fault zone along the eastern margin of the Coast Ranges that includes, from north to south, the Stony Creek, Greenville, and Ortigalita faults.

The offshore counterpart of the main San Andreas fault, which trends seaward and westward from Punta Gorda to the Mendocino triple junction, represents the latest segment of the northward-growing transform. This east-west-trending, offshore segment of the fault is located chiefly on seismic and bathymetric evidence; it follows along the north face of the Gorda Escarpment (along lat 40°23′ N. and west of long 124°39′ W.) and the south wall of Mattole Canyon (from the east end of the Gorda Escarpment southeast to lat 40°17′ N., long 124°27′ W.), but water depths of as much as 2,000 m, high submarine relief, and sea-floor deposits of young sediment (Silver, 1971; McCulloch and others, 1985) obscure details of its Quaternary history.



EXPLANATION

Alluvial and estuarine deposits (Quaternary)—Chiefly basin fill; may also include some Pliocene deposits

Clear Lake Volcanics (Quaternary and Tertiary)—Flows, tuffs, and breccias of dacite and rhyolite and less abundant basalt. Age is late Pliocene to Holocene

Bedrock (Tertiary and older)—Varied rock types

Fault exhibiting evidence of Quaternary displacement—Dotted where concealed by water

FIGURE 4.3.—Geologic sketch map of the northern Coast Ranges, central California, showing faults with Quaternary activity and basin deposits in northern section of the San Andreas fault system. Fault patterns are generalized, and only major faults are shown. Several Quaternary basins are fault bounded and aligned parallel to strike-slip faults, a relation most apparent along the Hayward-Rodgers Creek-Maacama fault trend.

From Punta Gorda southward to Point Arena the fault is almost entirely off shore; its location is known from sea-floor features, coastal geomorphology, and relations at Point Delgada, where it locally intersects the coastline. A line of coastal bluffs, 350 to 850 m high and sloping 33°–43°, trends N. 50° W. for 20 km northwest of Point Delgada. At the base of the bluffline, Lajoie and others (1982) measured Holocene uplift rates of about 0.5 cm/yr from dated molluscan fossils in beach ridges 30 m above present sea level. Seaward of the bluffs, the Spanish and Delgada Submarine Canyons head near the present coast, 2 to 3 km landward of the 100-m bathymetric contour, which approximately defines the late Wisconsin sea level. Shoreward of this contour, both canyons are linear, and neither they nor the intervening sea floor exhibits evidence of vertical or horizontal displacement. These relations are consistent with a near-shore San Andreas fault, located in or near the surf zone and close to the base of the coastal bluffs. The unusually large component of vertical slip (0.5 cm/yr, northeast side up) for this segment of the fault may result from its more westerly trend than that of segments farther south, which exhibit almost pure strike slip; or, as suggested by Merritts and Bull (1989), it may result from the late Quaternary passage of the Mendocino triple junction along this part of the coast.

The fault intersects the coastline about 6 km northwest of Point Delgada, cuts across the point, and locally separates upper Pleistocene marine terrace gravel and younger alluvium (McLaughlin and others, 1983) along the coast from intensely deformed bedrock inland. Other locations have been suggested (Curry and Nason, 1967; Beutner and others, 1980; McLaughlin and others, 1983) for the fault here, but several lines of independent evidence support this trend, including fault slip during the 1906 earthquake (Lawson and others, 1908, p. 54–58), the alignment of scarps, sags, and saddles along the 1906 fault trend, bedrock faulting colinear with 1906 faulting (Brown and Wolfe, 1972), and continuity to the north and south with offshore and nearshore evidence of recent faulting.

From Point Delgada southward to Point Arena, a distance of 125 km, the fault is defined by aligned, chiefly west-facing scarps on the sea floor, the right-lateral deflection of Noyo Submarine Canyon, straight boundaries of irregular submarine topography, and a 2- to 5-km-wide zone of disturbed reflective layers evident in continuous seismic-reflection profiles (Curray and Nason, 1967). The shapes and dimensions of sea-floor features, as shown by seismic-reflection profiles and modern bathymetric maps, resemble fault-formed features on land and provide similar evidence for right-lateral strike slip. The offshore data, however, are insufficient to determine the amount of Quaternary displacement.

Onland segments of the fault between Point Arena and the Gabilan Range exhibit abundant geomorphic and geologic evidence of Quaternary displacement, some of which can be translated into slip rates. Trunk streams, systematically displaced from their headwaters by at least 10 km, record cumulative strike-slip faulting that must span much of Quaternary time. For example, the fault-deflected, northwest-trending courses of the Garcia and Gualala Rivers follow the fault zone for 50 km between Point Arena and Fort Ross; their present alignment (fig. 4.4) documents a long and complex history of channel extension and stream piracy. Three streams east of the fault—the Garcia River and the Wheatfield and South Forks of the Gualala River—exhibit similar offsets of about 13.5 km from possible former outlets to the sea west of the fault: the Garcia River from its present mouth near Point Arena, the Wheatfield Fork from the present mouth of the Gualala River near Gualala, and the South Fork from a low gap (110-m elevation) in the coastal ridge near the Sea Ranch. The average rate of post-Pliocene slip across the boundary between the North American and Pacific plates, derived from spreading rates at the mouth of the Gulf of California (DeMets and others, 1987, p. 912), is estimated at 5.1 cm/yr. In northern California, this slip is distributed chiefly on the San Andreas and other active faults to the east. On the San Andreas fault at Point Arena, Prentice (1989) obtained a maximum slip rate of 2.6±0.3 cm/yr from a faulted stream channel ^{14}C dated at 2,350 to 2,710 yr. Together with the assumed 13.5-km offsets, this rate implies that the postulated drainage diversions required about 519 ka. Other lines of evidence indicate much greater antiquity for this and nearby parallel strands of the fault.

Despite abundant evidence of Quaternary faulting along the northern section of the San Andreas fault, other examples of measurable fault displacement of dated upper Pliocene and Quaternary deposits are sparse. Much of the fault lies off shore, and most onshore segments cut older, highly deformed rocks of the Franciscan complex, from which the upper Cenozoic deposits have been eroded. Some reliable indicators of Quaternary slip, however, come from geologic and geomorphic relations observed from San Francisco southward.

On the San Francisco peninsula and farther south in the Santa Cruz Mountains, estimates of Quaternary slip on the San Andreas fault have been derived from offset biofacies and lithofacies relations. The fault offsets are in discontinuously exposed upper Cenozoic strata, which

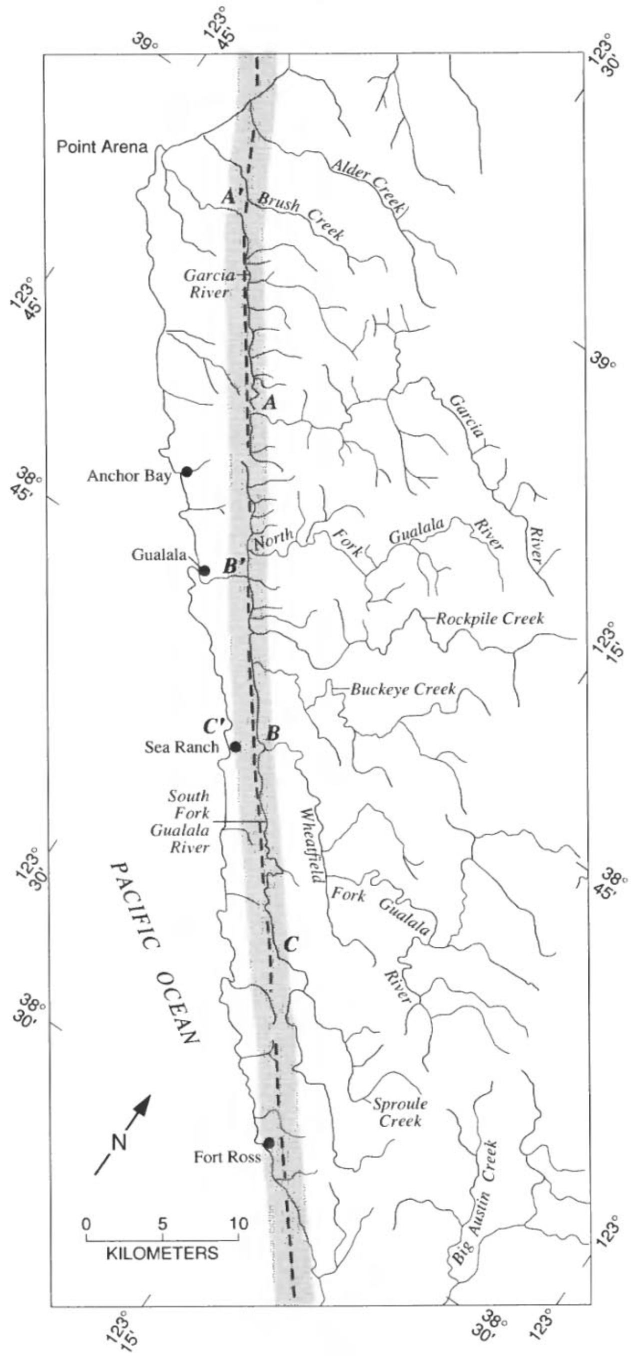


FIGURE 4.4.—Sketch map of part of northern California, showing coastal drainages south of Point Arena, systematically diverted by right-lateral slip on the San Andreas fault (dashed and shaded line). Possible offsets of 13.5 km are indicated for the Garcia River (*A–A'*), the Wheatfield Fork of the Gualala River (*B–B'*), and the South Fork of the Gualala River (*C–C'*).

have been assigned by different investigators to the marine Merced, or Merced(?), Formation and the nonmarine Santa Clara Formation. East of the San Andreas fault, both the Merced and Santa Clara Formations contain, in their upper parts, the 400-ka-old Rockland ash bed of Sarna-Wojcicki and others (1985), thus establishing at least a partial age equivalence of these two units.

The upper, Rockland ash-bearing part of the Merced Formation (Clifton and others, 1988) is fault bounded on the southwest and juxtaposed against a ridge of older rock for 11 km southeast of San Francisco (fig. 4.5). The minimum offset of 11 km from any western counterpart of the Merced outcrop belt and the 0.4- to 2.0-m.y. age of the faulted Merced strata require a minimum slip rate of 1.7 ± 1.0 cm/yr for this section of the San Andreas fault.

A similar rate can be derived from the present distribution of upper Pleistocene marine deposits, which Addicott (1969) interpreted as the faulted remnants of a narrow marine embayment that once extended southeastward across the San Andreas. The fault separation of 35 to 40 km (Addicott, 1969, fig. 2) and an assumed 2- to 3-m.y. age for the embayment yield a geologic slip rate of 1.6 ± 0.4 cm/yr.

Additional evidence for Quaternary strike slip (Dibblee, 1966; Cummings, 1968) comes from the southern Santa Cruz Mountains south and west of San Jose. Distinctive reworked conglomerate clasts in the Corte Madera facies of the Santa Clara Formation west of the San Andreas fault are displaced 28 km from their source, an Upper Cretaceous pebble conglomerate lens on the east side of the fault. The age of the Corte Madera facies is poorly constrained, but Cummings (1968) assumed a probable age range of 1 to 3 m.y., which yields slip rates of about 1 to 3 cm/yr.

These slip rates carry uncertainties as great as ±1 cm/yr, but because they integrate slip over millions of years of geologic time, short-term changes in fault activity influence them only slightly. For comparison, a late Holocene slip rate is available from a site on the San Francisco peninsula, 11 km south of San Francisco. There, displaced and abandoned stream channels and relict alluvial deposits (fig. 4.6) were explored and described by Hall (1984; N.T. Hall, written commun., 1986). The alluvium, ^{14}C dated at $1,130\pm160$ yr, accumulated along a northwest-flowing stream and behind a northwest-trending shutter ridge along the main fault trace. Alluviation ceased when fault slip, unusually high seasonal streamflow, or stream piracy caused the stream to abandon its fault-extended course and to carve a shorter, steeper, southwest-flowing channel across the fault and directly down the slope. This younger channel now exhibits 13.5 m of right-lateral offset where it is crossed by the fault; about 2.7 m of this total offset can be attributed to fault displacement during the 1906 earthquake. Hall's (1984) analysis of this sequence of depositional, erosional, and faulting events yields a minimum slip rate for the past 1,200 yr of about 1.25 cm/yr.

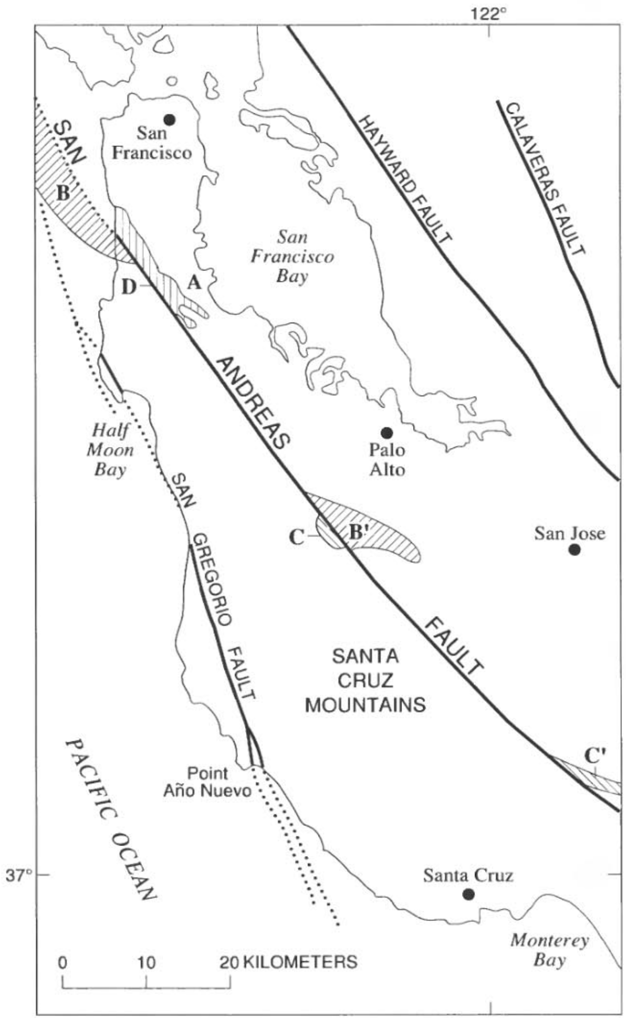


FIGURE 4.5.—Fault-displaced geologic units on the San Francisco peninsula provide a basis for estimating the rate of strike slip on this section of the San Andreas fault—about 1.5 cm/yr for the Quaternary. Critical field relations include: A, outcrop belt of the marine Merced Formation, 2.0–0.4 Ma, truncated and faulted against older rocks for 11 km on the southwest; B–B′, fault-displaced parts of a 3.0- to 2.0-Ma, late Pleistocene marine embayment (Addicott, 1969); C–C′, 3.0- to 1.0-Ma nonmarine conglomerate of the Corte Madera facies of the Santa Clara Formation west of the fault and its source area east of the fault (Cummings, 1968); D, site where 1.2-ka (late Holocene) slip rate of about 1.25 cm/yr (Hall, 1984) was measured. Quaternary slip has also occurred on the San Gregorio, Hayward, and Calaveras faults. Faults dotted where concealed by water.

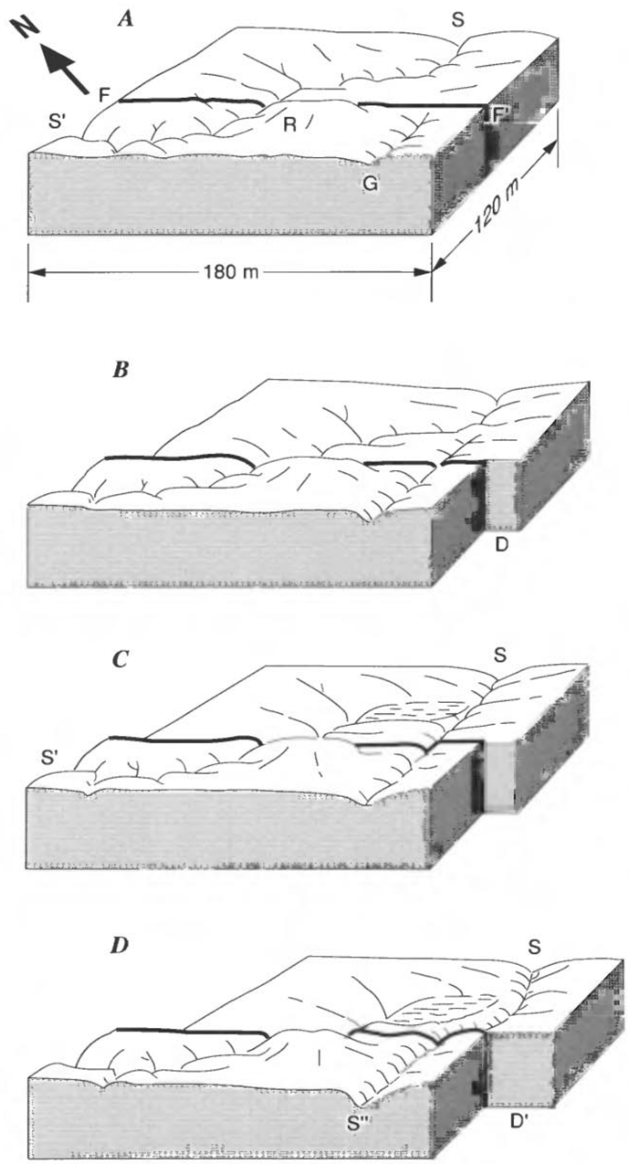


FIGURE 4.6.—Interpretative block diagrams, based on relations described by Hall (1984), for a site on the San Andreas fault 11 km south of San Francisco. Rate of fault slip, about 1.25 cm/yr, is derived from observed 13.5-m stream offset, which postdates alluviation along original (precapture) streamcourse. *A*, Stream, flowing obliquely downslope from S to S′, is partly diverted by ridge (R) where stream crosses the San Andreas fault (F–F′). Gully (G) heads southwest of fault, flowing toward observer. *B*, Displacements (D), caused by fault slip, offset stream and lengthen its channel; gully erodes headward across fault. *C*, Low gradient of stream channel causes alluviation upstream from fault, facilitating capture of its headwaters by gully and abandonment of streamcourse S–S′. Date of alluviation, 1,130±160 yr B.P., from detrital charcoal dated by ^{14}C methods. *D*, Renewed fault displacements (D′) offset captured stream (S–S″) by 13.5 m, an amount that includes 2.7 m of slip in 1906.

OTHER FAULTS

The rate of Quaternary strike slip along the northern section of the San Andreas fault south of San Francisco, about 1.5 cm/yr, is less than either the 5.1 cm/yr attributed to the plate boundary or the 2.5 to 3.5 cm/yr observed along more southerly segments of the fault. Much of this slip deficit can be accounted for by distributed slip on several other northern California faults that nearly parallel the main trace of the San Andreas.

One of these faults, the San Gregorio, is the northernmost of a 400-km-long set of coastal faults lying southwest of the main trace of the San Andreas. The San Gregorio fault extends northward from Monterey Bay, joining the San Andreas about 20 km northwest of San Francisco, near Bolinas Bay. Where it cuts the coastline near Point Año Nuevo, the San Gregorio is a complex, 3- to 5-km-wide zone of near-vertical strike-slip and northeast-dipping reverse faults. Faults in this zone offset stream channels incised into marine and nonmarine strata that were deposited on a 105-ka-old wave-cut platform; the faults also offset the shoreline angle of this and at least one older wave-cut platform (fig. 4.7). Evidence from offset shoreline angles and faulted strata indicates a late Pleistocene, right-lateral slip rate of 0.6 to 1.1 cm/yr across the fault zone (Weber and Cotton, 1981, p. 16, 72–75); Hamilton and others (1979), however, argued for rates of only 0.1 cm/yr in the same area.

If the higher slip rate on the San Gregorio fault and the rates estimated for the San Andreas fault south of San Francisco are correct, Quaternary slip on the San Andreas north of its junction with the San Gregorio must be about 2.6 cm/yr—the sum of the rates on the two separate faults. This rate agrees closely with that previously cited for the San Andreas near Point Arena (Prentice, 1989).

Additional slip occurs along faults northeast of the San Andreas, as shown by geomorphic evidence, alignment of earthquake epicenters, and, on some faults, gradual fault creep amounting to as much as 1 cm/yr. Direct geologic evidence of Quaternary slip on such faults as the Hayward, Calaveras, and Green Valley is abundant, but the age and crossfault correlation of displaced stratigraphic markers are uncertain, and Quaternary slip rates are only weakly constrained. These rates, however, can be estimated from such other criteria as modern creep rates, geologic slip rates for displaced pre-Quaternary markers, and geomorphic expression relative to that along the San Andreas fault.

On such evidence, the most active fault trend, with Quaternary slip rates estimated to range from 0.5 to 1.0 cm/yr, is that defined by the southern section of the Calaveras fault and by the Hayward, Rodgers Creek-Healdsburg, and Maacama faults (fig. 4.3). Together, these faults extend for 375 km as a series of chiefly right-stepping breaks that exhibit abundant geomorphic evidence of recent movement. The seismically active Green Valley fault, locally as well defined as the Rodgers Creek and 27 km farther east, offsets cultural features that record right-lateral creep of 0.5 cm/yr between 1922 and 1974 (Frizzell and Brown, 1976).

The east boundary of the northern section of the San Andreas fault system follows a series of faults that trend north-northwest, exhibit recognizable components of right-lateral strike slip, and approximately separate the Coast Ranges from the Great Valley. This discontinuous

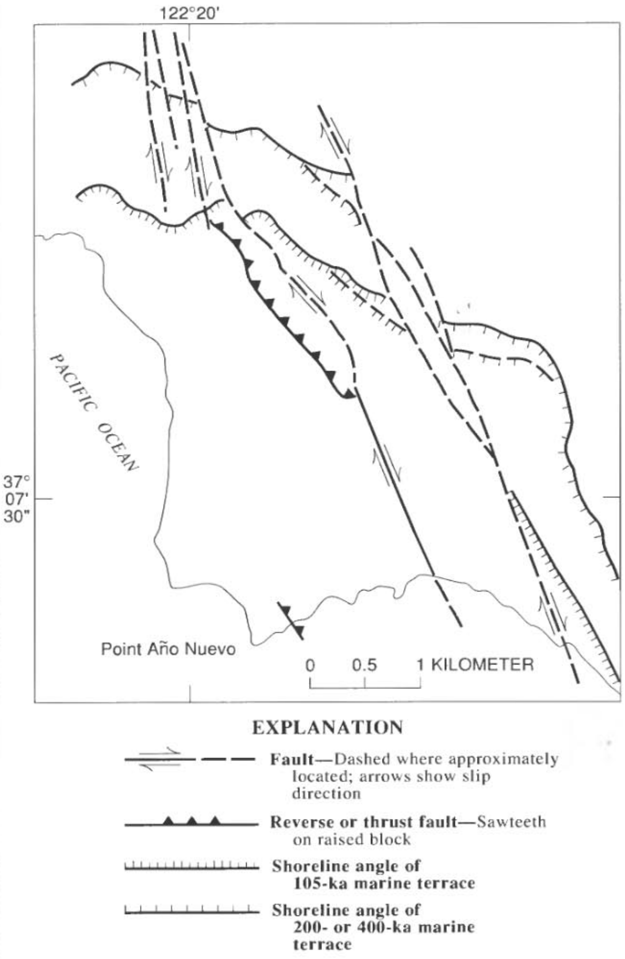


FIGURE 4.7.—Sketch map of Point Año Nuevo area, northern California, showing fault-displaced shoreline angles in the San Gregorio fault zone. Broken segments of shoreline angles indicate possible alternative locations. This figure, simplified from Weber and Cotton (1981), shows the difficulty of accurately measuring displacement where faults intersect a relict shoreline at acute angles (see fig. 4.8A).

and somewhat diffuse belt of faulting includes, from north to south, the Stony Creek, Greenville, and Ortigalita faults. No obvious surface faulting bridges the 100-km interval between the Stony Creek and Greenville faults, but major earthquakes in 1892 at Vacaville (lat 38°12.5′ N., long 121°35′ W) and Winters (lat 38° 18.5′ N., long 121°34′ W.) may signify fault continuity at depth on this trend.

The historically aseismic Stony Creek fault follows and locally truncates a major detachment surface (the Coast Range thrust) that has been rotated to vertical or overturned. It now exhibits a steep east-facing scarp along the front of the Coast Ranges and separates a mountainous Franciscan terrane on the west from less deformed rocks on the east. Stream-terrace and fan deposits of Quaternary age east of the fault terminate at its scarp and are gently tilted and dissected by erosion. Sparse geologic evidence of renewed Quaternary faulting favors dominantly vertical slip, up to the west, but a right-lateral strike-slip component is indicated by asymmetric cusps and bays in the mapped trace of the fault and by nearby southeasterly-plunging folds that deform rocks at least as young as late Pliocene (Fox, 1983, p. 22).

System-boundary faults to the south exhibit both local seismic activity and evidence of Quaternary slip. The Greenville fault, here (fig. 4.3) combined with the Marsh Creek and Clayton faults, displaces Quaternary stream-terrace deposits and soils, as well as fold axes in middle to upper Tertiary marine deposits. Right-lateral slip rates on these faults range from 0.01 to 0.30 cm/yr, but most Quaternary rates are less than 0.1 cm/yr (Sweeney, 1982; Wright and others, 1982). These relatively low rates are consistent with weak geomorphic expression along this fault trend.

FOLDING, UPLIFT, AND VOLCANISM

Northwest- or east-west-trending folds deform much of the San Andreas fault system except for the relatively undeformed Sebastopol block (Fox, 1983) between the San Andreas fault and the fault trend defined by the Hayward, Rodgers Creek, and Maacama faults. The relative structural simplicity of this block is most evident between San Francisco Bay and about lat 39°30′ N. (fig. 4.3), where flat-lying upper Miocene and Pliocene strata of the Wilson Grove (Fox, 1983) and Ohlson Ranch (Higgins, 1960) Formations extend across much of its surface. The erosional surface of this part of the block, the Mendocino Plateau (Lawson, 1894; Wahrhaftig and Birman, 1965, p. 323; Fox, 1983, p. 22–24), is a planar or gently warped upland with accordant ridge crests at elevations of 300 to 600 m. Fox (1983) contrasted the apparent stability of his Sebastopol block with a more typical, highly deformed region to the east, his Santa Rosa block.

In the Santa Rosa block and in other more easterly parts of the Coast Ranges, Quaternary folding and faulting have left uplifted or anticlinal ridges and down-warped or downfaulted basins. Some of the larger basins, now filled with locally derived sediment of Pliocene and Quaternary age, are the southern arm of the San Francisco Bay, Napa and Livermore Valleys (lat 38°20′ N., long 122°20′ W., and lat 37°40′ N.,long 121°50′ W.), and the topographic basin surrounding Clear Lake (lat 39°01′ N., long 122°30′ W.). Smaller aligned or linear basins that follow northwest-trending faults or synclinal folds (fig. 4.3) clearly are structurally controlled.

Rates of folding and uplift are best known for coastal regions. Marine terraces between San Francisco and Monterey Bay indicate general uplift of 120 to 180 m during the past 0.5 to 1 m.y. (Helley and others, 1979, p. 18)—an uplift rate of about 0.02 cm/yr. Local variation in uplift is shown by the deformed shoreline angle and wave-cut platform of the youngest (82 ka) terrace (fig. 4.8); near Half Moon Bay, the wave-cut platform has been warped by northwest-trending folds into a surface that exhibits 60 m of structural relief over a distance of about 11 km (Lajoie, 1986, fig. 6.21). About 10 km west of Santa Cruz, this terrace is about 14 m above modern sea level (Bradley, 1957; Bradley and Griggs, 1976; Hanks and others, 1984, p. 5776–5777), indicating a local uplift rate of 0.04 cm/yr.

Coastal uplift south of San Francisco contrasts with Quaternary crustal subsidence 25 to 30 km inland and east of the San Andreas fault (figs. 4.3, 4.5). Estuarine, stream-laid, and freshwater-swamp deposits of Quaternary age underlie the northwest-trending structural basin containing the San Francisco Bay and the Santa Clara Valley (lat 37°10′ N., long 121°40′ W.) to depths greater than 200 m below sea level. This prolonged Quaternary downwarping (Wahrhaftig and Birman, 1965) locally attained subsidence rates of 0.02 to 0.04 cm/yr (Atwater and others, 1977) during post-Sangamon time.

Despite such local variations in the amount and orientation of crustal processes, Quaternary uplift (fig. 4.9) prevails throughout the northern Coast Ranges. Regional uplift, at least partly of Quaternary age, is greatest and most evident east of the Hayward-Rodgers Creek-Maacama fault trend. Summit elevations north of Clear Lake exceed 1,500 m (Wahrhaftig and Birman, 1965, fig. 9), and those in the Diablo Range, south of the Livermore Valley, range from 600 to 1,200 m (Christensen, 1965, pl. 1). Both of these colinear uplands exhibit high relief, evidence of rapid downcutting, and cores of the emergent Franciscan complex flanked by outward-dipping strata of Pliocene and Quaternary age.

Volcanic rocks of late Cenozoic age, widely distributed between the San Pablo Bay and Clear Lake, define a triangular, northwest-trending outcrop area, 120 km long by 35 km wide, with its most acute, north apex at Clear Lake. These rocks are assigned to two geographically separated extrusive sequences: the late Miocene and Pliocene Sonoma Volcanics to the south, and the younger, more areally restricted Clear Lake Volcanics (fig. 4.3) to the north. The Clear Lake Volcanics is almost wholly of Quaternary age. Flow surfaces, volcanoes, cinder cones, obsidian domes, and craters retain their original

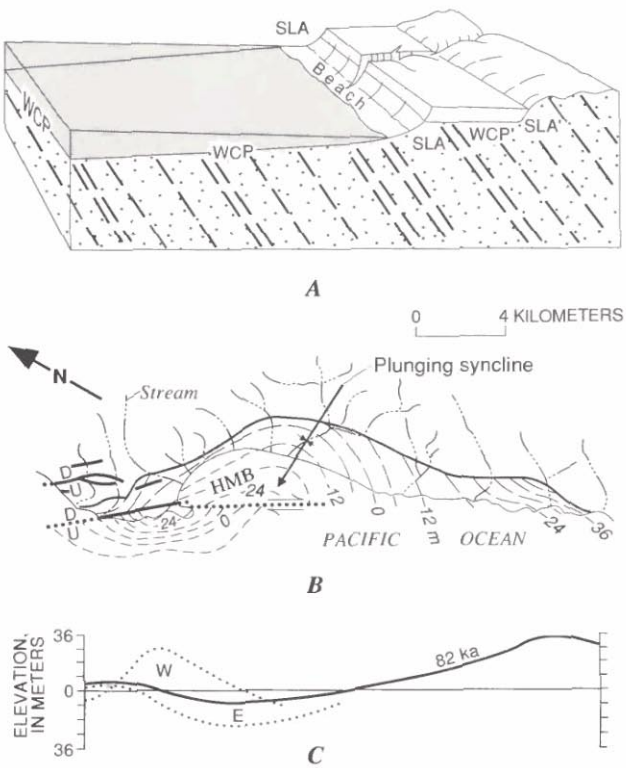


FIGURE 4.8.—Local variability in coastal uplift shown by deformed shoreline angle and wave-cut platform. *A*, Coastal geomorphic features used to measure Quaternary deformation. SLA, shoreline angle carved by marine erosion at present sea level; WCP, wave-cut platform; WCP′ and SLA′, elevated surface and shoreline angle, respectively, of an older wave-cut platform now mantled by marine terrace deposits and terrestrial sediment (light stippling). Normal seaward slope of wave-cut platform, exaggerated in diagram, is about 1°–2°. *B*, Folding and right-lateral faulting along the Seal Cove branch of the San Gregorio fault zone near Half Moon Bay (HMB), as shown by warped surface of an 82-ka wave-cut platform and deformation of its landward edge, the shoreline angle (heavy line). Structure contours (long dash on land, short dash off shore) on platform are derived from shallow boreholes and seismic-refraction data. Arrows on fault (dotted where concealed) indicate direction of relative movement: U, upthrown side; D, downthrown side. Modified from Lajoie (1986). *C*, Platform profiles on fault plane (dotted lines: E, east; W, west), showing vertical separation across fault and deformation relative to shoreline angle (heavy line). Modified from Lajoie (1986).

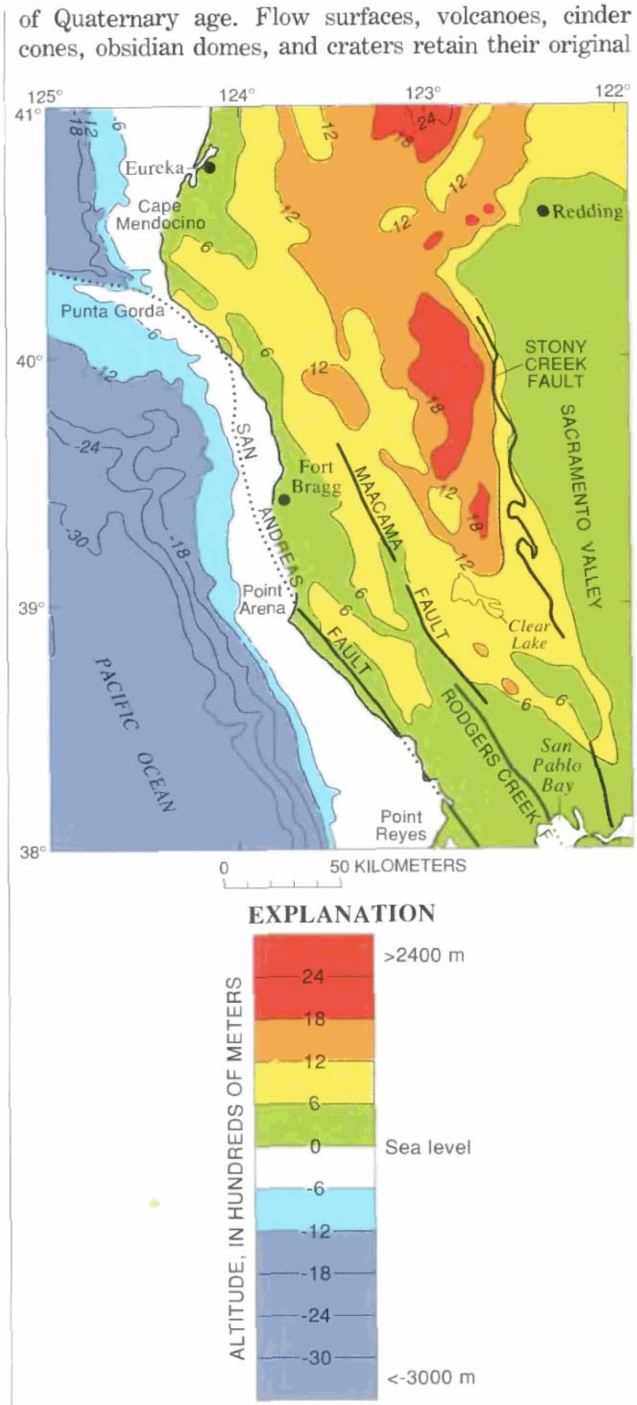


FIGURE 4.9.—Generalized surface on summit altitudes (*Gipfelflur*) in the Coast Ranges north of San Francisco, showing major faults with Quaternary activity in the San Andreas fault system—that part of the map south of Cape Mendocino and west of the Sacramento Valley. *Gipfelflur* approximately defines regions of Quaternary uplift and crustal blocks bounded by strike- and dip-slip faulting (dotted where concealed). Generalized from Wahrhaftig and Birman (1965).

constructional form, and the Geysers Hot Springs area on the west side of the main volcanic field attests to continuing geothermal activity. Lava flows range in composition from olivine basalt to rhyolitic obsidian, and pyroclastic deposits are nearly as varied. The oldest well-dated rocks in the Clear Lake Volcanics yield K-Ar ages near 2.1 Ma; the youngest—ash beds in lake sediment beneath Clear Lake—yield ^{14}C ages of about 11 ka (Hearn and others, 1976; Sims and Rymer, 1975).

The sustained late Cenozoic volcanic episode recorded by the Sonoma and Clear Lake Volcanics is unique within the San Andreas fault system, although similar but less extensive Quaternary volcanism marks the northern end of the Gulf of California ridge-transform system in the Salton Trough (lat 33°19′ N., long 115°50′ W.).

CENTRAL SECTION OF THE SAN ANDREAS FAULT SYSTEM

SAN ANDREAS FAULT

From the Gabilan Range southward to the Transverse Ranges, the San Andreas fault itself dominates the fault system. Except for the San Gregorio-Hosgri set of coastal faults, branch faults are few and short, and exhibit less evidence of Quaternary activity than those farther north. This relatively simple pattern changes at the northern margin of the Transverse Ranges, where major folds and faults trend more east-westerly and incorporate large components of reverse and thrust motion. In this chapter, faults in the western Transverse Ranges and southern Coast Ranges are grouped together as components of the central section of the San Andreas fault system. This combination of two different structural and physiographic provinces stresses that the transition from compressional structures in the Transverse Ranges to strike-slip structures in the Coast Ranges is more gradual and less sharply defined than the physiographic boundary.

This section of the fault system, 340 km long by 140 km wide, extends from the northern Gabilan Range to the southern Transverse Ranges, near lat 34° N. (fig. 4.10). Besides the San Andreas, faults with Quaternary slip include the Hosgri, San Simeon, and Rinconada in the north; the Big Pine, Ozena, South Cuyama, and Morales to the south and in the Coast Ranges; and the east-west-trending reverse and thrust faults in the Transverse Ranges. Several faults in the Transverse Ranges continue offshore into the Santa Barbara Basin.

The San Andreas fault trends S. 40° E. from the northern Gabilan Range to the Carrizo Plain; there, it bends eastward and ultimately attains a S. 75° E. trend in the Transverse Ranges. North of the bend, it follows a series of nearly aligned stream valleys, which separate the Diablo Range and parts of the Temblor Range on the

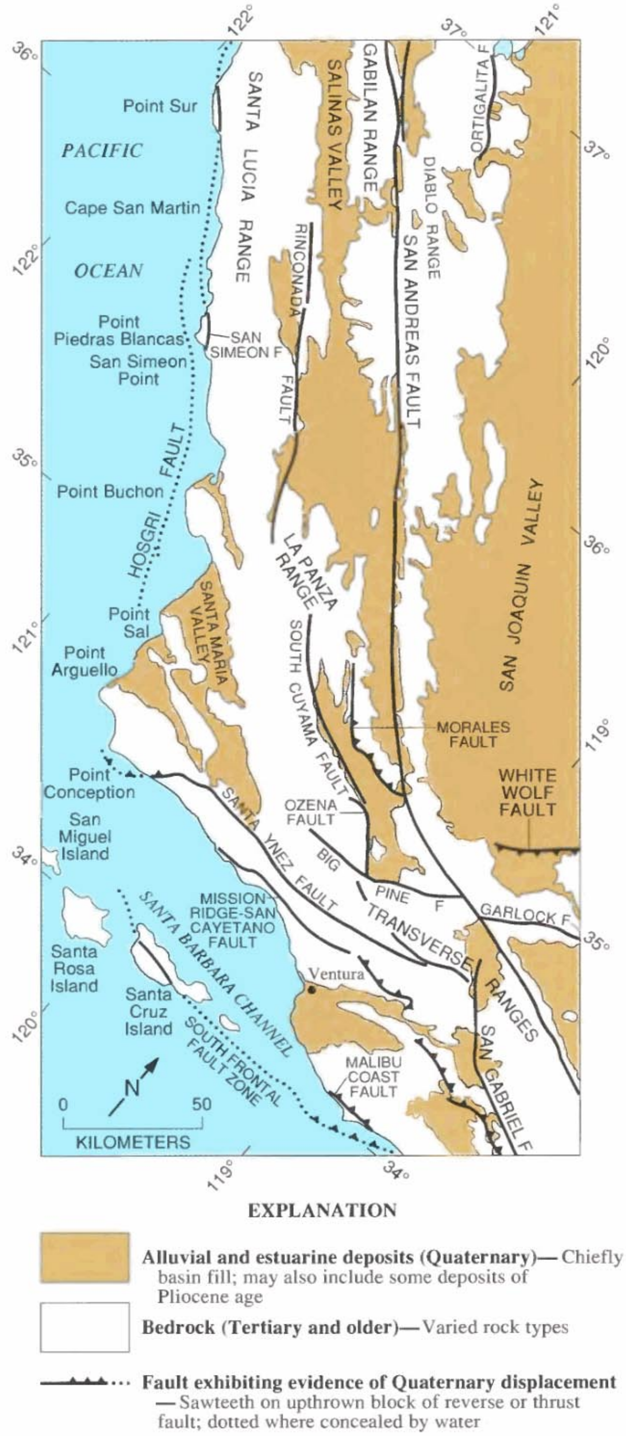


FIGURE 4.10.—Sketch map of southern Coast Ranges and western Transverse Ranges, southern California, showing faults with Quaternary activity and basin deposits in the central section of the San Andreas fault system. Fault patterns are generalized, and only major faults are shown.

northeast from the Gabilan Range, Cholame Hills (lat 35°27′ N., long 120°18′ W.), and Caliente Range (lat 35°02′ N., long 119°46′ W.) on the southwest (Brown, 1970; Vedder and Wallace, 1970). An actively creeping length of the fault, with historical slip rates as high as 3.4 cm/yr, extends 160 km southward from the northern Gabilan Range to the south end of the Diablo Range.

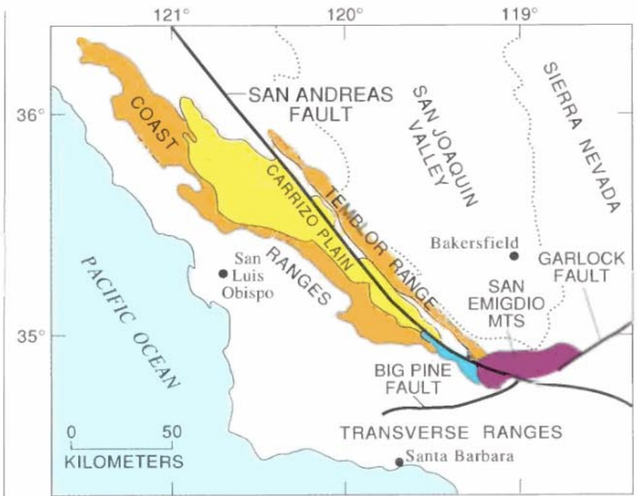
To the south, along the boundary between the Transverse Ranges and the Mojave Desert, the fault continues as a series of closely aligned echelon breaks, in a narrow (0.5 km wide) linear trench. This segment, which also displays abundant geomorphic evidence of Quaternary slip (Ross, 1969), is currently locked and seismically quiet.

Hill and Dibblee (1953, p. 446), in proposing large sustained strike slip on the San Andreas fault, described fault-juxtaposed gravels of similar age but different lithologies in the area between the Temblor Range and the Transverse Ranges (fig. 4.11). Pebble gravel in the Paso Robles Formation, of Pleistocene and Pliocene age, consists chiefly of porcellanite and siliceous shale clasts derived from the Miocene Monterey Formation of the western Coast Ranges and the Temblor Range. These distinctive Paso Robles gravel beds are most extensive southwest of the San Andreas fault, but northeast of the fault they extend as a narrow band to about lat 35° N. For several kilometers near this latitude, they are faulted against Pleistocene gravel containing clasts of plutonic and metamorphic rock and indurated sandstone, derived from the San Emigdio Mountains to the south. According to Hill and Dibblee (1953, fig. 2), the depositional contact between the two gravel lithologies is displaced about 16 km from its prefaulting location.

Farther north, between lat 35°30′ and 35°45′ N., Galehouse (1967, p. 974–976) described different clast compositions and heavy-mineral assemblages in Paso Robles strata on opposite sides of the fault. These differences are reasonably and consistently resolved if 40 km of right-lateral fault slip is removed, restoring the offset facies to their original positions.

These displaced stratigraphic relations imply Quaternary slip of 16 to 40 km, but the uncertain age of the faulted strata makes estimates of the slip rate unreliable. More accurate measurements of fault slip have been obtained at three localities north of the Transverse Ranges: two in the creeping segment and one in the more southerly, currently locked segment that produced the 1857 earthquake.

At the northernmost locality (lat 36°34.9′ N., long 121°10.4′ W.), along the San Benito River near the east boundary of the Gabilan Range, the fault displaces the risers of river terraces (fig. 4.12), exhibiting 64 m of right slip. Trenches on the terrace near the fault disclosed a fluvial scarp and a distinctive sand bed, both offset about 17.7 m by faulting during the past 790±144 ^{14}C yr



EXPLANATION

[Distribution of rock units shown only for region adjacent to San Andreas fault]

Coast Ranges

Paso Robles Formation (Pleistocene and Pliocene)—Chiefly gravel, sand, and clay; gravel clasts, derived from sources in the Coast Ranges and Temblor Range, consist chiefly of porcellanite and siliceous shale from the Monterey Formation

Monterey Formation (Miocene)—Well-bedded siliceous shale, porcellanite, and sandstone. Source unit for the type Paso Robles Formation of the southern Coast Ranges

San Emigdio Mountains

Deformed alluvial deposits of Vedder (1970) (Pleistocene)—Chiefly gravel and sand; gravel clasts, derived from sources in the San Emigdio Mountains, consist chiefly of plutonic and metamorphic rocks and indurated sandstone. Mapped by some authors as Paso Robles Formation

Plutonic, metamorphic, and sedimentary rocks (Paleogene and pre-Tertiary)—Source rocks for conglomerate near the San Emigdio Mountains

FIGURE 4.11.—Midway between Bakersfield and Santa Barbara, Calif., the San Andreas fault locally juxtaposes conglomerates of similar age but different lithologies. Porcellanite and siliceous shale clasts immediately northeast of the fault were derived chiefly from the folded and uplifted Monterey Formation in the southern Coast Ranges; plutonic, metamorphic, and sedimentary clasts across the fault to the southwest were derived from the San Emigdio Mountains of the northern Transverse Ranges. Total displacement and precise age of conglomerate units are unknown, but mapped offset of at least 16 km requires sustained Quaternary strike slip, as recognized by Hill and Dibblee (1953).

(Perkins and others, 1989). The slip rate calculated from these data, about 2.2 cm/yr, agrees closely with creep rates currently observed along this section of the fault.

In Bitterwater Valley (lat 36°23.9′ N., long 120°58.9′ W.), 27 km southeast of the San Benito River locality, fault-displaced buried channels in an alluvial fan of Quaternary age record a slip rate over the past 1 ka of about 2.8 cm/yr (Cotton and others, 1986), but the slip rate, as well as its distribution within the fault zone, has varied over time. The historical slip rate, 3.4 cm/yr, represents chiefly gradual fault creep and is based on offsets observed in fences built in 1908 and in channels that presumably date from about 1885. According to Cotton and others (1986), at least one episode of slower movement is evident, and, during the past 1 ka, slip across the 20-m-wide fault zone has followed different breaks.

Sieh and Jahns (1984) measured and dated late Quaternary displacement on the San Andreas fault at Wallace Creek (lat 35°16.3′ N., long 119°49.7′ W.), near the southwestern margin of the Temblor Range. "Wallace Creek," an informal name (Sieh and Jahns, 1984, p. 896) for a previously unnamed drainage, does not appear on published U.S. Geological Survey topographic maps. At this locality, dated fan and channel deposits, stratigraphic and geomorphic relations, and fault offsets of both abandoned and existing stream channels document 128±1 m of strike-slip displacement (fig. 4.13). This record of cumulative fault slip began with incision of the existing channel of Wallace Creek sometime after 3,680±155 yr ago and ended with the nearly 10 m of fault slip that accompanied the 1857 earthquake. Because the 3,680-yr ^{14}C age is measured relative to A.D. 1950, the appropriate timespan for the measured slip is 3,680−(1,950−1,857), or 3,587 yr. The minimum rate is

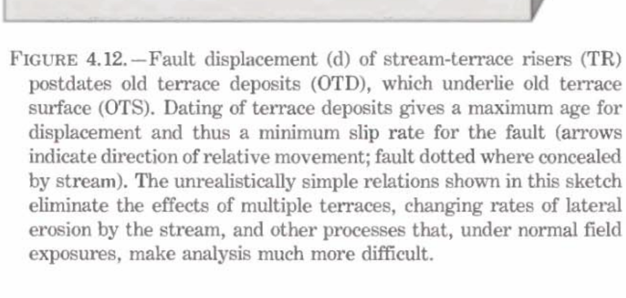


FIGURE 4.12.—Fault displacement (d) of stream-terrace risers (TR) postdates old terrace deposits (OTD), which underlie old terrace surface (OTS). Dating of terrace deposits gives a maximum age for displacement and thus a minimum slip rate for the fault (arrows indicate direction of relative movement; fault dotted where concealed by stream). The unrealistically simple relations shown in this sketch eliminate the effects of multiple terraces, changing rates of lateral erosion by the stream, and other processes that, under normal field exposures, make analysis much more difficult.

thus 128 m/3,587 yr, or 3.57±0.2 cm/yr; the maximum rate, based on the stratigraphy and geometry of the abandoned channel, is 3.53±0.2 cm/yr. When these maximum and minimum values are combined and adjusted to incorporate uncertainty in the state of strain at the beginning of the time interval, a preferred slip rate (Sieh and Jahns, 1984, p. 891) of 3.39 ± 0.3 cm/yr is obtained. A similar but more complex analysis of 13,250-yr-old fan deposits displaced 475 m from their source gullies yields a slip rate of 3.58±0.5 cm/yr (Sieh and Jahns, 1984, p. 891–892) for the past 13,250 yr. The close agreement of these rates suggests that the average rate of late

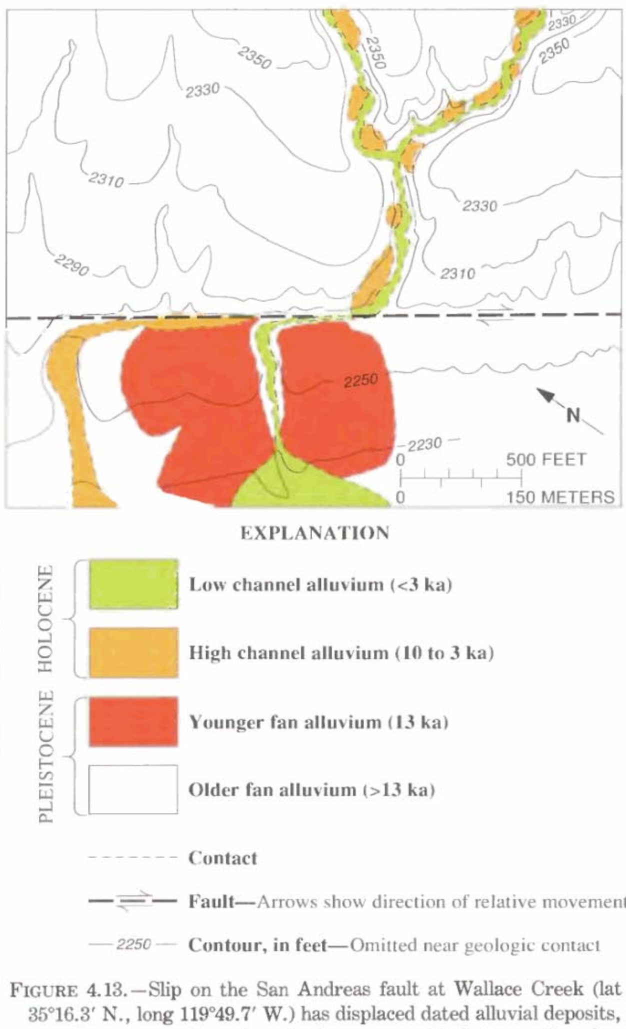


FIGURE 4.13.—Slip on the San Andreas fault at Wallace Creek (lat 35°16.3′ N., long 119°49.7′ W.) has displaced dated alluvial deposits, as well as stream channels and other geomorphic features. Trenches excavated across and parallel to fault at this locality disclose details of stratigraphy, origin of stratigraphic units, and their age as determined from detrital charcoal. Displacements of different ages yield similar average slip rates of about 3.4 cm/yr. Original source drainages for older fan alluvium are near or southeast of right margin of figure. Simplified from Sieh and Jahns (1984, fig. 2).

Quaternary fault slip has been relative uniform at this locality.

Horizontal slip rates on the San Andreas fault are less well constrained in the western Transverse Ranges. Davis (1983, p. 368) and Rust (1982) independently estimated slip rates in the range 2–5 cm/yr for areas 70 km apart and on opposite sides of the junction of the Garlock fault with the San Andreas. These estimates involve substantial uncertainty in the amount and (or) timing of slip; they also apply to different parts of the Quaternary—no more than the past 400 ka for displaced gravel deposits in the San Emigdio Mountains (Davis, 1983), and no more than the past 2 ka for offset landslide deposits 32 km southeast of the Garlock-San Andreas fault junction (Rust, 1982). These rates, however, are broadly consistent with those measured to the north. Moreover, they indicate that much Quaternary strike slip in the western Transverse Ranges has followed the main trace of the San Andreas—a departure from pre-Quaternary history, when the San Gabriel fault to the southwest accommodated much of the fault slip (Crowell, 1975).

OTHER FAULTS

Other faults with known or probable Quaternary slip in the central Coast Ranges include the Rinconada, Big Pine, Ozena, South Cuyama, Morales, and a coastal fault defined by its aligned but separately named segments: Hosgri, San Simeon, Sur (lat 36°10.8′ N., long 121°32′ W.), Monterey Bay (lat 36°40′ N., long 122°06′ W.), and San Gregorio. For most of these faults, the evidence of Quaternary activity is sparse, discontinuous along strike, and in places arguable. It includes weakly expressed scarps and drainage offsets, displaced deposits of late Pliocene and Quaternary age, and historical seismicity along some fault trends. The geologic and geophysical evidence for Quaternary activity is somewhat more convincing for the Hosgri fault and its northern, colinear counterparts than for faults farther inland.

The Hosgri and similarly aligned coastal faults trend north-northwesterly from near Point Conception (Steritz and others, 1986) to the latitude of Monterey Bay (Silver and Normark, 1978), where they continue northward as the San Gregorio fault. For most of its length, this coastal fault zone is a complex, multistrand break a few kilometers off shore; it is recognized and mapped from juxtaposed stratal units interpreted from seismic-reflection profiles and truncated magnetic anomalies. Locally, sea-floor scarps and displaced Holocene deposits, interpreted from the seismic-reflection profiles, confirm its Quaternary activity (Wagner, 1974; Leslie, 1981).

The San Simeon fault (fig. 4.14), which may be an onshore segment of the Hosgri (Leslie, 1981), is also a multistrand break; it cuts and displaces late Pleistocene marine terraces and Holocene dune sands near San Simeon Point (Weber, 1983). Although faulted shoreline-angle geometry and the correlation of wave-cut platforms across this fault are subject to some uncertainty, Weber (1983, p. 56–59) and Hanson and others (1987) suggested a horizontal right-slip component of about 0.5 cm/yr. Earthquake focal mechanisms along the San Simeon fault indicate a dip of 55° E. and nearly equal components of reverse and strike slip (Eaton, 1984). Right-oblique slip at a rate of about 0.5 cm/yr on the Hosgri fault is indicated by earthquake focal mechanisms, sea-floor scarps, the distribution of late Quaternary wave-cut platforms, and faulted seismic-reflection horizons of late Cenozoic age. Much of this evidence is documented from investigations near the Diablo Canyon Powerplant (Pacific Gas and Electric Co., 1988), where it has been interpreted as pure strike slip.

In the western Transverse Ranges, faults with Quaternary displacement include some, like the San Andreas and San Gabriel, that exhibit chiefly strike slip and others, trending east-west or southwest, that exhibit reverse or oblique slip. The left-lateral Santa Ynez fault is an exception to the more general pattern of reverse and thrust faults. The reverse- and oblique-slip faults in the Transverse Ranges are complicated by splays, offsets, and changes in strike, but from north to south they define at least four major continuous, or nearly continuous, fault zones of different lengths: the Santa Ynez (130 km); the More Ranch-Mission Ridge-San Cayetano (110 km), from the coast near Santa Barbara, eastward; the Mission Hills-San Fernando-Sierra Madre (56 km), along the southwest side of the San Gabriel Mountains; and the South Frontal (250 km). Many of these faults exhibit evidence of Holocene movement, and the San Fernando fault produced the surface rupture and destructive $M=$ 6.6 earthquake of February 1971. Some of these faults, and others with east-westward trends, extend offshore into the Santa Barbara Channel (lat 34°09′ N., long 119°33′ W.), where they also cut Pleistocene or Holocene deposits (Clarke and others, 1985). Ziony and Yerkes (1985, p. 43–60) provided more detailed descriptions and maps of the late Quaternary faults in this and nearby areas; they also noted (p. 44) a profound increase in deformation rates in and near the Transverse Ranges during the past 750 ka. This pulse of orogenic activity—manifested by the growth of folds, uplift, and accelerated slip on reverse and thrust faults—coincides with middle Pleistocene and younger deformation observed to the south (Woodford and others, 1954, p. 77–78) in the Los Angeles Basin.

Maximum and minimum slip rates for many of the faults in the Transverse Ranges are deduced from offsets observed in drainages, fan surfaces, river terraces, and wave-cut platforms. Reported by numerous investigators (Clark and others, 1984), these rates of chiefly oblique slip cluster around a few tenths of a centimeter per year, but dip-slip components as great as 0.9 cm/yr are reported (Rockwell, 1988) for the San Cayetano fault. Observed slip rates may represent only a fraction of the total structural growth of the ranges because much of the late Quaternary deformation is by folding and uplift.

Although most Quaternary faulting south of the Gabilan Range is confined to structural blocks west and south of the San Andreas, two major faults, the Garlock and White Wolf, diverge northeastward from the San Andreas near the north boundary of the Transverse Ranges (fig. 4.10). Neither of these faults exhibits a clearly defined junction with the San Andreas, but together they

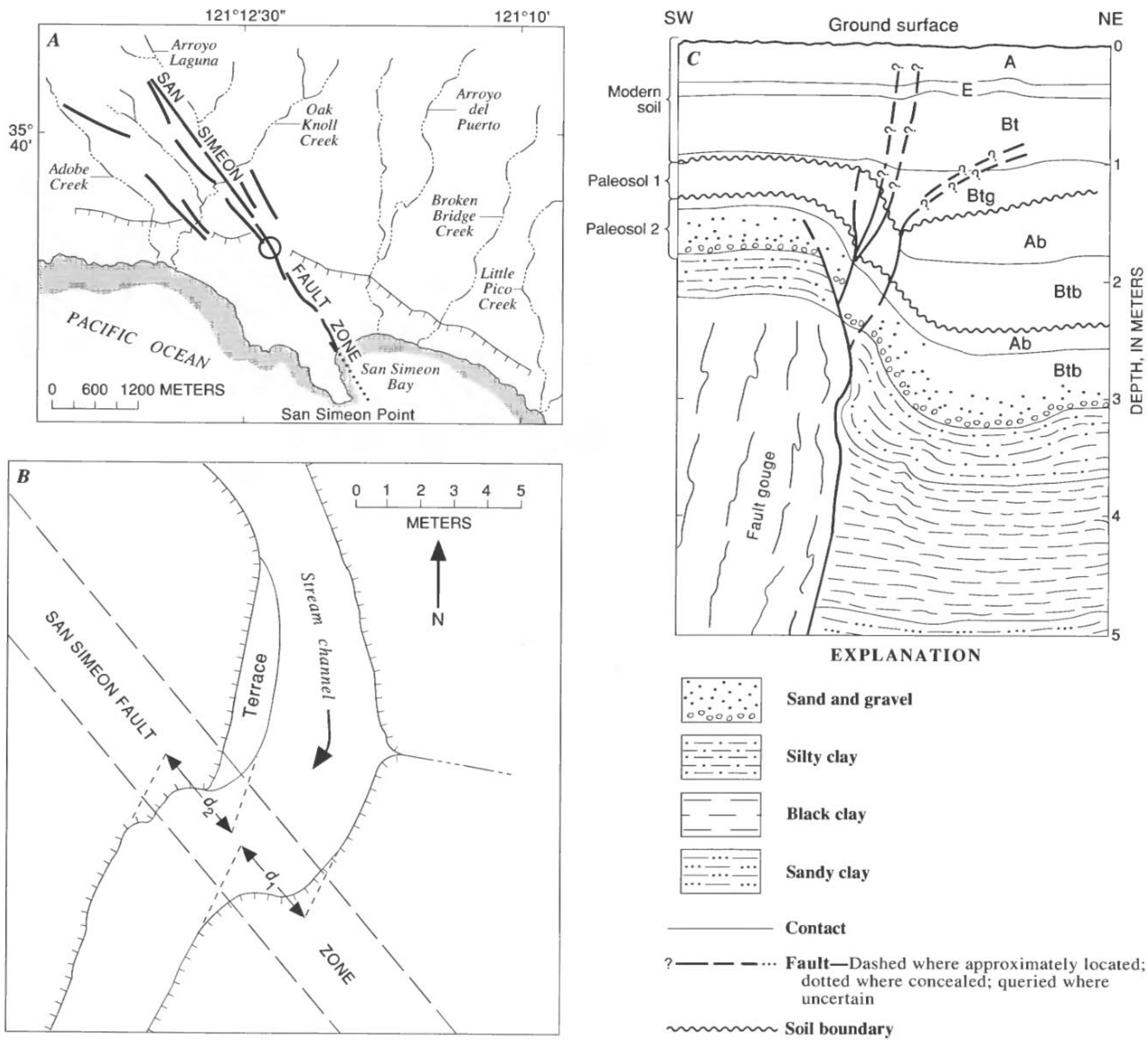


FIGURE 4.14.—Sketch maps and columnar section of San Simeon area, central California, showing selected examples of Quaternary faulting on the San Simeon fault zone. *A*, Displacement of shoreline angle (hachured line) of 124-ka wave-cut platform; other younger and older marine terraces, mapped by Weber (1983), are not shown. *B*, 3-m offset (d_1 and d_2) of stream channel near circled locality in figure 4.14*A*. *C*, Faulted paleosols and possibly faulted modern soil in trench exposure near circled locality in figure 4.14*A*; letters on right designate soil classifications. Quaternary strike-slip rate for this fault at the surface is about 0.5 cm/yr, but earthquake focal mechanisms (Eaton, 1984) indicate right-reverse slip at 6.6-km depth. From Pacific Gas and Electric Co. (unpub. data, 1986; see Pacific Gas and Electric Co., 1988).

bound the horstlike block of Sierran basement that makes up the Tehachapi Mountains. The White Wolf, a southeast-dipping reverse fault that was the source of the Kern County $M=7.7$ earthquake of July 1952, exhibits geomorphic evidence of recent slip at the range front but is concealed to the west beneath the southern San Joaquin Valley. The Garlock, devoid of major historical seismicity, exhibits clear evidence of left-lateral Quaternary slip (Clark, 1973) that increases eastward from 0.2 cm/yr at a point 55 km east of the San Andreas to 1.1 cm/yr at a point 75 km to the east (Clark and others, 1984).

FOLDING AND UPLIFT

Typically, Quaternary folds are more intense and better defined in thick Tertiary marine sequences than near or above such basement blocks as the granitic and metamorphic complexes of the Santa Lucia, La Panza, and Gabilan Ranges or the Franciscan core of the Diablo Range. Thus, some of the best expressed Quaternary folds are in the western Transverse Ranges (Bailey and Jahns, 1954, p. 95–98), the west side of the San Joaquin Valley (Harding, 1976), the Santa Maria Basin (Woodring and Bramlette, 1950, p. 109–116), and the southeast flank of the Santa Lucia Range (Compton, 1966). Harding (1976) used subsurface geologic data from oil fields northeast of the San Andreas fault to demonstrate that folding has moved outward from the San Andreas over time—the more northeasterly folds along the west side of the San Joaquin Valley being the youngest.

Rates of Quaternary folding in the westernmost Transverse Ranges exceed those elsewhere in the fault system. On the coast near Ventura (lat 34°07′ N., long 119°18′ W.), Pleistocene basin deposits more than 4 km thick have been intensely folded and faulted during the past 200 ka, attaining dips of 32°–45° in the southern limb of the Ventura Avenue anticline (fig. 4.15); uplift rates of about 1 cm/yr (Yeats, 1977; Lajoie and others, 1982) characterize the axis and southern limb of this fold. Uplift and folding elsewhere in the western Transverse Ranges may be slower but probably still exceeds deformation rates elsewhere in the fault system.

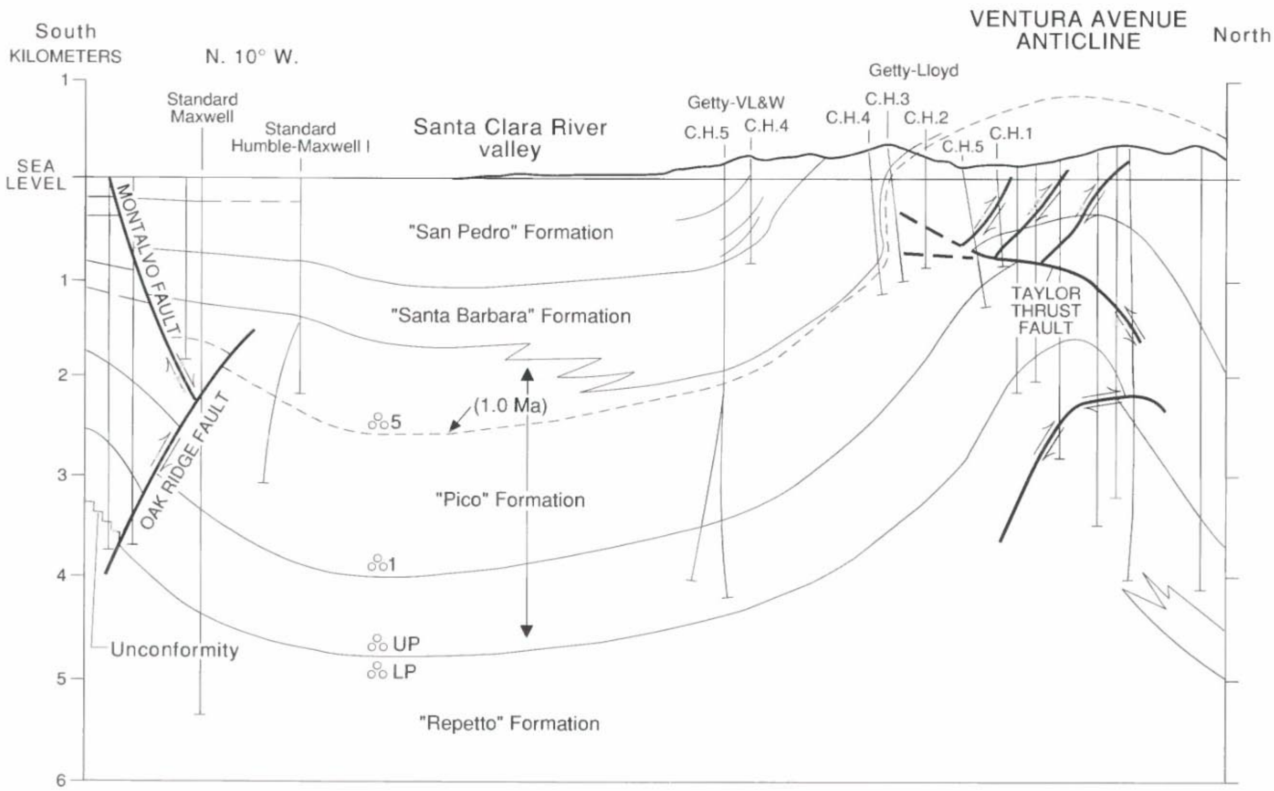


FIGURE 4.15.—Many drill holes penetrate well-dated Quaternary strata near the Ventura Avenue anticline. Besides the provincial microfaunal control shown here (3 small circles), Lajoie and others (1982b) employed a marine terrace (0.1–0.08 Ma) and 3 ash beds (0.6, 0.7, and 1.2 Ma) in the "San Pedro," "Santa Barbara," and "Pico" Formations of Yeats (1982) to estimate an average uplift rate of 1.25 cm/yr at the fold crest during the past 200 ka. Nearly all of this uplift is Quaternary in age; most is late Quaternary, as this highly generalized figure shows. Modified from Yeats (1982, fig. 7). Contacts and faults dashed where approximately located; arrows on faults indicate direction of relative movement. C.H., corehole; LP, lower Pliocene; UP, upper Pliocene; 1 and 5, provincial microfaunal markers.

Evidence for Quaternary uplift in this part of the San Andreas fault system is abundant and varied. High-standing ranges (Diablo, Santa Lucia, La Panza, and Transverse) emerge from a cover of their own eroded debris, represented by the Paso Robles Formation of the Coast Ranges, the Tulare Formation of the San Joaquin Valley and northern San Emigdio Mountains, and the Saugus Formation (and equivalent marine deposits) of the western Transverse Ranges. These upper Tertiary and Quaternary strata consist chiefly of alluvial debris, which has been deposited in fans, channels, and flood basins. Although the stratified deposits have been tilted, uplifted, and eroded (Bailey and Jahns, 1954; Christensen, 1965; Compton, 1966; Yeats, 1977; Davis, 1983), the map pattern of their remnants documents regional patterns of uplift.

Christensen (1965) employed such evidence (fig. 4.16) to document uplift of 600 m in the Diablo, Santa Lucia, and La Panza Ranges and to establish general systemwide uplift, north of the Transverse Ranges, of about 300 m. This broad pattern of late Pliocene and Quaternary uplift is reversed chiefly in the Salinas and Santa Maria Valleys (lat 36°09′ N., long 121°09′ W., and lat 34°34′ N., long 120°15′ W.), Kettleman Plain (lat 35°55′ N., long 120°05′ W.), and southern San Joaquin Valley, where elongate deep (100–900 m) but local basins have formed at the edge of basement blocks.

Late Pliocene and Quaternary uplift of the northern San Emigdio Mountains totals about 1,800 m (Davis, 1983, p. 299–300), the present average height of a Pliocene erosion surface preserved on accordant ridge crests near the summit of the mountains. Relatively rapid uplift of the western Transverse Ranges was also accompanied by local downwarping of narrow basins—for example, the offshore Santa Barbara Basin and the Santa Clara River valley (fig. 4.15) east of Ventura.

Evidence that uplift is still continuing is found in raised, paired stream terraces and youthful drainage patterns in the Santa Lucia, Diablo, and western Transverse Ranges, in elevated Holocene marine terraces near Ventura (Lajoie and others, 1982), and in the radially segmented slopes of Holocene alluvial fans that record progressive episodes of deformation along the east front of the Diablo Range (Bull, 1964).

SOUTHERN SECTION OF THE SAN ANDREAS FAULT SYSTEM

SAN ANDREAS FAULT

South of the Transverse Ranges, the San Andreas fault system (fig. 4.17) extends to the latitude of the Salton Sea as a broad belt of northwest-trending strike-slip faults bounded on the northeast by the San Andreas and on the southwest by the offshore Santa Cruz-Catalina Ridge fault zone. Between the Salton Sea and the Gulf of California, the San Andreas fault system merges with a complex pattern of active ridge segments and transform faults that continues beneath the gulf for more than 1,200 km (see chap. 3). Alluvium of the Colorado River, lake deposits, and the waters of the gulf obscure the transition

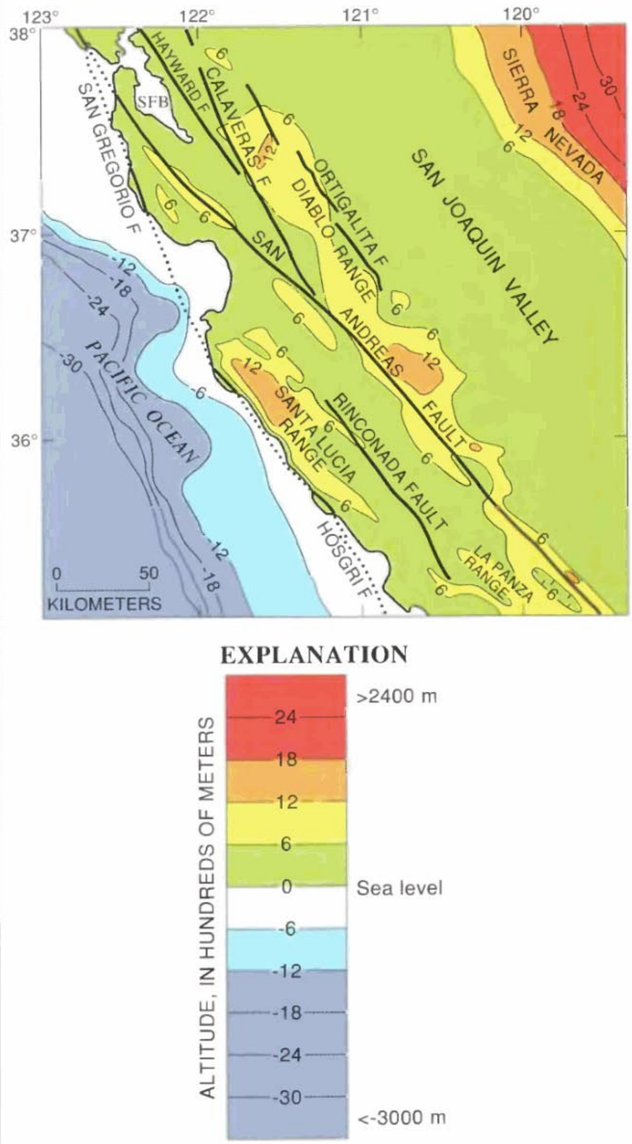


FIGURE 4.16.—Generalized topographic map of central California between the San Francisco Bay (SFB) and the La Panza Range, showing major faults with Quaternary activity in the San Andreas fault system. Modified from Christensen (1965, pl. 1). Faults dotted where concealed by water; hachures on contours indicate area of closed low. Compare with figure 4.9.

from the San Andreas pattern of deformation, dominated by northwest-trending strike-slip faults, to the ridge-transform pattern of the gulf, but current practice (see chap. 3; Crowell, 1981, p. 596–597) places the south boundary of the fault system near the latitude of the Salton Sea. Thus defined, the southern section of the San Andreas fault system is about 200 km long by 150 to 175 km wide.

Late Quaternary faulting in this region follows several major breaks, of which the San Andreas is the most easterly and most active. The dominant role of the San Andreas fades south of Cajon Canyon (lat 34°18′ N., long 117°28′ W.), where the San Jacinto fault diverges from it, and farther south along the south front of the San Bernardino Mountains, where it merges into the Banning and Mission Creek reverse faults (lat 33°56′ N., long 116°47′ W., and lat 34°00′ N., long 116°33′ W.). Despite such complexities, continuity of Quaternary faulting on the main San Andreas can be traced at least as far south as the Salton Sea.

Large increments of Quaternary strike slip on the segment of the San Andreas fault along the San Gabriel Range front near Palmdale (lat 34°34′ N., long 118°07′ W.) were first recognized by systematic right-lateral stream offsets and by Pleistocene fan and terrace deposits displaced 2 to 8 km from their source regions across the fault (Wallace, 1949, p. 799–802; Noble, 1954, p. 46). Underlain by distinctive bodies of plutonic and metamorphic rocks, the ranges have contributed eroded debris to fans that spread across the range-front faults. Subse-

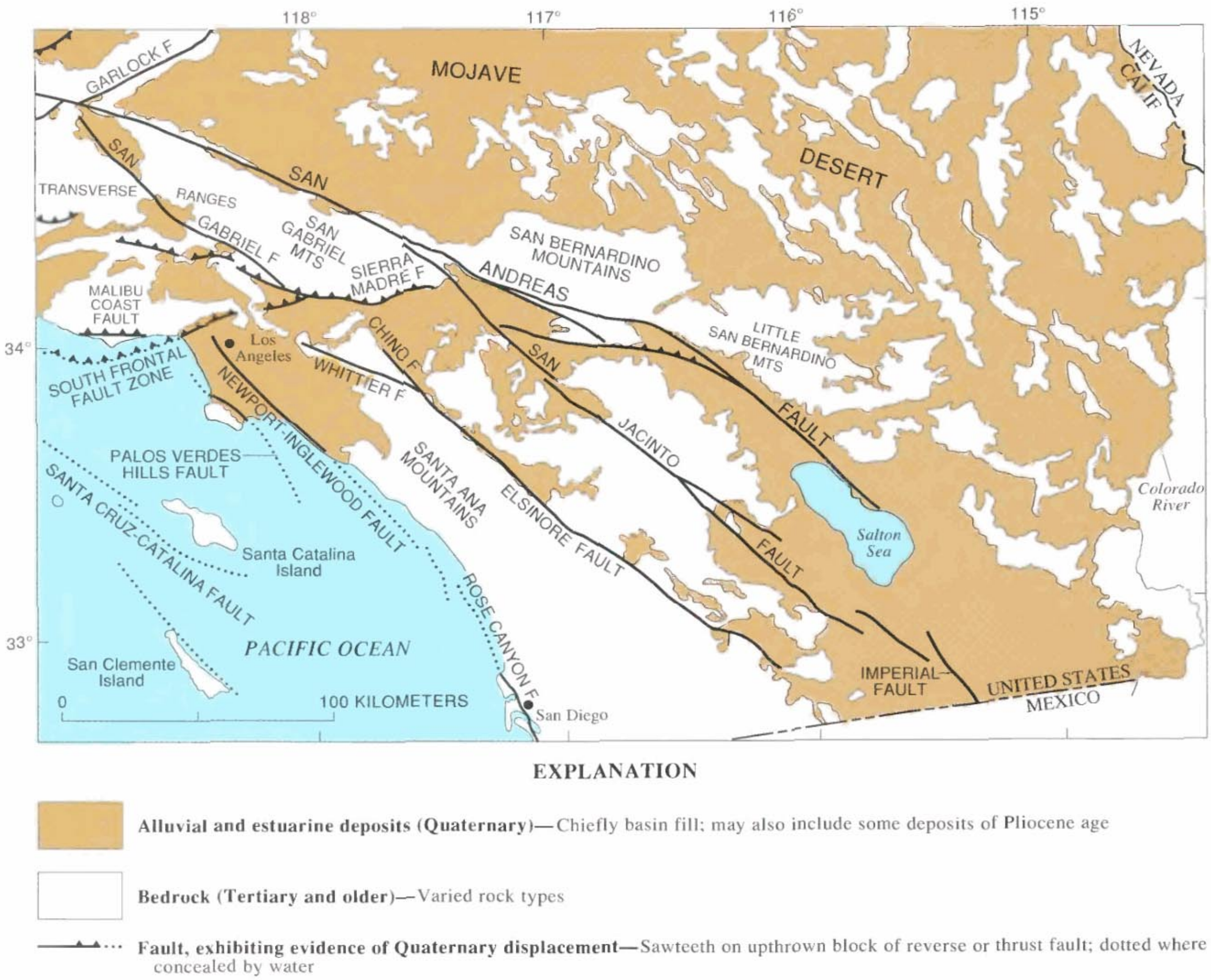
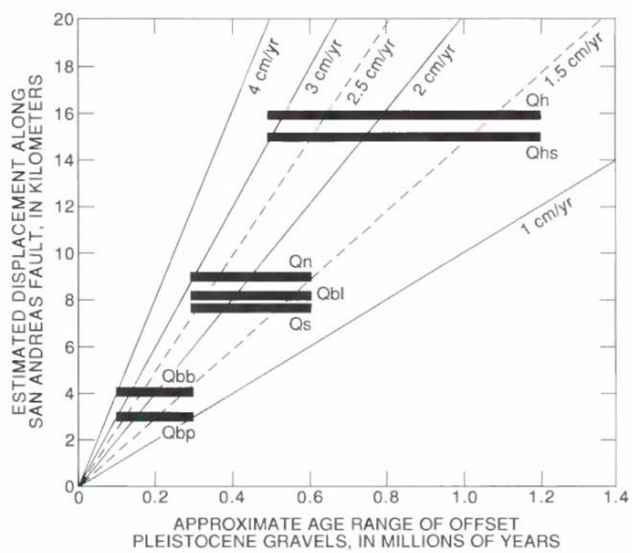


FIGURE 4.17.—Sketch map of the eastern Transverse Ranges, Mojave Desert, and Salton Trough area, southern California, showing faults with Quaternary activity and basin deposits in the southern section of the San Andreas fault system. Fault patterns are generalized, and only major faults are shown.

quent strike slip along these faults has displaced the distal parts of the fans laterally, separating them from their source rocks and opposing them against unlike rock types in nearby parts of the range front. Recent mapping (Barrows and others, 1985, p. 195–197) along the fault segment first described by Wallace (1949) and Noble (1954) constrains the slip rate there to values of 1.5 to 3.0 cm/yr (fig. 4.18).

Most historical slip on the San Andreas fault has accompanied earthquakes of $M \geq 6$. A remarkable record of earlier earthquake-related faulting has been interpreted (Sieh, 1978, 1984; Sieh and others, 1989) from natural and manmade exposures across the fault at Pallett Creek, about 55 km northeast of Los Angeles, within the eastern part of the segment mapped by Barrows and others (1985). At Pallett Creek, Sieh described sandblows and other liquefaction structures, buried scarps, and truncated fault strands in dated peat and alluvium that record (fig. 4.19) a history of 12 earthquakes during the past 1,700 yr. The latest 10 episodes of faulting



EXPLANATION

Qh **Harold Formation (undifferentiated)**
Qhs **Harold Formation (schist and sandstone clast member)**
Qn **Nadeau Gravel**
Qbl **Boulder gravel (Little Rock Creek)**
Qs **Shoemaker Gravel**
Qbb **Boulder gravel (Big Rock Creek)**
Qbp **Boulder gravel (Pallet Creek)**

FIGURE 4.18.—Estimated ranges in strike-slip rate on a 90-km segment of the main San Andreas fault north of Los Angeles. Stratigraphic nomenclature (from Barrows and others, 1985, fig. 4) identifies lithologically distinctive Quaternary deposits that have been horizontally displaced by fault slip on the San Andreas fault system.

establish an average recurrence interval of about 132 yr (Sieh, 1989) but show an irregular, clustered distribution over time for large earthquakes on this section of the fault.

Slip rates along the San Andreas south of Pallett Creek are lower than those in the central section of the fault system; in part, this difference is accounted for by slip on the San Jacinto and other, more westerly faults.

A site on the San Andreas fault in Cajon Canyon (lat 34°16.4′ N., long 117°27.9′ W.) about 100 km east of Los Angeles, establishes a consistent slip rate (Weldon and Sieh, 1985) for the late Pleistocene and Holocene time. Along Cajon and Lone Pine Creeks, the fault displaces terrace risers, buried and active stream channels, and landslides. The alluvial and swamp deposits have yielded 14 ^{14}C ages. These dated fault displacements, in combination with a reconstructed fluvial history of the site, provide four independent measurements of fault slip that document an average slip rate for the past 14.4 ka of 2.5 ± 0.4 cm/yr (fig. 4.20; Weldon and Sieh, 1985).

Harden and Matti (1989) reported slip rates that are less well constrained and possibly more variable for the San Andreas fault near Yucaipa, 45 km southeast of Cajon Canyon. There, displaced alluvial fans yielded average slip rates of 1.4 to 2.5 cm/yr for the past 14 ka, 2.2 to 3.4 cm/yr for the past 30 ka, and 1.2 to 1.6 cm/yr for the past 65 or 90 ka. These rates imply an accelerating rate of latest Quaternary slip, but uncertainties in measurements of displacement and age permit rates that are constant or even diminishing over time.

Paired stream offsets along the southern branch of the San Andreas fault (lat 34°07.5′ N., long 117°10.0′ W.), between Yucaipa and Cajon Canyon and in San Bernardino (lat 34°06′ N., long 117°17′ W.), indicate a maximum slip rate of 2.5 cm/yr (Rasmussen, 1982, p. 112) based on estimated ages of 30 and 50 ka for faulted alluvial units. If, as Rasmussen suggested, these are minimum ages, the actual slip rate may be somewhat lower.

On the San Andreas fault and about 30 km north of the Salton Sea (lat 33°46.9′ N., long 116°14.4′ W.), Keller and others (1982) mapped a total offset of 700 m where two strands of the fault cut an alluvial fan. Soils developed on the fan surface indicate an age of 30 to 20 ka, bracketing the slip rate between 2.3 and 3.5 cm/yr. At a nearby locality, a rate of only a few tenths of a centimeter per year can be derived from displaced (1 m) sedimentary deposits associated with the latest highstands of former Lake Cahuilla, 700–300 yr B.P. (Sieh, 1981). These deposits, however, may be too young to record slip accompanying large earthquakes with recurrence times longer than 700 yr.

The San Andreas follows the east side of the Salton Sea southward for about 30 km; its trace is marked by offset

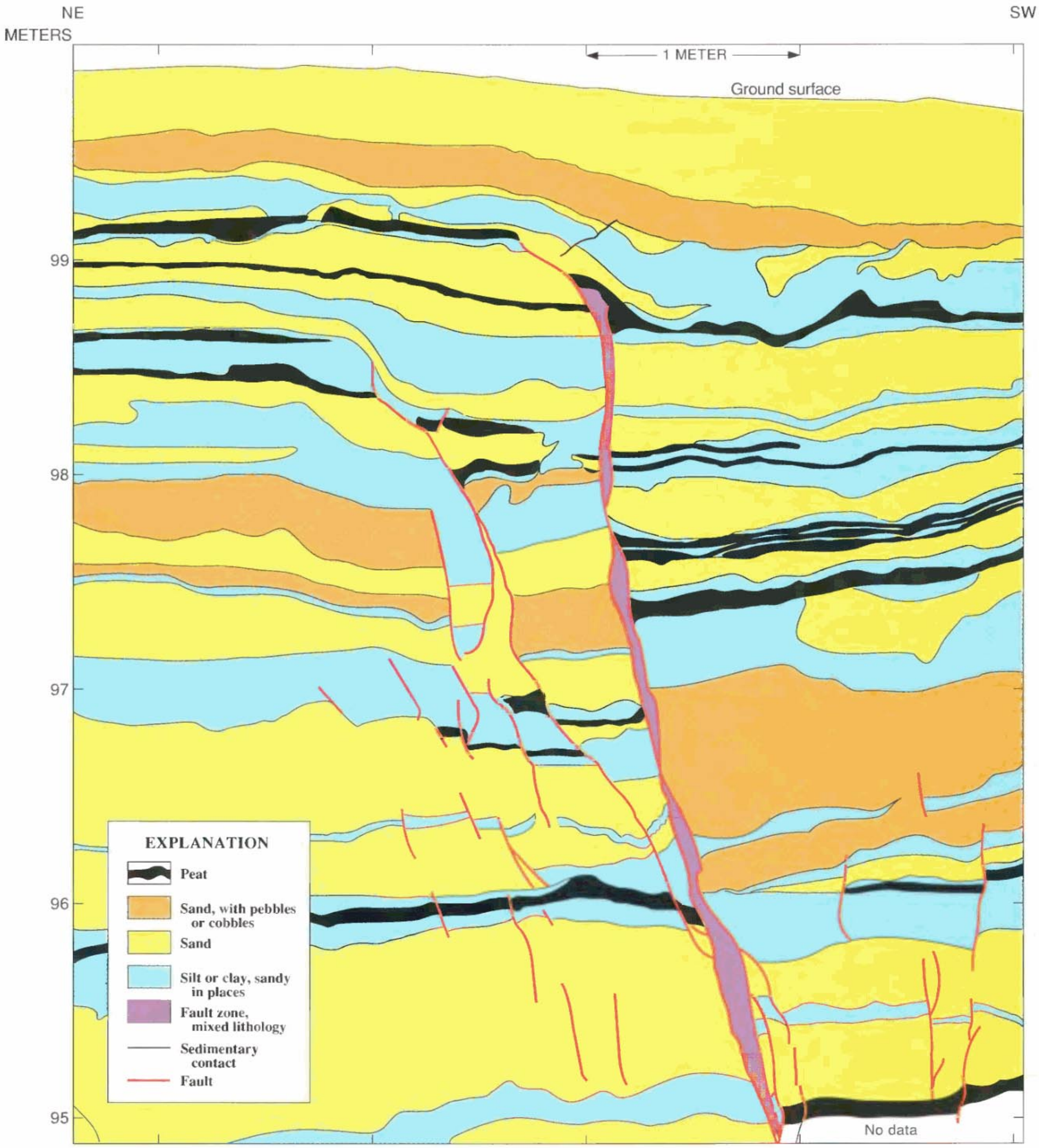
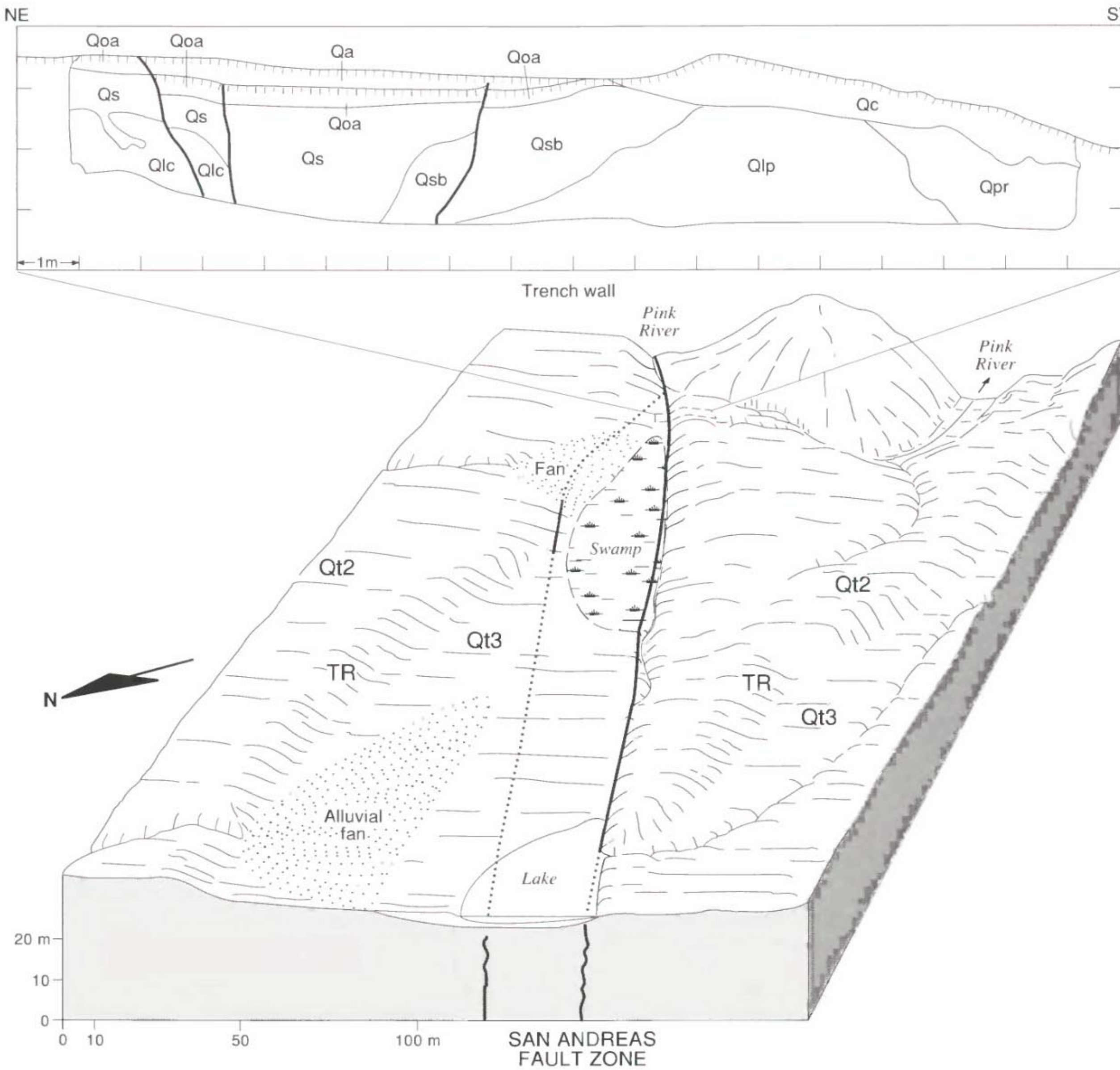


FIGURE 4.19.—San Andreas fault exposed in southeast wall of a trench at Pallett Creek, Calif., 55 km northeast of Los Angeles. Black strata are peat layers, datable by ^{14}C methods, that show increasing amounts of vertical displacement with depth, owing to cumulative slip from repeated earthquakes. Vertical component of displacement visible here is a few percent of net displacement, which is chiefly strike slip, approximately normal to trench wall, with block on right moving toward observer. Uppermost, unfaulted deposits postdate 1857 earthquake; lowermost peat bed on southwest side of fault was deposited about A.D. 800. Modified from Sieh (1978).



EXPLANATION

[Units exposed in trench wall]

Qc	**Colluvium (Holocene)**
Qa	**Alluvium (Holocene)**—A.D. 1725-1805 near base
Qoa	**Older alluvium (Holocene)**
Qsb	**Fault-scarp breccia (Holocene)**
Qs	**Organic-rich sandy clay; swamp deposits (Holocene)**—~ 2,510-500 yr B.P., in part contemporaneous with unit Qsb
Qlc	**Lake clay (Holocene)**—~ 8,350-2,500 yr B.P.
Qpr	**Channel fill of Pink River (Holocene)**
Qlp	**River gravels of Lone Pine Creek (Pleistocene)**—~ 13,000 yr B.P.

Contact—Hachures indicate ground surface or buried ground surface

Fault—Dotted where concealed

Holocene features and at least two historical slip events (Sharp, 1982, p. 9). Farther south, in the Imperial Valley, evidence of surface faulting disappears, and a 40-km gap separates the south end of the San Andreas from the north end of the Imperial fault. This gap, nearby geothermal and volcanic activity, and the broad structural trough occupied by the Salton Sea and the Imperial Valley indicate a major change in deformation processes and a transition from the San Andreas fault system to the ridge-transform system of the Gulf of California.

OTHER FAULTS

The seismically active San Jacinto fault diverges from the San Andreas northwest of Cajon Canyon and follows a nearly straight course for 215 km, ending along the southwest side of the Salton Trough. On small-scale maps, it appears as a linear southward extension of the San Andreas segment bounding the San Gabriel Mountains—a simpler, more direct break than the arcuate, branching pattern of the nearly parallel San Andreas, 45 km to the northeast. Geomorphic and geologic evidence of Quaternary strike slip (Sharp, 1967, 1972, 1981) resembles that for the main San Andreas, but locally vertical motion, southwest side up, may account for as much as 10 percent of the net slip.

Sharp (1981) determined minimum slip rates for two active segments of the San Jacinto fault zone: the Clark fault near Anza Valley and the Coyote Creek fault, 80 km farther south. At the Anza Valley locality (lat 33°34′ N., long 116°39′ W.), the base of a distinctive gravel marker bed, displaced at least 5.7 km from its source terrane of schist, gneiss, and amphibolite, overlies 30 m of sediment which, in turn, overlie a rhyolite ash layer dated at 730 ka and correlated with the air-fall ash at the base of the Bishop Tuff. Geologic data require a slip rate of at least 0.8 cm/yr (Sharp, 1981, p. 1755–1757), and a higher rate, as high as 2.5 cm/yr, is possible (R.V. Sharp, in Clark and others, 1984). North of Anza, geologic relations during the past 30 ka yield evidence of average slip rates of 1.2 to 1.7 cm/yr (Merifield and others, 1987) for this fault. The minimum Holocene slip rate for the past 6 ka on the Coyote Creek fault—derived from a 14C-dated, displaced channel margin (lat 33°05.4′ N., long 116°02.7′ W.)—is 0.3 cm/yr, but a much higher rate is possible (R.V. Sharp, oral commun., 1986). Upper limits for the slip rate on the San Jacinto fault (Prentice and others, 1986; Rockwell and others, 1986; Merifield and others, 1987) thus range from 1.0 to 1.7 cm/yr, in close agreement with Sharp's (1981) estimate of 0.8 to 1.2 cm/yr for the late Quaternary.

The Elsinore fault and its northern branches, the Whittier and Chino faults, lie about 35 km to the southwest of the San Jacinto fault. Seismic activity, occurring chiefly as small earthquakes, increases southward, but the strongest evidence for Quaternary faulting is along the north half of the fault, where Kennedy (1977) and Ziony and Yerkes (1985, table 5) reported examples of offset stratigraphy and landforms. South of lat 33°30′ N., evidence of recent movement on the fault is sparse and widely spaced (Clark, 1975), although faulted Holocene fan deposits within 25 km of the United States-Mexican border indicate a strike-slip rate of about 0.4±0.1 cm/yr (Pinault and Rockwell, 1984).

South of its junction with the northeast-dipping Whittier reverse fault, the northern section of the Elsinore fault displays consistent evidence of oblique, dominantly horizontal slip. The vertical component is up to the southwest (Jahns, 1954, p. 45–46; Kennedy, 1977; Heath and others, 1982), as it is along the San Jacinto fault. For 100 km, the northern section of the Elsinore fault follows the northeast front of the Santa Ana and Elsinore Mountains, juxtaposing a thick Quaternary sedimentary fill on the northeast against pre-Tertiary crystalline and sedimentary rocks in the mountain blocks. South of Lake Elsinore (lat 33°39′ N., long 117°21′ W.), a facies boundary between sandstone and conglomerate, dated at about 700 ka by a layer of the Bishop Tuff, is offset 5 km (Kennedy, 1977, p. 5, 9), indicating a strike-slip rate of 0.7 cm/yr. North of Lake Elsinore, Millman and Rockwell (1985) reported at least 1.6 km of strike-slip offset since the middle Quaternary, equivalent to a minimum slip rate of about 0.2 cm/yr. These observations and other geologic and geomorphic evidence along the fault suggest that the component of horizontal slip on the northern section of the Elsinore fault during the late Quaternary has been somewhat less than on the San Jacinto and probably does not exceed 0.7 cm/yr.

The Newport-Inglewood zone of deformation (Hill, 1971, p. 2958), 40 km southwest of the Elsinore fault, is a narrow (1–3 km wide) belt of echelon folds and

◀

FIGURE 4.20.—Near Cajon Canyon, 75 km east-northeast of Los Angeles, a displaced terrace riser (TR) between two Quaternary terrace levels (Qt2 and Qt3 of Lone Pine Creek, out of view in foreground) records slip on the San Andreas fault. Sketch, based on a planetable map (Weldon and Sieh, 1985, fig. 5), exaggerates relief by about 1.4×; terrace risers actually slope no more than 25°. Relations used to establish Holocene history of faulting and a slip rate of about 2.5 cm/yr are derived from trench-wall exposures, here generalized from Weldon and Sieh (1985, fig. 12), and from geomorphic and stratigraphic evidence of stream piracy and other fluvial processes.

left-stepping fault segments, characterized by oblique right slip, chiefly down to the west (Harding, 1973, fig. 5). This zone contains six major oil fields, within which subsurface structural relations in upper Cenozoic strata are well defined by drilling. Quaternary folding and faulting is expressed as an aligned series of anticlinal hills and by deformed and faulted upper Pliocene and Pleistocene deposits (Poland and others, 1959; Barrows, 1974). The overall structural trend is commonly mapped as the Newport-Inglewood fault (fig. 4.17), but individual segments are less continuous and less closely aligned than along other major strike-slip faults in the San Andreas system. Moreover, many anticlines along the zone retain their original ellipsoidal form even where they are cut by strike-slip faults (Harding, 1973, figs. 2, 4, 7, 9–15).

The onshore, northern part of the Newport-Inglewood fault zone extends 65 km from the Santa Monica Mountains (lat 34°03′ N., long 118°24′ W.) at the southern margin of the Transverse Ranges southeastward to Newport Beach. Farther southeast, the offshore part of the zone continues for about 70 km, defined by folding and faulting in Tertiary and Quaternary deposits (Clarke and others, 1985, p. 359) beneath the sea floor. Whether this zone of deformation is continuous with aligned but more distant offshore faults, such as the Rose Canyon fault near San Diego, is unresolved; if the zone is continuous, its overall length is at least 240 km.

Aligned swales and discontinuous eroded scarps, a few meters to as much as 80 m high, delineate individual fault segments; many of these scarps cut folded Pleistocene deposits. At the Inglewood and Long Beach oil fields on the northern, onshore part of the fault, folding and faulting are nearly as great in upper Pliocene strata as in older rocks (California Division of Oil and Gas, 1961, p. 577, 595), indicating that most of the deformation is Quaternary in age. Historical faulting is evident from the 1933 Long Beach earthquake (M=6.3) on an offshore segment of the zone, and from faulted artificial fill near Newport Beach (lat 33°22′ N., long 117°33′ W.) (Guptill and Heath, 1981). The horizontal slip in upper Pliocene strata, estimated from offset fold axes and from structure-contour maps of producing zones in faulted anticlines (Poland and others, 1959, p. 75; California Division of Oil and Gas, 1961), is about 1.5 km, equivalent to a slip rate of less than 0.1 cm/yr. Vertical components of slip are about a fifth as large, and vertical separation of faulted basal Pleistocene deposits rarely exceeds 60 m (Yerkes and others, 1965, p. A48).

West of the Newport-Inglewood fault zone, northwest-trending faults that exhibit evidence of Quaternary slip (Clarke and others, 1985, fig. 185) include the Palos Verdes Hills fault, and the offshore San Pedro Basin and Santa Cruz-Catalina Ridge faults. The direction and amount of Quaternary displacement on these faults are ill defined, but they probably have strike-slip components smaller than those on the San Jacinto and San Andreas faults.

Many northwest-trending faults end near the 34th parallel against a major structural boundary that extends westward 250 km from the San Jacinto fault to Santa Cruz Island. This boundary separates the east-west-trending structures of the Transverse Ranges, Santa Barbara Basin, and northern Channel Islands (lat 34° N., long 120° W.) from northwest-trending structures to the south; it also separates higher land and sea floor to the north from lower to the south. A north-dipping zone of aligned or echelon faults (Yerkes and Lee, 1987; Ziony and Jones, 1988), here named the "South Frontal fault zone" (of the Transverse Ranges block), follows the structural boundary and includes, from west to east, the Santa Cruz Island, Anacapa, Santa Monica, Hollywood, Raymond, Sierra Madre, and Cucamonga faults. All of these faults are down to the south, all exhibit evidence of Quaternary activity, and many have been active during the Holocene. The San Fernando fault, an element of the Sierra Madre trend, was the source of the damaging M=6.6 San Fernando earthquake in 1971.

Slip rates on the South Frontal fault zone are probably lower than 0.5 cm/yr but are difficult to measure because most of the best exposed range-front faults consist of several branches. Typically, the youngest branches are farthest from the range front (Bull and others, 1979; McFadden and others, 1982) and cut tectonically derived fan deposits.

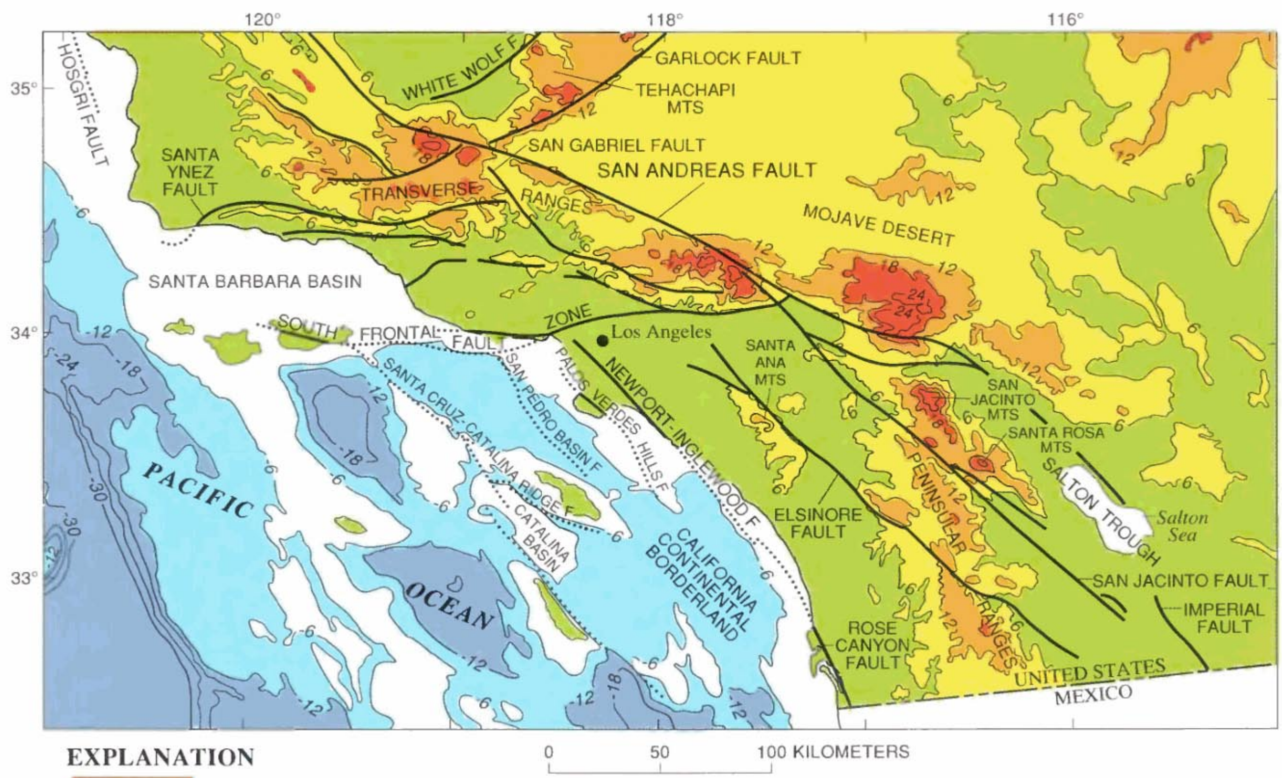
The vertical component of slip on the Cucamonga fault, about 0.3 cm/yr (Matti and others, 1982), is derived from a progressive increase in scarp heights—all close multiples of 2 m—in successively older alluvial-fan deposits. These deposits range in age from middle Pleistocene (approx. 700 ka) to late Holocene. The ages are based on stratigraphic relations, the maturity of soils developed on the fan surface (McFadden and others, 1982), and correlation of these soils with others (Bull and others, 1979) on ancient stream terraces in the San Gabriel Mountains.

FOLDING AND UPLIFT

The southern section of the San Andreas fault system resembles an inclined block (fig. 4.21), with its raised northeast edge along the San Andreas fault and its downtilted southwest half submerged beneath the Pacific Ocean. Near Los Angeles, topographic relief across this block exceeds 4,300 m: from Mount San Antonio (3,067 m) in the San Gabriel Mountains to the floor of the Catalina Basin (−1,300 m). This sloping and apparently tilted surface actually incorporates the results of strike-slip and reverse or thrust faulting, and regional uplift.

Marine Quaternary deposits of the Los Angeles Basin, Ventura Basin, and adjoining offshore areas are locally as thick as 1,200 m (Yerkes, 1972), and lower Pleistocene beds, folded along northwestward trends, exhibit structural relief of more than 1 km in some parts of the Los Angeles Basin. Upper Pleistocene strata are deformed nearly as much, and evidence from drill holes and surface geologic mapping (Durham and Yerkes, 1964; Yerkes and others, 1965; Yerkes, 1972; Shoellhamer and others, 1981) show that much of the folding is of late Quaternary age. Offshore Pliocene and Quaternary basins and folds also trend northwest. These basins, which border the coast as far south as San Diego (Howell and others, 1978), contain a thinner section of Upper Cenozoic strata than the Los Angeles Basin.

Some of the Quaternary folding, like that along the Newport-Inglewood fault zone, is probably directly related to strike slip on deeper wrench faults (Wilcox and others, 1973). Other, more westerly striking folds may reflect a compressional component of deformation similar



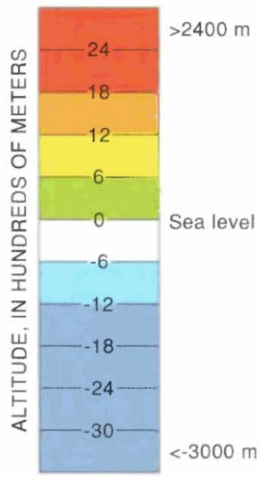


FIGURE 4.21.—Generalized topographic map of southern California, showing major faults with Quaternary activity in the San Andreas fault system. Faults dotted where concealed by water; hachures on contours indicate area of closed low. Compare with figures 4.9 and 4.16.

to that shown by folds in the central and southern Coast Ranges. Fold patterns in the Los Angeles Basin are complicated by unknown amounts of differential compaction over a faulted and folded basement surface. This surface, nearly 10,000 m deep at the center of the basin (Yerkes and others, 1965, fig. 2), underlies a nearly complete section of marine Neogene strata, of which the near-surface Quaternary deposits make up a small part. The basin fill thus records almost continuous subsidence and marine deposition from Miocene time to the present.

Northeast of these late Cenozoic coastal basins, crystalline basement rocks either crop out or lie within a few hundred meters of the surface. Neogene subsidence of the coastal marine basins contrasts sharply with sustained and evidently rapid uplift, accompanied by thrust faulting, of the mountainous region to the east and northeast. The north-dipping San Fernando fault provided an example of such range-front tectonics in February 1971. Failure on this fault caused an $M=6.6$ earthquake, opened a 15-km-long zone of surface thrusting, and elevated the land north of the fault by as much as 2 m. Similarly, major Quaternary upwarping and faulting have helped shape the San Gabriel and San Jacinto Mountains; the San Bernardino Mountains (just beyond the boundary of the fault system as defined here) also display evidence of Quaternary uplift and thrust faulting and have apparently deformed with the other ranges.

Geologically recent uplift and tilting of the mountain ranges is indicated by extensive summit areas above 2,000 m, steep southwesterly-flowing streams in narrow V-shaped canyons, extensive alluvial fans and fan complexes at the northeast and southwest range fronts, and incompletely dissected Quaternary surfaces at elevations near 2,000 m. The dissected upland surfaces, most evident in the San Bernardino (Dibblee, 1975) and San Gabriel Mountains, appear as accordant ridge crests and as remnants of originally extensive uplands, some of which are underlain by Quaternary fan deposits and alluvium.

Other geologic evidence also implies rapid late Pleistocene and Holocene uplift. The Blackhawk and Silver Reef debris-avalanche deposits at the north edge of the San Bernardino Mountains record high-velocity (31 m/s), voluminous (0.28×10^9 m^3) debris flows (Woodford and Harriss, 1928; Shreve, 1968), which surged northward from the range front as recently as 17.4 ka (Stout, 1975, 1977), leaving relict lobes of slide debris on the desert floor 10 km from the slide source. Smaller and slower debris flows and rock slides still occur from time to time in both the San Gabriel and San Bernardino Mountains.

Rates of late Quaternary uplift can be estimated for parts of the southern and central San Gabriel Mountains: near the mouth of Little Tujunga Canyon (lat 34°17′ N., long 118°22′ W.) (Menges and others, 1979), on the North Fork of the San Gabriel River (lat 34°09′ N., long 117°31′ W.) (McFadden and others, 1982), and across the Cucamonga fault (lat 34°10′ N., long 117°31′ W.) (Matti and others, 1982). Strath and fill terraces at the first two localities have been dated by physiographic position, ^{14}C methods, and soil maturity; they range in age from middle Pleistocene to late Holocene (approx 1,000–700 ka). Terrace elevations above modern stream channels reflect both climatic and tectonic influences, but Bull and others (1979) and Menges and others (1979) separated these effects to obtain uplift rates of about 0.3 cm/yr for the Holocene and about 0.03 cm/yr for the late Pleistocene. Interpretation (Matti and others, 1982) of the displacement history across strands of the Cucamonga fault, as discussed above, also results in an uplift rate of about 0.3 cm/yr for the latest Pleistocene and Holocene at the south front of the range. Together, these consistent estimates of uplift rate sample a 78-km segment of the San Gabriel front. Regional uplift rates to the north and northwest and within the main body of the Transverse Ranges are probably somewhat higher; rates for the western Transverse Ranges, as discussed in the section above entitled "Central Section of the San Andreas Fault System," are locally as high as 1 cm/yr near Ventura.

Elevated wave-cut platforms and marine-terrace deposits document Quaternary uplift of the southern California coast from the Transverse Ranges southward to San Diego. Mappable, well-dated (450–85 ka) marine terraces, which correlate with major worldwide highstands of the sea, show nearly uniform coastal uplift at rates that range from about 0.01 to 0.05 cm/yr (Lajoie and others, 1979).

Similar uplift rates (approx 0.02 cm/yr) can be interpreted from the elevations and estimated ages of Quaternary erosional surfaces on the Perris structural block, which lies between the Elsinore and San Jacinto faults. Late Quaternary drainage systems on the Paloma erosional surface are presumed to be superimposed from the Gavilan-Lakeview surface (Woodford and others, 1971), which is nearly 200 m higher and an estimated 1 Ma older than the Paloma surface. Persistent uplift of the Perris block must be geologically recent because a late Miocene erosional surface, overlain by basalt dated at 8.3 ± 0.5 Ma (J.W. Hawkins, in Woodford and others, 1971), is at an altitude intermediate between the two younger surfaces. The nearly horizontal remnants of the late Miocene erosional surface and the relatively undeformed detrital and eruptive strata of Neogene age attest to long-term vertical stability of the Perris structural block.

Together, the Quaternary geomorphic and geologic evidence south of the Transverse Ranges implies systemwide Pleistocene and Holocene uplift, but at higher rates toward the northeast than on the Perris and coastal blocks.

SUMMARY

Right-lateral strike slip on fewer than 10 major faults dominates the Quaternary record of deformation within the San Andreas fault system. Of these faults, the San Andreas is the longest and most active, but the fault system includes other structural elements, such as shorter or discontinuous strike-slip faults, reverse and thrust faults, regional fold systems, minor folds genetically related to strike slip along wrench faults, and tilted, uplifted, or depressed crustal blocks. All of these structures result from relative, predominantly horizontal motion at the boundary separating the Pacific and North American plates.

Though chiefly strike slip, the detailed pattern of Quaternary deformation differs from place to place within the fault system. Although the ultimate causes of these different structural patterns are ill defined and the subjects of continuing research, some geologic controls are evident: (1) the lithology and structure of basement rocks (see chap. 3), (2) the thickness of upper Mesozoic and Cenozoic strata overlying geologic basement, (3) the geometric orientation of major strike-slip faults, especially the San Andreas, and (4) the slip rates along structures controlling deformation.

Plutonic basement includes the granitic and associated metamorphic rocks of the Salinian block west of the San Andreas fault in the central Coast Ranges, similar rocks of the southern California batholith in the Peninsular Ranges, and a more complex suite of metamorphic and crystalline rocks in the central and eastern Transverse Ranges. Elsewhere in the fault system, the dominant basement-rock unit is the intensely sheared and broken Franciscan complex, which locally contains ophiolite bodies and remobilized, cold intrusive masses of serpentinite. The simplest patterns of Quaternary deformation are within regions of exposed or near-surface plutonic basement, where block-bounding strike-slip faults and block uplift or tilting prevail. Deformation is greater and more complex in regions of exposed or near-surface Franciscan basement, where broad anticlinoria, local basins, and distributed shearing are more evident. It is most intense and complex where basement rocks are covered by a kilometer or more of stratified upper Mesozoic or Cenozoic rocks.

Control of Quaternary deformation processes by fault geometry, or the interdependence of process and geometry, is best shown at the Big Bend in the San Andreas fault near the north boundary of the Transverse Ranges. There, west-northwest-trending folds and northwest-trending strike-slip faults of the northern and central sections of the fault system abut against a compressional domain characterized by east-west-trending folds, active thrust and reverse faults, and accelerated rates of vertical uplift. On much smaller scales, similar changes in structural trend and pattern appear at other changes in strike of the San Andreas or major branch faults.

The effect of different slip rates is demonstrated by the contrast in structural style along the San Andreas fault in central California and along the Newport-Inglewood fault zone in southern California. At a slip rate of 3.5 cm/yr, the San Andreas has displaced middle Pleistocene (1 Ma) outcrop belts and major structures by about 35 km, effectively creating—on opposite sides of the fault—two independent structural domains, each of which responds differently to its new structural setting. In the same period of time, the much lower slip rates on the Newport-Inglewood fault zone have separated Quaternary structures by less than 500 m, leaving the initial structural patterns at least partly intact and connected.

Our current knowledge of Quaternary deformation within the San Andreas fault system can be expressed in terms of estimated rates for deformation processes (fig. 4.22), even though reliable quantitative measurements of slip, folding, and uplift are few. Other lines of evidence from geologic mapping and geophysical investigations permit reasonable inferences regarding regional rates of deformation and the history of the fault system. Although some of these interpretations may change as new data are acquired, several major characteristics of the fault system and its Quaternary history are documented by the available evidence:

1. Quaternary tectonism within the San Andreas fault system has deformed an area of 160,000 km^2, extending from Punta Gorda to the Salton Sea, a system length of about 1,100 km, and from the Great Valley and the Mojave Desert to fault zones off shore in the Pacific Ocean, an average system width of about 145 km.
2. Throughout the fault system, the rate of right-lateral strike slip on northwesterly-trending faults typically exceeds the geologically determined rates for other deformation processes by an order of magnitude. Despite some important exceptions, horizontal slip approximately parallel to the plate boundary dominates the Quaternary history of the fault system.
3. In the central section of the fault system, between lat 35°45′ and 36°30′ N., most of this slip has followed the main San Andreas fault; slip rates on this section of the fault are the highest observed to date within the system, averaging about 3.5 cm/yr.
4. Strike slip is distributed more broadly in both the northern and southern sections of the fault system, where the main San Andreas splits into several active branches; slip rates on some of these branches may equal or exceed the rate on nearby parts of the main fault.

5. Observed rates of Quaternary faulting, summed across the fault system, are insufficient to account for all of the relative movement (5.1 cm/yr) attributed to the Pacific-North American plate boundary, but neither the magnitude of the difference nor its cause is well constrained.
6. East-westerly- to northwesterly-trending reverse and thrust faults occur near many strike-slip faults and elsewhere in the system; they are longer, more active, and best defined in and near the Transverse Ranges (between lat 33°45′ and 35°00′ N.), where they accompany rapid Quaternary uplift and intense folding on east-west-trending axes.
7. Major west-northwest-trending fold belts deform Quaternary and older strata overlying deeply buried (1–5 km deep) basement rocks; most regional fold belts strike obliquely to strike-slip faults and are consistent with wrench-fault structural patterns, but the age and intensity of folding differ from place to place.
8. Several fault-bounded basement blocks are internally little deformed: the Sebastopol block in northern California (Franciscan basement between the San Andreas and Rodgers Creek faults), the Salinian block in central California (granitic basement between the Rinconada and San Andreas faults), and the Perris block in southern California (granitic basement between the Elsinore and San Jacinto faults).
9. Throughout the Quaternary, widespread uplift has characterized most of the fault system; locally downwarped, fault-controlled basins that reverse this general pattern are the San Francisco Bay and Santa Clara Valley (northern California), the Santa Clara River valley-Ventura Basin (southern California), the Los Angeles Basin, and basins near the southern and southwestern margin of the San Joaquin Valley.
10. Maximum observed uplift rates (0.5–1.0 cm/yr) for the late Quaternary occur near Punta Gorda and in the Transverse Ranges; elsewhere, measured uplift rates average about 0.05 cm/yr, but in large areas of the fault system no reliable measurements of uplift rates are available.
11. Major strike-slip faults bound the west edge of several uplifted blocks in northern California: the Santa Rosa block, bounded by the Rodgers Creek and Maacama faults; the Diablo Range and Temblor Range blocks, bounded by the Calaveras and San Andreas faults; and the Santa Cruz Mountains and Santa Lucia Range blocks, bounded by the San Gregorio, San Simeon, and Hosgri faults.
12. In the Transverse and Peninsular Ranges of south-

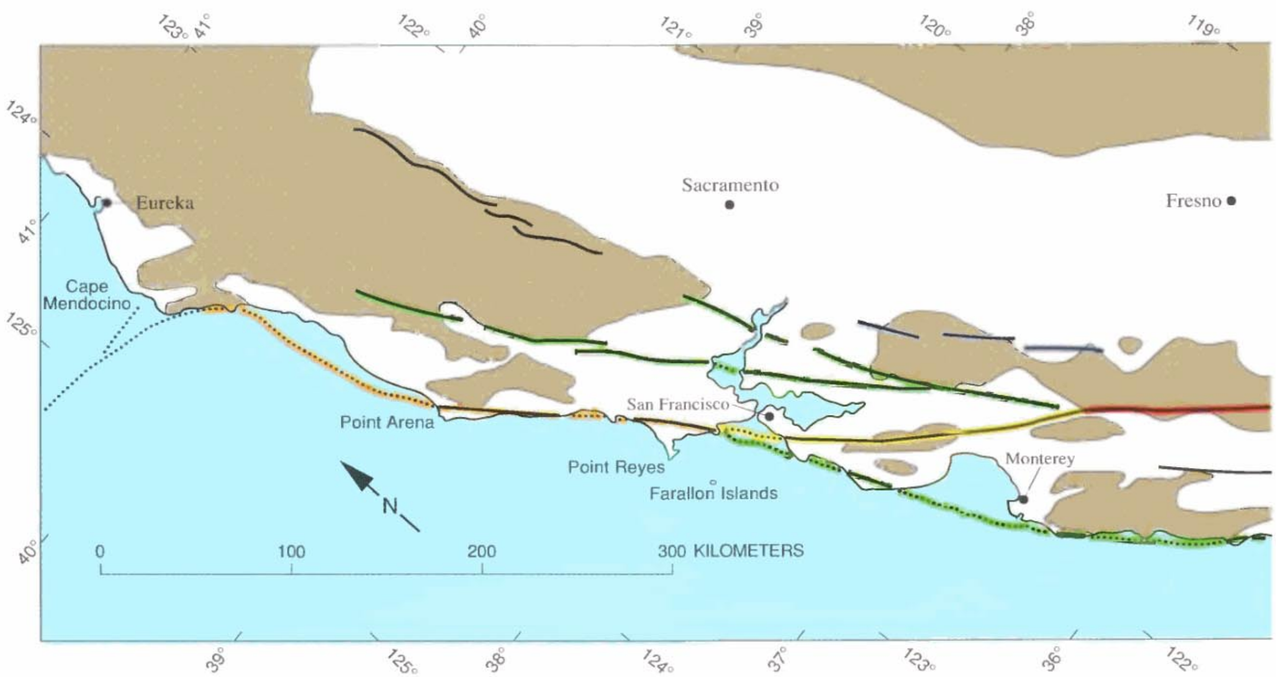


FIGURE 4.22.—Sketch map of western and southwestern California, showing selected major faults exhibiting evidence of Quaternary activity in the San Andreas fault system. Average Quaternary slip rates are based on measured values from published sources and, where measurements are incomplete or unavailable, on interpreted geologic and geomorphic evidence. Slip components on northwest-trending faults are predominantly horizontal, right lateral, and consistent with North American-Pacific plate motion. Group of east-west-trending faults between

ern California, Quaternary uplift near strike-slip faults has produced two nearly orthogonal mountain chains: (1) the west-northwesterly-trending ranges that separate the Mojave Desert from coastal lowlands and that lie along the trend of Transverse Ranges thrust faults and the southern branch of the San Andreas fault, and (2) the north-south-trending mountain system composed of discrete, northwest-trending ranges that are separated and possibly offset by the Elsinore and San Jacinto faults west of the Salton Sea.

13. Rates of Quaternary faulting, folding, and uplift resemble those for the pre-Quaternary fault system; significantly higher rates, evident near Punta Gorda and in the Transverse Ranges, signify late pulses of accelerated tectonic activity that are still underway.

Despite many still-unsolved problems and unanswered questions, the San Andreas fault system has proved a productive laboratory in which to pursue three tasks: to quantitatively evaluate earthquake hazards in the densely populated, high-risk regions of California; to develop new investigative and analytical methods that can be applied in other regions of high earthquake risk; and to better understand how geologic processes deform the Earth's crust at plate margins. None of these tasks is finished, but the progress so far has improved our knowledge of crustal-deformation processes and aided our efforts to reduce the hazards from damaging earthquakes.

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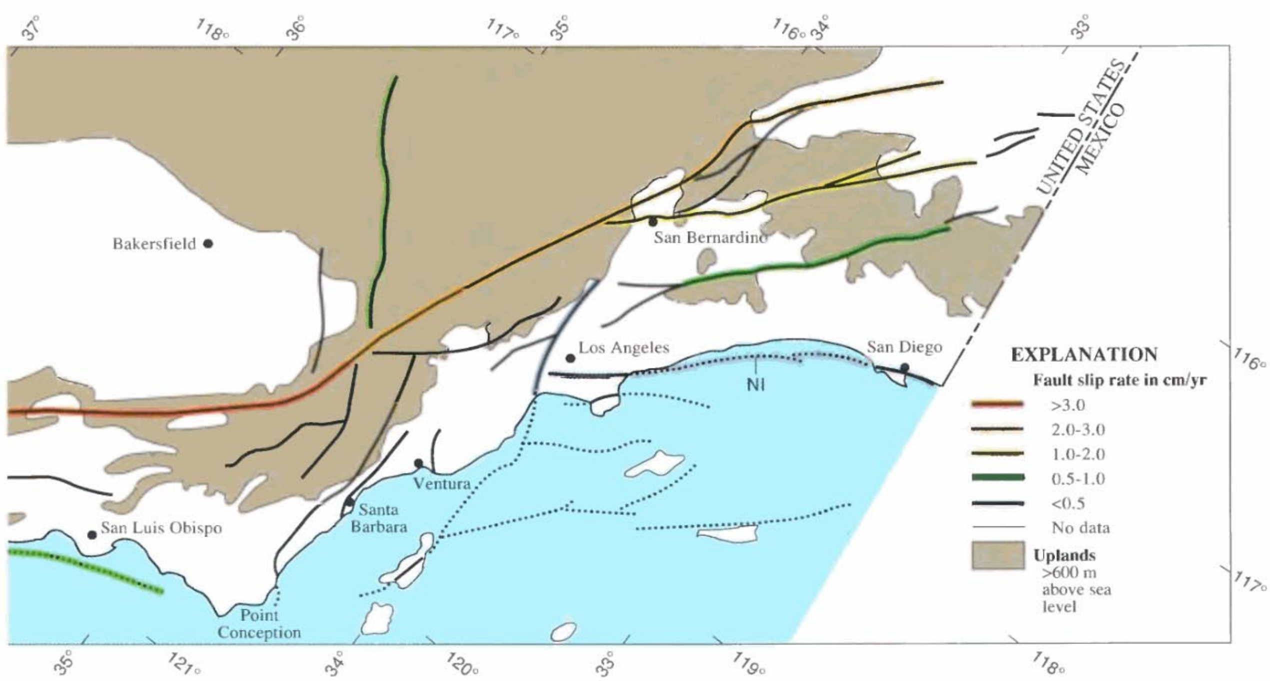

lat 34°00′ and 35°30′ N. exhibit a more complex slip pattern, including chiefly reverse faulting but also some strike slip. Areas above 600-m elevation (colored) exhibit evidence of late Cenozoic uplift and enclose most areas of Quaternary uplift, but elevation pattern reveals no such major local uplifts as those near Ventura (approx 1 cm/yr) and along the Newport-Inglewood fault zone (NI). Faults dotted where concealed by water.

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San Francisco Bay
Coast Ra
Santa Cruz Mountains
Monterey Bay
0 5 10 15 20 KILOMETERS

Tens of thousands of small earthquakes occur in California each year, reflecting brittle deformation of the margins of the Pacific and North American plates as they grind inexorably past one another along the San Andreas fault system. The deformational patterns revealed by this ongoing earthquake activity provide a wealth of information on the tectonic processes along this major transform boundary that, every few hundred years, culminate in rupture of the San Andreas fault in a great (M≈8) earthquake.

5. SEISMICITY, 1980–86

By DAVID P. HILL, JERRY P. EATON, and LUCILE M. JONES

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INTRODUCTION

Earthquake activity along the San Andreas fault system (fig. 5.1) reflects brittle accommodation of the crust to the relative motion along the dextral transform boundary between the Pacific and North American plates (see chap. 3). Great ($M\approx8$) earthquakes along the main branch of the San Andreas fault accommodate most of this relative plate motion. These plate-boundary earthquakes rupture the entire 15- to 20-km thickness of the brittle crust with right-lateral offsets of as much as 10 m extending for several hundred kilometers along the fault trace, and they recur along a given section of the San Andreas fault at intervals of several hundred years (Sieh, 1981; Sieh and Jahns, 1984). The 1857 Fort Tejon

◀ FIGURE 5.1.—Seismicity from 1969 to 1980 superimposed on color Landsat image for the central Coast Ranges between the San Francisco Bay and Monterey Bay. Size of earthquake epicenters (yellow circles) increases with earthquake magnitude from 1.5 to 6.0. Compiled by Jean Olsen.

earthquake in southern California and the 1906 San Francisco earthquake in northern California are only the two most recent such great events along the San Andreas fault (see chap. 6).

In this chapter, we focus on the smaller, more frequent earthquakes that dominate the seismicity within the San Andreas fault system between recurrences of great, plate-boundary events. Although this interevent seismicity contributes only marginally to relative plate motion, it is symptomatic of processes underlying the earthquake cycle. In particular, the wealth of data generated by frequent smaller events provides important clues to the seismotectonic fabric, kinematics, and state of stress within the brittle crust and, ultimately, to the seismogenic processes common to earthquakes of all sizes within the San Andreas fault system. This persistent, interevent seismicity also captures widespread popular interest because it includes most of the felt earthquakes in California (earthquakes of $M \geq 3$ can be locally felt), and the larger of these interevent earthquakes (M=6–7) can cause extensive damage and loss of life when they strike near major population centers.

We examine here the detailed patterns of earthquake occurrence along the San Andreas fault system recorded by the combined northern and southern California seismograph networks for the 7-yr interval 1980–86. These networks, which had evolved to much their present configuration (fig. 5.2) by mid-1979, enable uniform detection and location of all earthquakes of $M \geq 1.5$ throughout the San Andreas fault system and of $M \geq 2$ throughout most of California. The telemetered seismic stations in the combined networks approach 550 in number. Signals from the 300 central and northern California stations are recorded and processed at the U.S. Geological Survey's (USGS) offices in Menlo Park; signals from the 250 southern California stations are recorded and processed under a joint USGS-California Institute of Technology (Caltech) effort on the Caltech campus in Pasadena. These dense telemetered networks overlie regional seismic networks operated by the University of California, Berkeley, and Caltech that provide records of $M \geq 3$ earthquakes in northern and southern California, respectively, from the early 1930's onward (table 5.1; Hileman and others, 1973; Bolt and Miller, 1975).

After a brief overview of the San Andreas fault system in the context of a broad transform boundary, we focus on the three-dimensional distribution of earthquakes along the San Andreas fault system itself on the basis of a series of detailed seismicity maps and cross sections for the years 1980–86. We then review selected focal mechanisms for the larger of these earthquakes as a guide to the kinematics of seismogenic deformation along the fault system. Finally, we discuss the implications of these seismicity patterns in terms of current tectonic processes along the transform boundary.

The seismicity maps and cross sections in this chapter, which form the core of our presentation, are largely self-explanatory. The following points, however, deserve special emphasis:

1. The reliability of hypocentral locations correlates closely with the local density of the seismograph network (fig. 5.2). Relative epicentral locations are better than ± 0.5 km for earthquakes within the densest sections of the network (corresponding focal depths are better than ± 1.0 km). Relative locations may be uncertain by several kilometers or more, however, for earthquakes occurring beyond the margins of the network.
2. All cross sections have a 2× vertical exaggeration as a means of illustrating patterns in the depth distribution of earthquakes beneath profiles that are many times longer than the limited range of focal depths (less than 15 km along most of the fault system).
3. Hypocentral locations are plotted using small circles that scale only weakly with magnitude, to better emphasize detailed spatial structures within the seismicity patterns.
4. The locations of the most commonly used place names and faults in this chapter are shown in figure 5.3 (see front of book for a more complete map).

REGIONAL SEISMICITY AND THE SAN ANDREAS TRANSFORM BOUNDARY

Dickinson (1981), among others, emphasized that the San Andreas fault system and the San Andreas transform boundary are not strictly equivalent structures. The latter is more general, incorporating, for example, the concept of temporal evolution of Pacific-North American plate interaction and the recognition that the faults accommodating most of the plate motion have changed over time. In this section, we emphasize that, although great earthquakes along the San Andreas fault system currently accommodate most of the relative plate motion, plate interactions along the transform boundary influence deformation of the brittle crust over a much broader region.

The breadth of the seismicity pattern in California and western Nevada (fig. 5.4) suggests the lateral extent of deformation associated with the San Andreas transform boundary. Indeed, it corresponds closely to the zone of distributed shear between those plates as interpreted by Ward (1988) from more than 5 years of very long baseline interferometry (VLBI) observations at 20 Western United States stations from 1982 through 1987. Figure 5.4 includes all $M \geq 1.5$ events recorded by the telemetered seismic networks in figure 5.2 during the 7-yr interval 1980–86, as well as events recorded by adjacent telemetered networks in Nevada (see Rogers and others, in press). Although details within this seismicity pattern fluctuate from year to year, the broad aspects of the pattern have remained stable for the entire historical

TABLE 5.1.—*Number of short-period seismic stations in California*

Year	1940	1965	1971	1975	1981
Northern California	<10	<20	≈100	≈200	≈300
Southern California	<10	<20	≈30	≈100	≈200

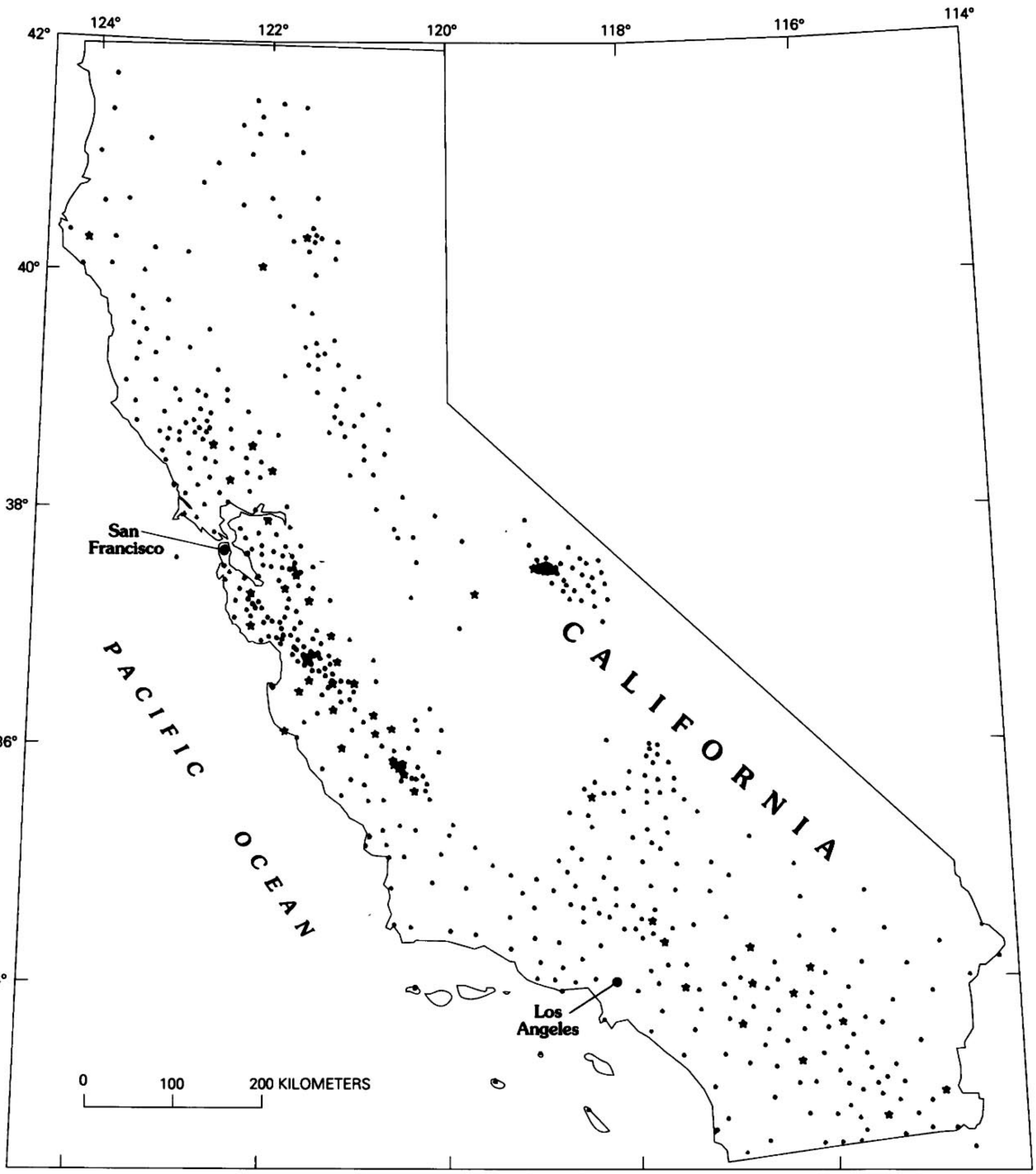


FIGURE 5.2.—Stations in telemetered seismic networks in California operating during 1986. Dot, single (vertical)-component station; star, multicomponent station.

record of earthquake occurrence in California (see chap. 6; Ellsworth and others, 1981; Hill and others, in press; Hutton and others, in press).

In outline, the seismicity pattern for California and western Nevada forms a hollow ellipse with its long axis nearly coincident with the transform boundary. This

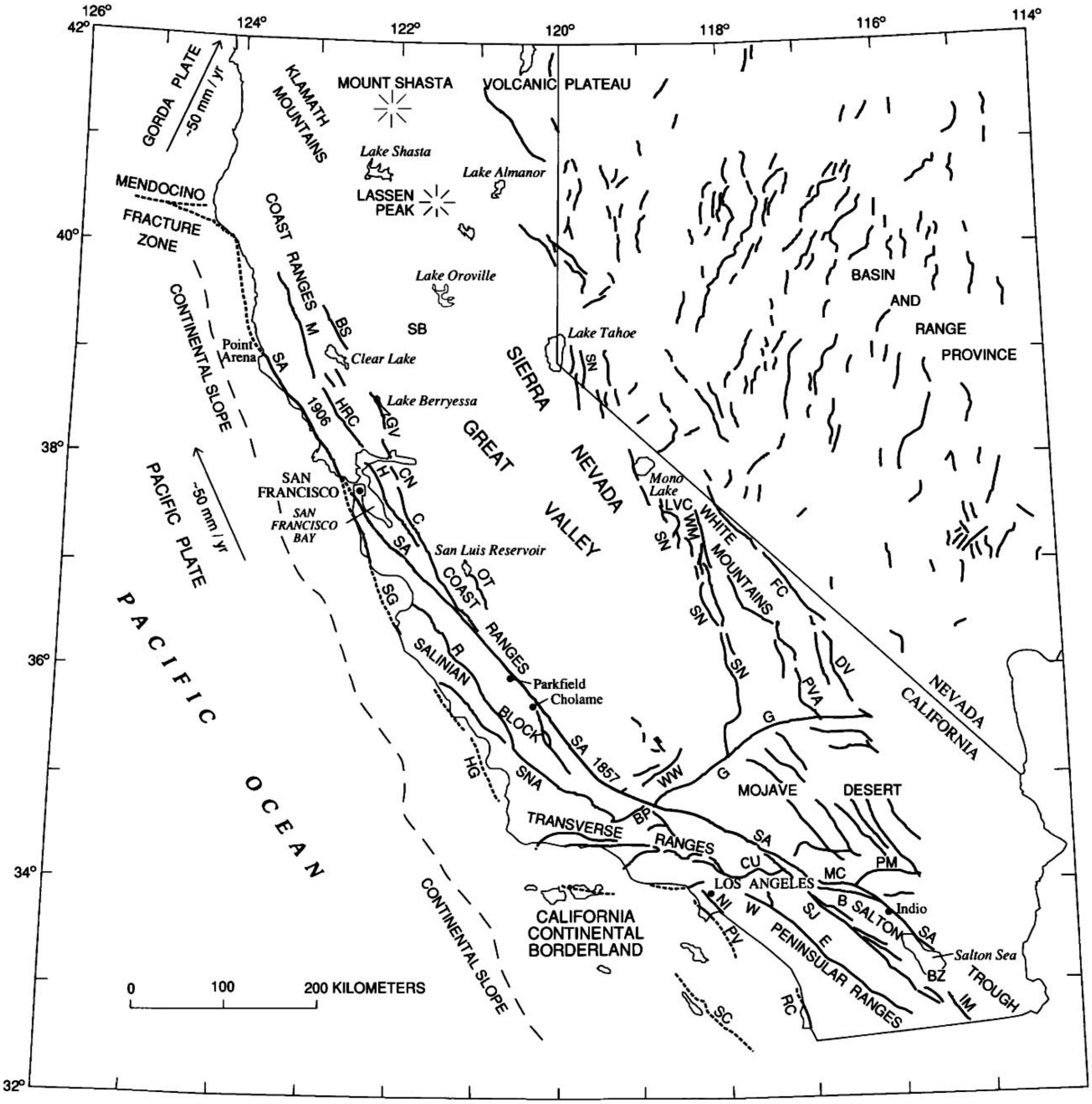


FIGURE 5.3.—Place names and faults most commonly used in text (see front of book for more complete maps of place names and faults). Faults (dotted where concealed): B, Banning; BP, Big Pine; BS, Bartlett Springs; BZ, Brawley seismic zone; C, Calaveras; CN, Concord; CU, Cucamonga; DV, Death Valley; E, Elsinore; FC, Furnace Creek; G, Garlock; GV, Green Valley; H, Hayward; HG, Hosgri; HRC, Healdsburg-Rodgers Creek; IM, Imperial; LVC, Long Valley caldera; M, Maacama; MC, Mission Creek; NI, Newport-Inglewood; OT, Ortigalita; PM, Pinto Mountain; PV, Palos Verdes; PVA, Panamint Valley; R, Rinconada; RC, Rose Canyon; SA, San Andreas; SC, San Clemente Island; SG, San Gregorio; SJ, San Jacinto; SN, Sierra Nevada; SNA, Sur-Nacimiento; W, Whittier; WM, White Mountains; WW, White Wolf. Arrows and numbers indicate direction and amount of motion, respectively, of Pacific and Gorda plates with respect to North American plate to the east; red lines indicate 1857 and 1906 ruptures of San Andreas fault.

pattern is widest across central California, where it approaches nearly a third of the 1,100-km length of the transform boundary, from the Mendocino triple junction in the north to the head of the Gulf of California at the south. Extended alignments of epicenters within this pattern suggest a coarse structural fabric linking the broad distribution of earthquakes to the transform boundary. Seismicity along the San Andreas fault system itself stands out as a series of subparallel, northwest-trending lineations extending the length of coastal California. The alignment of epicenter clusters along the east side of the Sierra Nevada in eastern California branches northward from the south end of the San Andreas fault system in the Salton Trough only to bend back toward the north terminus of the San Andreas fault system at the Mendocino triple junction in northern California. The

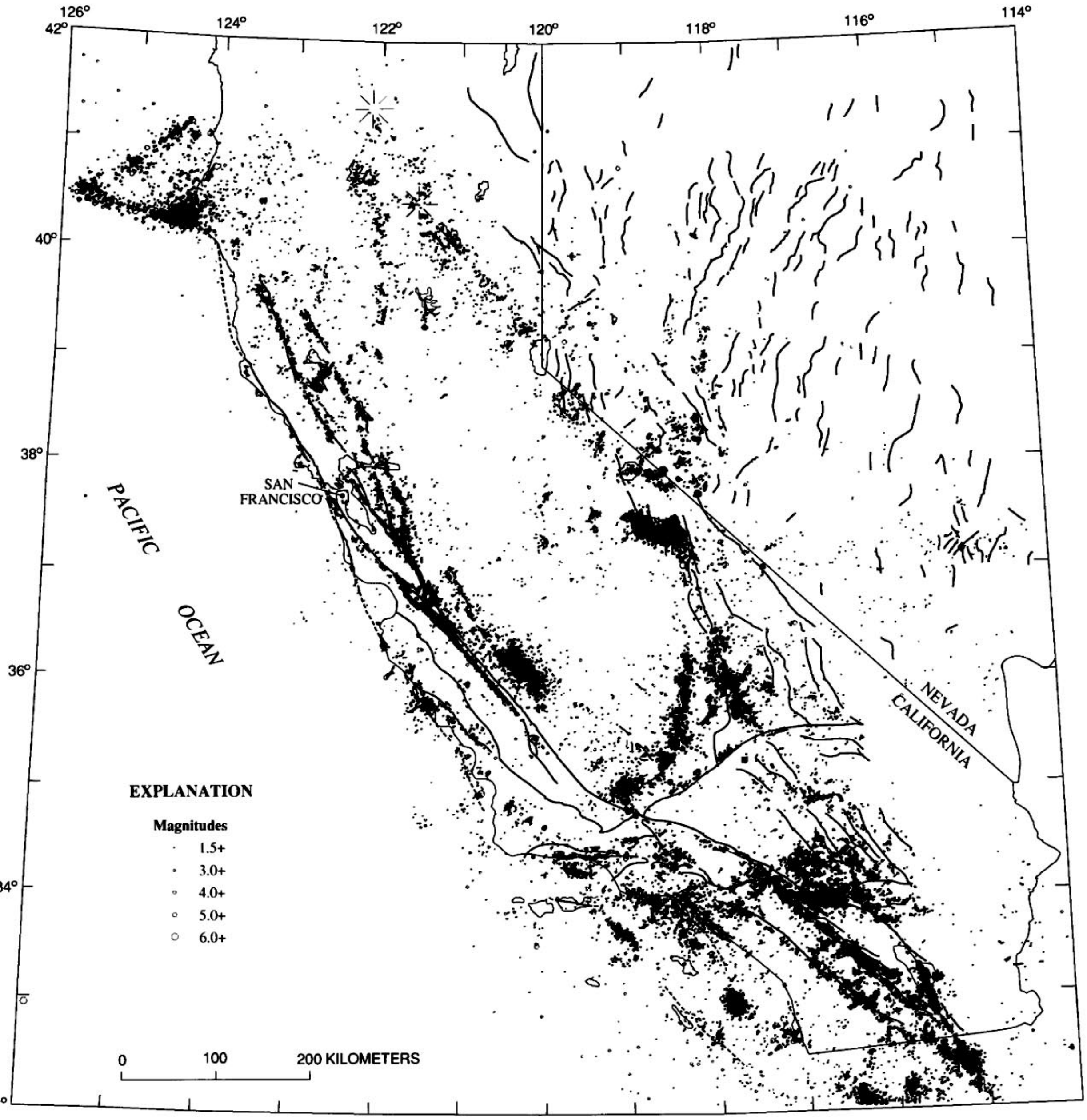


FIGURE 5.4.—Locations of 64,000 $M \geq 1.5$ earthquakes in California and western Nevada during 1980–86 and mapped Holocene faults (dotted where concealed; major branches of the San Andreas fault system marked in red).

Sierra Nevada-Great Valley and western Mojave Desert blocks form a broad quiescent region between the San Andreas and eastern California seismicity bands. In southern California, pronounced transverse seismicity belts coincident with the southern margin of the Sierra Nevada and Transverse Ranges, respectively, span this otherwise-quiescent region. A weaker, more diffuse seismicity belt near lat 37° N. spans the Sierra Nevada-Great Valley block in central California, forming a visual, if not structural, link between the San Andreas fault system and the dense cluster of epicenters in eastern California. This major cluster in the eastern Sierra Nevada represents an episode of intense earthquake activity in Long Valley caldera and vicinity that began in 1978 and has persisted to the present (Van Wormer and Ryall, 1980; Hill and others, 1985b).

The displacement pattern associated with earthquakes throughout California and western Nevada is broadly consistent with deformation under a coherent, regional stress field dominated by plate-boundary interaction along a northwest-striking, dextral transform boundary (Hill, 1982). Strike-slip focal mechanisms with right-lateral slip on northwest- to north-northwest-striking planes, for example, are common through most of the region. Regional variations within this pattern include a tendency toward normal slip on northerly-striking planes along the western margin of the extensional Basin and Range province in eastern California, and toward reverse slip on easterly-striking planes in the Transverse Ranges of southern California. Compressional deformation perpendicular to the San Andreas fault within the Coast Ranges, however, represents an important deviation from this regional pattern.

SEISMICITY ALONG THE SAN ANDREAS FAULT SYSTEM

Sections of the San Andreas fault system stand out on seismicity maps as a network of northward-branching alignments of epicenters through the central and northern Coast Ranges and as subparallel lineations of clusters of epicenters that branch northward from the south end of the Imperial fault toward the Transverse Ranges in southern California (fig. 5.4). One of the most remarkable aspects of the seismicity pattern associated with the fault system, however, is the nearly complete absence of earthquake activity down to even the smallest magnitudes ($M \approx 1.5$) along those sections of the fault that have ruptured with the largest historical earthquakes, the great ($M \approx 8$) 1857 and 1906 earthquakes (see figs. 5.3, 5.4). The southernmost section of the San Andreas fault, from Indio to the Salton Sea, also lacks microseismicity, although no large earthquake has ruptured this section in the past 200 yr. These quiescent ("locked") segments of the fault stand in sharp contrast to the segments marked by persistent linear concentrations of small to moderate earthquakes.

This dual expression of the fault system evident on current seismicity maps apparently reflects fundamental differences in the long-term behavior of the respective segments. In particular, seismic activity along the "locked" segments of the main trace of the San Andreas fault may be limited to the recurrence of major earthquakes at intervals of 100 to 300 yr accompanied by immediate foreshock and aftershock sequences, and these segments may remain quiescent for most of the interevent time associated with the cycle between great earthquakes (Ellsworth and others, 1981). In contrast, those segments with persistent microearthquake activity probably seldom, if ever, rupture with great earthquakes, although they may be capable of generating earthquakes as large as $M \approx 6$.

Aseismic creep also characterizes and is largely confined to those fault segments along the San Andreas fault system that show persistent microearthquake activity (Wesson and others, 1973; Schulz and others, 1982). Creep is most pronounced along the central California segments of the fault system, where average creep rates match the long-term displacement rates of 32 to 34 mm/yr. Louie and others (1985) documented creep along sections of the seismically active fault segments in the Salton Trough, and Astiz and Allen (1983) documented creep along a section of the Garlock fault that is marked by microearthquake activity. The creep rates in these two areas, however, are more than an order of magnitude less than the long-term deformation rates.

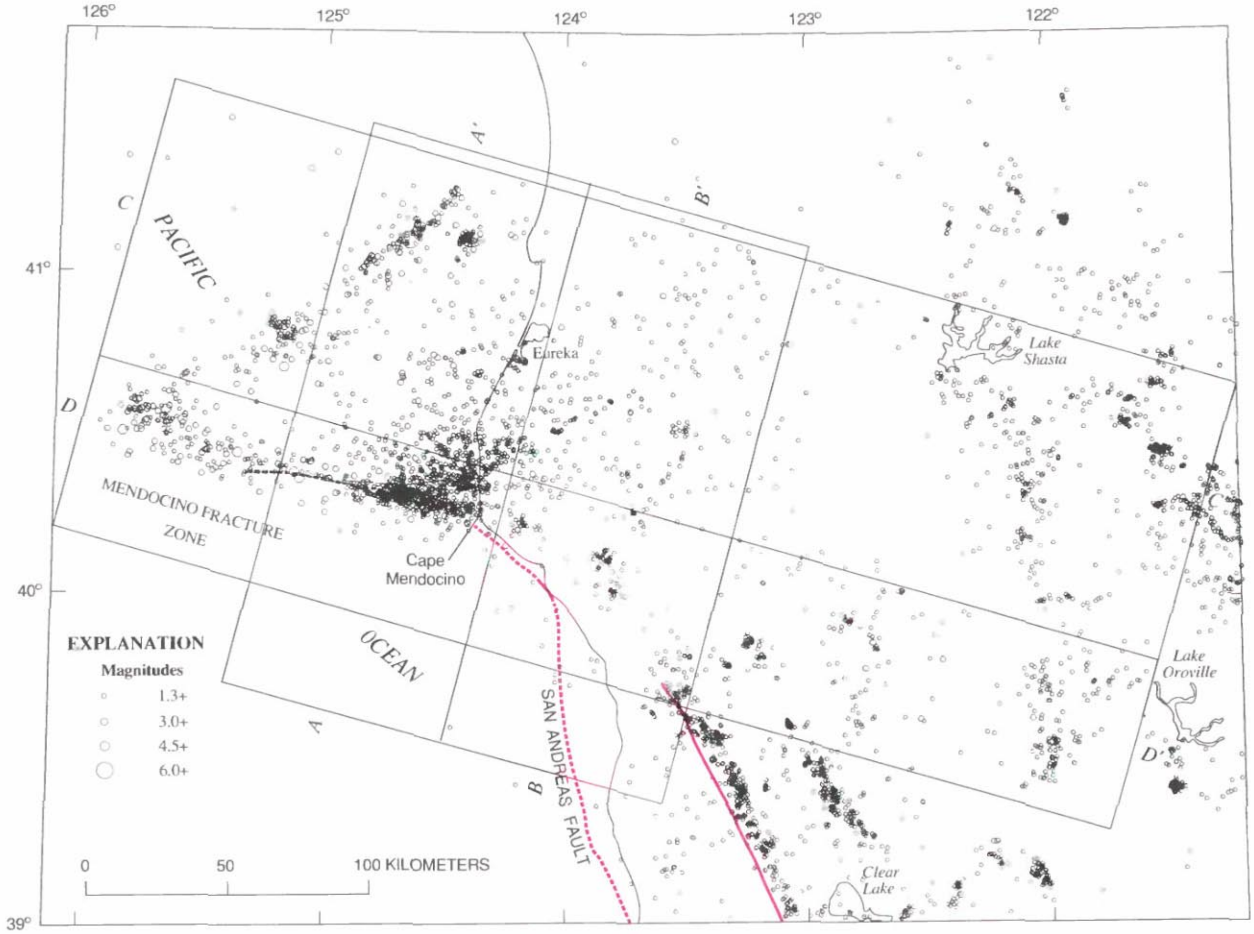
In the following subsections, we consider the 1980–86 seismicity along and adjacent to the major sections of the San Andreas fault system in more detail. We begin with the Mendocino triple junction in the north and move southward, generalizing slightly Allen's (1968) subdivision of the fault system into four major sections of contrasting seismic behavior: (1) the quiescent 1906 break and subparallel branches, (2) branches forming the central California active (creeping) section, (3) the quiescent 1857 break, and (4) branches forming the southern California active section south of the Transverse Ranges.

MENDOCINO TRIPLE JUNCTION

The three lithospheric plates that dominate the modern tectonics of coastal California meet at the Mendocino triple junction, which is marked by a dense cluster of epicenters just off Cape Mendocino (fig. 5.5*A*; see chap. 3). North of this triple junction, oblique subduction dominates, with the eastern margin of the Gorda plate (the southernmost section of the Juan de Fuca plate) slipping beneath the North American plate north-northeastward at a rate of 30 to 50 mm/yr (Wilson, 1986). South of the triple junction, the Pacific plate is moving past the North American plate along the San Andreas transform boundary on a heading of 35°–38° W. of N. at a rate of approximately 50 mm/yr (DeMets and others, 1987).

The dense lineation of epicenters that trends west-northwest from Cape Mendocino corresponds closely to the Mendocino Fracture Zone (MFZ) and the Pacific-Gorda plate boundary but follows a slightly more northerly trend. Details of how the San Andreas fault ties into the triple junction, however, are unclear. The trace of the San Andreas fault lies off shore north of Point Arena, and the broad area of seismic quiescence south of the triple junction offers few clues to the kinematics of this northernmost segment of the fault.

The conspicuous linear zone of epicenters marking a northeast-trending slice across the southwest corner of the Gorda plate is the aftershock zone of the M=7.2 Eureka earthquake of November 8, 1980. This was the largest earthquake to occur in California during the interval 1980–86. The N. 53° E. trend of its aftershock zone agrees closely with the strike of the left-lateral slip plane inferred from the focal mechanism of the main shock, which was located about a fourth of the way downstrike from the northeastern end of the aftershock zone (Eaton, 1989). The aftershocks from this earthquake



A

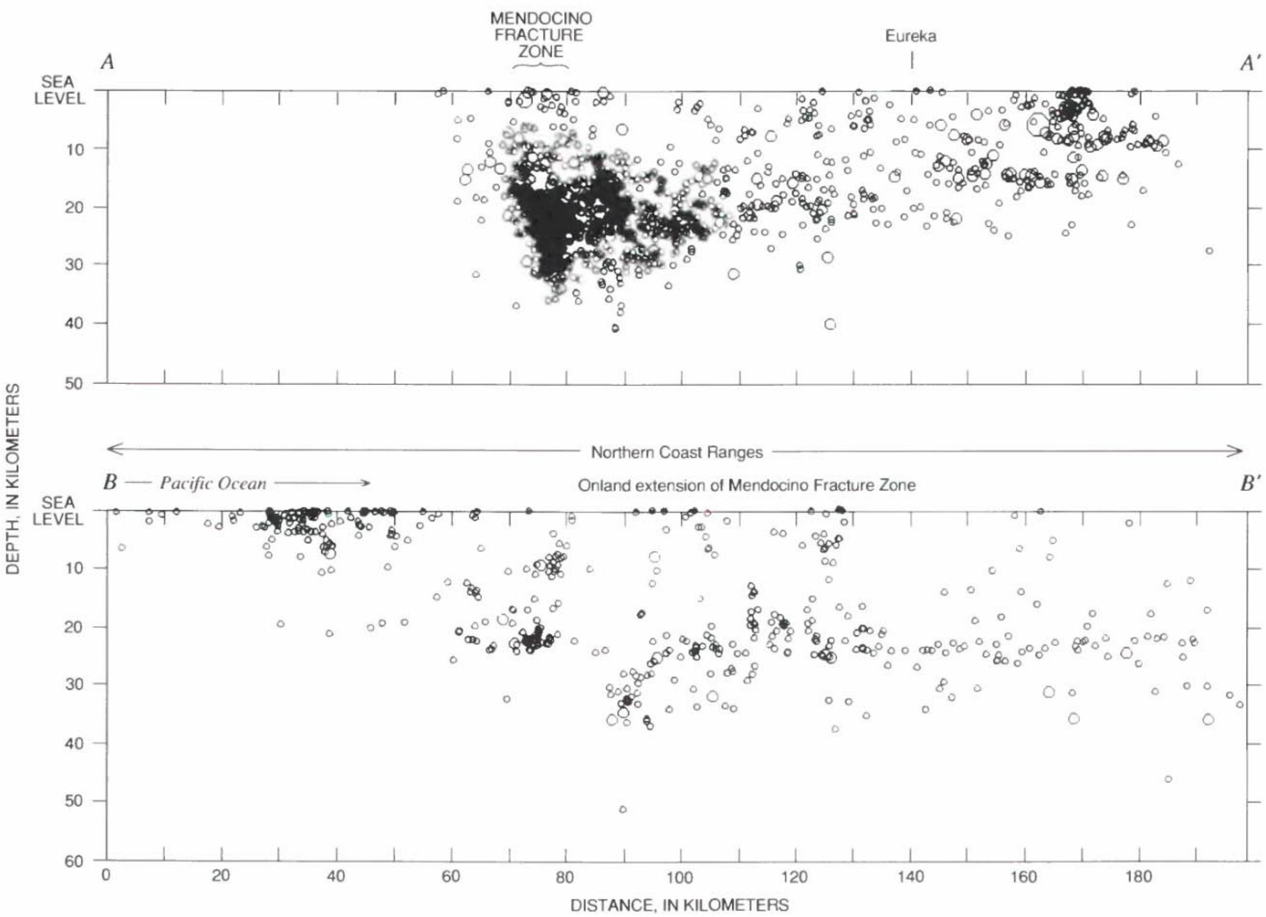
FIGURE 5.5.—Seismicity in the Mendocino triple junction area, northern California. *A*, Earthquake locations, showing major branches of the San Andreas fault system in red; faults dotted where concealed. Magnitude symbols shown in explanation are scaled with enlargement of cross section. *B*, Depth sections perpendicular to N. 75° W. trend of the Mendocino Fracture Zone (*A–A′* and *B–B′* outlined in fig. 5.5*A*). *C*, Depth sections parallel to N. 75° W. trend of the Mendocino Fracture Zone (*C–C′* and *D–D′* outlined in fig. 5.5*A*).

died off within a few months after the main shock—a notably short aftershock sequence for an earthquake of this size.

A third, more diffuse group of earthquakes in the vicinity of the triple junction shows little tendency to concentrate in linear zones. These epicenters form an irregular zone with the greatest concentration in the vicinity of Cape Mendocino, gradually dying off with distance to the north, east, and west. To the south, the seismicity dies off abruptly across the MFZ and its landward extension.

The three-dimensional aspects of this triple junction seismicity are illustrated by four cross sections (figs. 5.5*B*, 5.5*C*). The two cross sections perpendicular to the N. 75° W. trend of the MFZ (fig. 5.5*B*) compare the distribution of focal depths within the submarine section of the Gorda plate adjacent to the triple junction (*A–A′*) with that within the adjacent, subducted section of the Gorda plate and the overlying North American plate (*B–B′*). Earthquake hypocenters along the southern margin of the submarine Gorda plate define a dense, vertically elongate zone beneath the MFZ that dips 70°–75° N. and extends to depths of nearly 35 km. Earthquakes north of this zone cluster in a somewhat less dense, wedge-shaped core outlined by a northward shallowing of maximum focal depths accompanied by a northward deepening of minimum focal depths that converge at a depth of about 20 km (Eaton, 1989). Overlying this relatively dense wedge is a more diffuse distribution of hypocenters, the northernmost of which represent the 1980 M=7.2 event and adjacent aftershocks. The absence of seismicity south of the MFZ indicates that the northeast corner of the Pacific plate behaves as a rigid block in its interaction with the younger, thinner, and internally deforming Gorda plate (Wilson, 1986; Eaton, 1989).

In the onshore cross section (*B–B′*, fig. 5.5*B*), the intense seismicity associated with the MFZ loses most of



B

FIGURE 5.5.—Continued.

its expression. Here, the southern margin of the subducted Gorda plate is marked only by isolated clusters of hypocenters at depths of 10 and 25 km. To the north, however, a band of hypocenters concentrated at about a depth of 20 km corresponds closely to the base of the wedge-shaped distribution beneath the submarine section of the Gorda plate, including the downward flexing of this band as it approaches the southern margin of the Gorda plate. South of the landward extension of the MFZ, the seismicity shallows rather abruptly, reflecting the edge of the subducted Gorda plate beneath the North American plate and the rather thin seismogenic crust associated with the San Andreas fault system to the south.

The cross section parallel to and including the MFZ and its landward extension (*D–D′*, fig. 5.5*C*) reveals that the dense seismicity cluster along the MFZ near the triple junction tapers westward along the MFZ with a wedge-like geometry to a 20-km-deep band of hypocenters, much the same as it does to the north (cross sec. *A–A′*, fig. 5.5*B*). (The pronounced linear concentration of hypocenters at 15-km-depth beneath the submarine Gorda plate in cross sections *A–A′* and *D–D′* represents the default focal depth for the more poorly located earthquakes beyond the perimeter of the onshore seismic network.) The landward extension of the MFZ shows up only weakly as a diffuse scattering of hypocenters extending to a small, isolated cluster of 25-km-deep hypocenters some 50 km east of the triple junction (Δ=190 km, cross sec. *D–D′*) and, possibly, as far as a handful of 30- to 50-km-deep hypocenters 100 km east of the triple junction (Δ=260 km, cross sec. *D–D′*). Focal depths of the shallow seismicity in the northern Coast Ranges are confined to the upper 10 km of the crust. Farther east, however, focal depths increase again to depths of 35 to 40 km beneath the north end of the Great Valley. An east-dipping quiescent band, about 10 km thick, appears to separate the seismicity associated with the MFZ from that beneath the northern Coast Ranges and the Great Valley to the east. The geometry of this band suggests that it may somehow be related to the geometry of the subducted Gorda plate beneath the western margin of the North American plate.

The parallel cross section immediately to the north (*C–C′*, fig. 5.5*C*) reinforces the impression that the distribution of hypocenters carries an image of subduct-

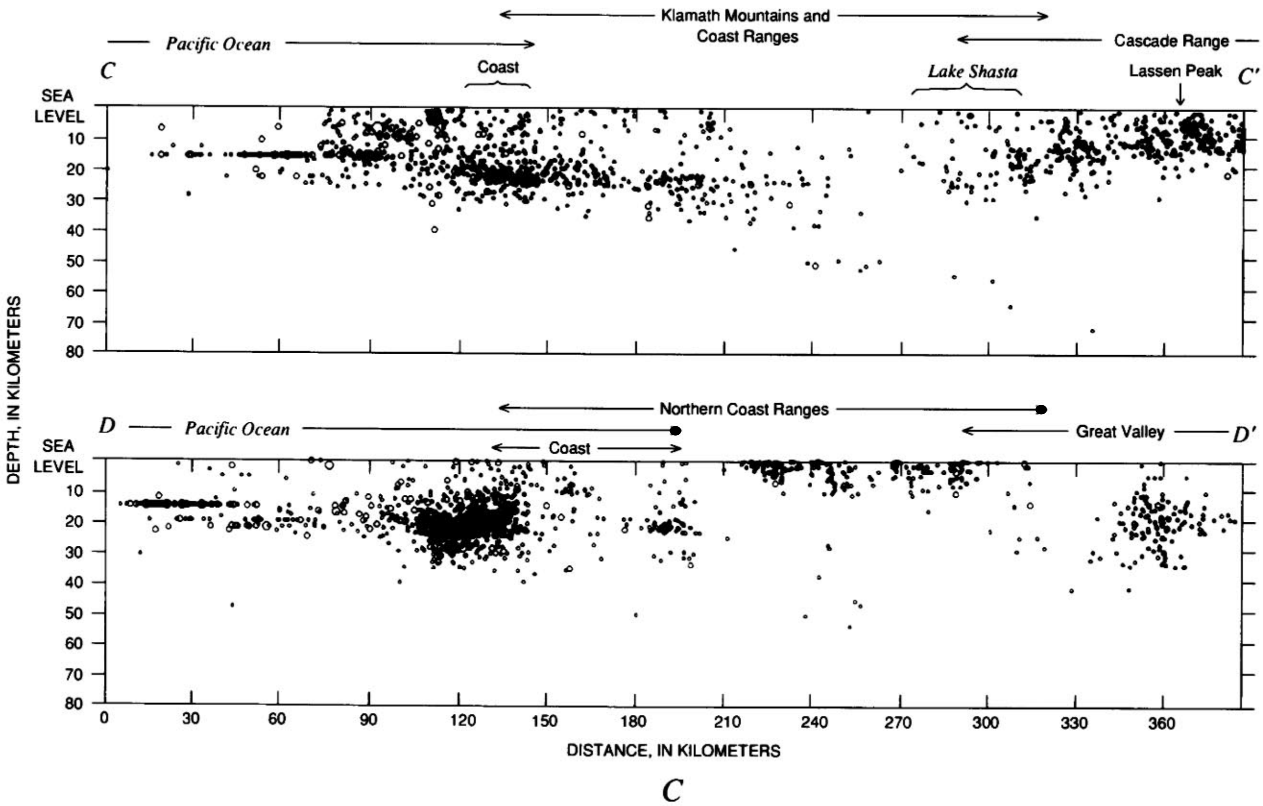


FIGURE 5.5.—Continued.

ed-Gorda-plate geometry. Maximum focal depths increase systematically from 25 to 30 km beneath the submarine Gorda plate to nearly 80 km beneath the southern Cascade volcanoes. Although the easternmost of these deep earthquakes are small and few, their locations are well constrained (Cockerham, 1984; Walter, 1986). As in the section of the fault to the south, a seismically quiescent, east-dipping band appears to separate earthquakes within the Gorda plate from those in the overlying North American plate.

THE 1906 BREAK AND THE NORTHERN COAST RANGES

Aside from a light scattering of epicenters about the trace of the San Andreas fault through the San Francisco peninsula and the Santa Cruz Mountains to the south, the rupture zone of the 1906 earthquake is nearly aseismic. This pattern has persisted not only through the period 1980–86 shown in figure 5.6 but also at least since the mid-1930's, when instrumental data became available for reliable earthquake locations in the area (see Bolt and Miller, 1975; Hill and others, in press). It was interrupted, however, by the M=7.1 Loma Prieta earthquake on October 17, 1989, which ruptured the southernmost 45 km of the 1906 break (cross sec. L–L', fig. 5.7; see chap. 6). The cluster of epicenters along the fault just west of San Francisco coincides closely with Boore's (1977) estimate of the epicentral location for the 1906 main shock. We note that the greatest offsets along the 1906 rupture occurred north of the epicenter along the stretch of the fault that now shows the lowest seismicity (see Thatcher and Lisowski, 1987).

The pair of subparallel epicenter lineations through the northern Coast Ranges east of the 1906 break closely follow the Rodgers Creek-Healdsburg-Maacama fault zone (west) and the Green Valley-Bartlett Springs fault zone (east). In both lineations, the epicenters tend to cluster along the eastern margins of these 2- to 3-km-wide fault zones, which are characterized by multiple strands of subparallel, curvilinear fault traces (see maps at front of book; Dehlinger and Bolt, 1984). These fault zones are essentially colinear with the Hayward and Calaveras faults to the south, although an aseismic interval coincident with the eastern arm of the San Francisco Bay (San Pablo and Suisun Bays) obscures the connection between these branches of the fault system. Most of the earthquakes defining the pair of subparallel lineations through the northern Coast Ranges are small ($M \leq 3$), and, indeed, these fault zones were not recognized as seismically active branches of the San Andreas system until after the northern Coast Ranges section of the telemetered network (fig. 5.2) became operational in late 1979.

Dense clusters of epicenters just south of Clear Lake define a northeast trending pattern transverse to and midway along these northern two branches of the San Andreas fault system. The southwesternmost of these clusters represents microearthquake activity associated with the Geysers geothermal field (Eberhart-Phillips and Oppenheimer, 1984; Oppenheimer, 1986). The cluster just to the northeast underlies the Clear Lake volcanic field, which last erupted about 10 ka (Donnelly-Nolan and others, 1981). Scattered clusters farther to the northeast suggest a tenuous link between this Geysers-Clear Lake trend and the north-south-trending lineation of epicenters along the axis of the north end of the Great Valley.

In longitudinal cross section (H–H', fig. 5.6), earthquakes occurring along the two northern branches of the San Andreas fault system are moderate in number and rather evenly distributed except for the dense, shallow cluster beneath the Geysers-Clear Lake area. The depth to the base of the continuously seismogenic crust shows considerable relief, deepening to between 12 and 13 km south of the Geysers-Clear Lake area and shallowing to only 5 km beneath and just north of the geothermal field. Farther north, the base of the seismogenic crust deepens gradually to a maximum of about 10 km. Note the isolated cluster of small but well-located events at depths of 13 to 18 km beneath Clear Lake, just north of the shallowest depths to the base of the continuously seismogenic crust. Another isolated cluster of deep earthquakes located beneath Suisun Bay have focal depths as great as 15 to 25 km. The more numerous earthquakes along branches of the fault system south of Suisun Bay paint in a dense distribution of hypocenters throughout the upper 10 to 15 km of the crust.

Although the two transverse cross sections across the northern Coast Ranges (E–E', F–F', fig. 5.8A) show the concentration of hypocenters around the Rodgers Creek and Green Valley branches of the San Andreas fault, they provide no hint of the location of the main branch of the San Andreas fault that ruptured in 1906. The southern of these two cross sections (F–F') includes the dense, shallow cluster of events associated with the Geysers-Clear Lake activity, as well as the cluster of deeper events beneath the eastern margin of the Coast Ranges. Focal depths in the latter cluster, which falls at the northeast end of the Geysers-Clear Lake lineation and at the south end of the north-south-trending lineation beneath the Great Valley, range from 10 to 25 km, a depth range common to earthquakes near the north end of this Great Valley seismicity lineation (cross sec. D–D', fig. 5.5C). Maximum focal depths increase by several kilometers from west to east in both cross sections. Farther east, they increase abruptly to depths of 25 km or so along the Great Valley lineation.

CENTRAL CREEPING SECTION

Densely aligned epicenters mark the nearly straight, creeping section of the San Andreas fault that separates the south end of the 1906 break near San Juan Bautista from the north end of the 1857 break near Cholame (fig. 5.6*B*). Densely aligned epicenters follow the Calaveras fault northward to a point just east of the south tip of the San Francisco Bay, where the Hayward fault branches to the west and the Greenville fault zone branches to the east. Few epicenters fall along the northward extension of the Calaveras fault beyond this branching point, although a diffuse cluster of epicenters coincides with the right-stepping offset between the north end of the Calaveras fault and the Concord fault (fig. 5.6*A*). This dilatational offset was the site of pronounced earthquake swarms in June 1970 and August 1976 (Lee and others, 1971; Weaver and Hill, 1978/79).

Although these dense alignments of epicenters coincide closely with the mapped surface trace of the San Andreas fault system as first documented by Eaton and others (1970a), the coincidence is not everywhere perfect (fig. 5.6*B*). In the region where the Calaveras fault branches from the main trace of the San Andreas fault, for example, the densely aligned epicenters appear to be systematically displaced 3 to 4 km westward of the surface trace of the San Andreas fault and a somewhat smaller distance eastward of the surface trace of the Calaveras fault. Much of this apparent offset results from a strong contrast in rock type and *P*-wave velocity across the faults that is not adequately accounted for in routine hypocenter locations (Mayer-Rosa, 1973; Pavoni, 1973; Spieth, 1981). When the hypocenter locations are recalculated using a more appropriate, two-dimensional structural model, these offsets are much reduced but not completely eliminated. The remaining offsets reflect deviation of the faults from the vertical, with the San Andreas fault dipping 70° W. (Pavoni,1973; Spieth, 1981) and the Calaveras fault dipping 80° E. (Reasenberg and Ellsworth, 1982).

Wesson and others (1973) recognized the close correlation between active creep and persistent microseismic activity along the 200-km-long section of the San Andreas fault north of Parkfield and proposed that this correlation may hold for other branches of the fault in central California as well. Allen (1981) and Schultz and others (1982) pointed out that this correlation holds for the Calaveras-Hayward fault system, but creep measurements have yet to be made on the subparallel Rodgers Creek-Healdsburg-Maacama and Green Valley-Bartlett Springs faults. Creep is the dominant process for shallow slip along the central section of the San Andreas fault, and geodetic measurements spanning this section of the fault indicate that the long-term slip rate of 32 mm/yr along the fault accommodates nearly all of the local plate motion. Because it appears that little, if any, shear strain is accumulating in the blocks on either side of the fault, most seismologists believe that this section of the fault is unlikely to rupture in a great earthquake (see chap. 7).

The creeping section of the fault system, however, has produced several moderate earthquakes during historical time (see chap. 6). The most recent of these events, which occurred along the right-branching segments northeast of the San Andreas fault, where creep rates average several millimeters per year, include (1) the $M=5.9$ Coyote Lake earthquake of August 6, 1979, and the $M=6.2$ Morgan Hill earthquake of April 24, 1984, which ruptured adjacent 20-km-long segments of the Calaveras fault south of its junction with the Hayward fault (Reasenberg and Ellsworth, 1982; Bakun and others, 1984); and (2) the $M=5.5$ and 5.8 Livermore events of January 24 and 27, 1980, which ruptured a 20-km-long stretch of the Greenville fault north of Livermore (Bolt and others, 1981).

The most noteworthy sequence of moderate earthquakes along the central section of the San Andreas fault involve the five virtually identical $M=6$ events that have ruptured the same 30-km-long stretch near Parkfield at nearly 22-year intervals since 1881 (Bakun and McEvilly, 1984). This stretch of the fault is defined by a 1-km right-stepping offset on the south and a 5° W. bend on the north; it coincides with the transition between the south end of the creeping section of the fault and the north end of the 1857 break (see Bakun and Lindh, 1985, fig. 1). The most recent of these characteristic Parkfield earthquakes occurred in 1966, and an intensive monitoring experiment is underway to capture a detailed instrumental record of the next Parkfield earthquake, which is predicted to occur sometime within a 10-year window centered on 1987–88 (Bakun and Lindh, 1985).

The scattered seismicity within the Coast Ranges surrounding the San Andreas fault system is distinctly more intense in the Franciscan terrane east of the fault than in the granitic Salinian block to the west. The large, dense cluster of epicenters along the eastern margin of the Coast Ranges adjacent to the south end of the creeping section represents the aftershocks of the $M=6.7$ Coalinga earthquake of May 2, 1983, and the $M=5.7$ Kettleman Hills earthquake of August 4, 1985, both of which involved reverse slip on northwest-striking planes subparallel to the adjacent section of the San Andreas fault (Stein and King, 1984; Eaton, 1989). Scattered clusters of epicenters within the Franciscan terrane show a crude northwest-trending alignment with the southwest edge of the Coalinga-Kettleman Hills aftershock zone and the Ortigalita fault, the north end of which passes beneath the San Luis Reservoir (LaForge and Lee, 1982). This weakly defined lineation is essentially colinear with the Greenville fault, east of the San Francisco Bay (fig. 5.4).

The Salinian block west of the central section of the San Andreas fault and east of the Sur-Nacimiento fault forms a broad, nearly aseismic swath along the west flank of the Coast Ranges. These two seismically active fault zones separate the granitic Salinian block from the Franciscan terrane on either side (see chap. 3). The Rinconada fault, within the Salinian block, appears to be nearly aseismic except, possibly, toward the south where it approaches the Sur-Nacimiento fault zone. The small cluster of epicenters just east of the midpoint of the Rinconada fault represents a persistent spot of microearthquake activity at depths of 8 to 10 km near the San Ardo oil field (Poley, 1988).

In the cross section along the central section of the San Andreas fault (*L–L′*, fig. 5.7), the actively creeping section of the fault shows up as a densely mottled distribution of hypocenters within the upper 12 to 15 km of the crust. The density of hypocenters within this creeping section tends to decrease with depth, and the denser clusters generally are concentrated at depths of less than 5 to 8 km. The base of the seismogenic zone undulates about an average depth of some 13 km beneath most of the creeping section, but it deepens to 15 km beneath both the northern and southern transitions to the locked sections of the fault. In contrast to the creeping section of the fault, the sparse seismicity associated with the locked segments that ruptured in 1906 (north) and 1857 (south) tends to be concentrated toward the deeper parts of the seismogenic crust. Note that the 1989 Loma Prieta $M=7.1$ earthquake ruptured the 45-km-long section of the San Andreas fault with a pronounced U-shaped gap in shallow earthquakes immediately north of the creeping section of the fault (cross sec. *L–L′*, fig. 5.7; see chap. 6).

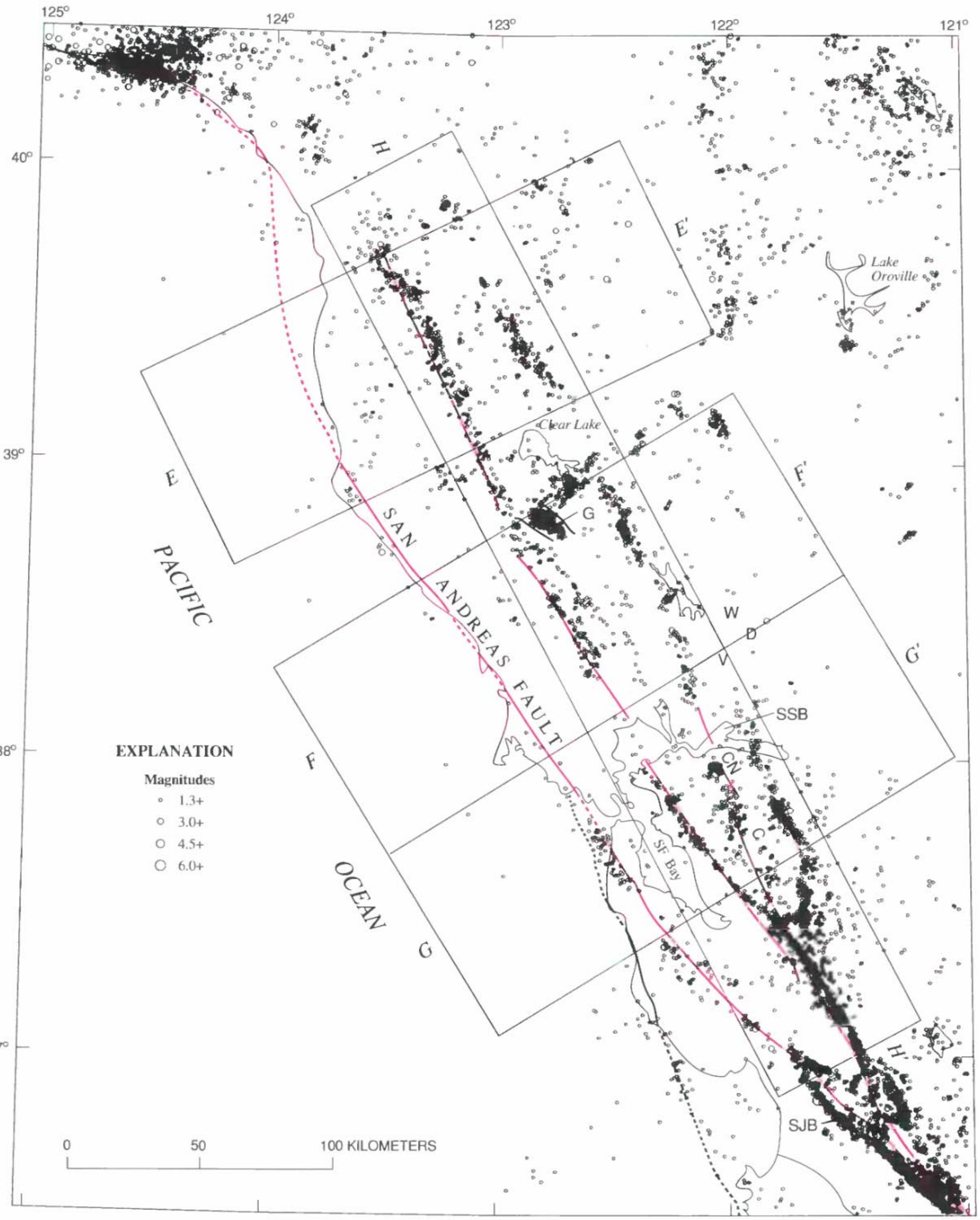
The cross sections transverse to the central San Andreas fault system (*G–G′*, fig. 5.8*A*; *I–I′*, *J–J′*, *K–K′*, fig. 5.8*B*) reveal the seismically active, creeping branches of the fault as narrow, near-vertical hypocenter distributions coincident with the fault plane. The broadened distribution in cross sections *I–I′* and *J–J′* (fig. 5.8*B*) reflects the oblique projection of earthquakes along the Calaveras fault zone and the clustering northeast of the fault in the Bear Valley region (Ellsworth, 1975), respectively. These transverse cross sections also emphasize the quiescence of the Salinian block relative to the Franciscan terrane on either side (note, however, the isolated cluster of deep events beneath San Ardo in the Salinian block in cross sec. *K–K′*), and the fairly uniform depth of 12 to 15 km to the base of the seismogenic zone that persists throughout the central Coast Ranges. As in the area farther north, however, maximum focal depths increase rather abruptly to 25 km beneath the eastern margin of the Coast Ranges and the Great Valley. This increase in focal depth is particularly pronounced beneath the dense cluster of hypocenters associated with the 1983 Coalinga earthquake and its aftershocks (cross sec. *G–G′*, fig. 5.8*B*).

THE 1857 BREAK AND THE TRANSVERSE RANGES

The 1857 rupture of the San Andreas fault began near Parkfield at the south end of the creeping section of the fault and propagated southeastward along the straight segment, through the Carrizo Plain and around the Big Bend near Tejon Pass, and thence along the relatively straight, east-southeastward trend of the Mojave segment to Cajon Pass, where the San Jacinto fault branches to the south (figs. 5.3, 5.9*A*). Right-lateral offsets associated with this great earthquake generally decreased from 9 m along the Carrizo Plain segment, through 6 m around Fort Tejon, to 3–4 m along the Mojave segment (Sieh, 1978).

The pronounced bends in the San Andreas fault at either end of the east-southeast-trending Mojave segment involve strong structural complexities and clusters of persistent seismic activity. Both bends, for example, spawn major left-lateral faults that form conjugate sets to the San Andreas system. Sykes and Seeber (1985) proposed that these two major bends in the San Andreas fault system represent large-scale asperities that exert a strong influence on the rupture patterns of great earthquakes along the San Andreas fault in southern California. The San Andreas fault appears to maintain its integrity as a single, more or less continuous zone through the 30° bend at Fort Tejon. Convergence resulting from the pronounced counterclockwise cant of the Mojave segment of the San Andreas fault (N. 66° W.) with respect to the average N 37° W. orientation of the transform boundary largely accounts for the crustal uplift and shortening expressed in the Transverse Ranges.

The straight Carrizo Plain segment is, except for a small cluster of events near Simmler (lat 35°25′ N., long 120°00′ W.), almost completely aseismic, much like the Point Arena segment of the 1906 break. The straight part of the Mojave segment also is seismically very quiet. The southernmost 80 km of the 1857 rupture zone produces few earthquakes, forming a sinuous lineation around the fault. Again, an analogy can be drawn with the 1906 rupture zone: The southernmost 80 to 100 km of the 1906 rupture, which exhibited less slip than the rupture zone farther north, also has a slightly higher background seismicity rate than that to the north. The Mojave earthquakes are temporally clustered (Sauber and others, 1983) and, because of their reverse focal mechanisms and displacement from the surface trace of the San

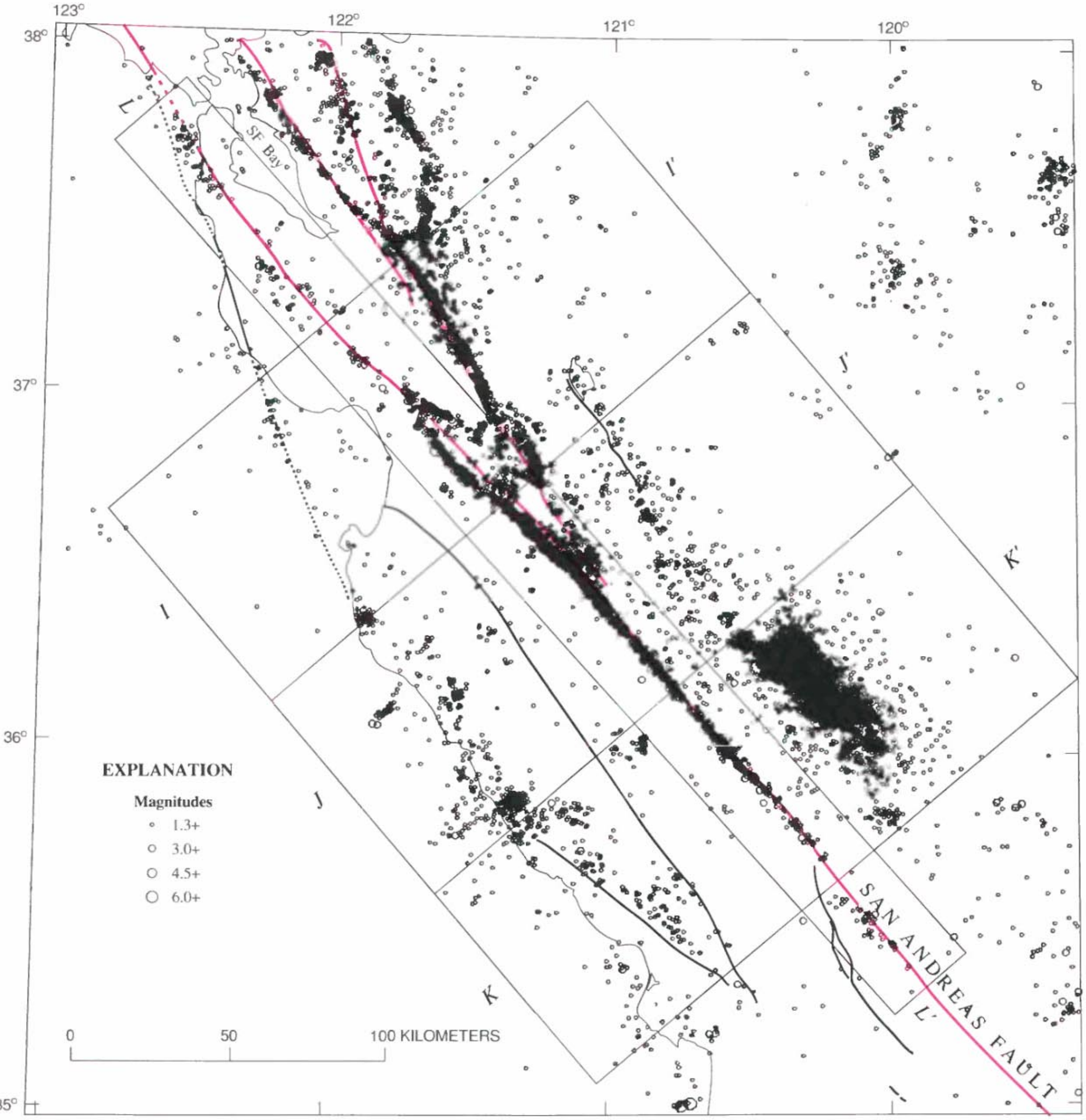


A

FIGURE 5.6.—Seismicity in the northern (*A*) and central (*B*) Coast Ranges. Major branches of the San Andreas fault marked in red; faults dotted where concealed. Earthquakes within rectangles are plotted in corresponding depth sections in figures 5.7 and 5.8. C, Calaveras fault; CN, Concord fault; G, The Geysers; SF Bay, San Francisco Bay; SJB, San Juan Bautista; SSB, Suisun Bay; D, Dixon; V, Vacaville; W, Winters.

Andreas, are thought to be on secondary fault structures rather than on the San Andreas fault itself.

Within the area of the Big Bend of the San Andreas fault near Tejon Pass, the level of seismicity is much higher than in the adjoining regions. Much of this activity is associated with the Pleito-White Wolf fault system, which abuts the San Andreas fault in the northern bend, some 40 km west of the junction with the Garlock-Big Pine faults (fig. 5.9*A*; cross sec. *N–N'*, fig. 5.9*B*; see fig. 5.12). The White Wolf fault ruptured in 1952 with the $M=7.7$ Kern County earthquake, accompanied by left-oblique reverse slip on a southeast-dipping fault plane (Richter, 1958; Stein and Thatcher, 1981). This is the largest earthquake to occur in California since the $M\approx8$ San Francisco earthquake. In contrast to the quiescent 1906 rupture, however, the White Wolf fault continues to



B

FIGURE 5.6.—Continued.

be marked by persistent aftershocks of the 1952 Kern County earthquake. The Garlock and Big Pine faults are essentially quiescent within 40 to 50 km of the San Andreas, although two small clusters of epicenters form a nearly symmetrical pattern on either side of the junction of these sinistral faults with the San Andreas.

Seismicity increases markedly near the south end of the 1857 rupture zone, where the San Jacinto fault and the east-west-striking Cucamonga fault, which forms the south front of the central Transverse Ranges, intersect the San Andreas fault. A bulbous lobe of epicenters extends westward along the Cucamonga fault from this junction. Scattered epicenters fill in the wedge of the Transverse Ranges between the Cucamonga and San Jacinto faults. In figure 5.9*A*, note the tight lineation of epicenters that appears to follow the trace of the Cucamonga fault westward to its intersection with the Elsinore fault (Chino branch). The significance of this lineation is unclear because the Cucamonga fault presumably dips north beneath the central Transverse Ranges (Morton, 1987).

The cross section along the Mojave segment of the San Andreas fault (*M–M′*, fig. 5.9*B*) shows a wide variation in focal depths. The few events along the straight section of the Mojave segment are strongly clustered around depths of 10 km, with the maximum focal depth always above 15 km and almost no shallow earthquakes. This pattern is similar to the concentration of hypocenters in the lower half of the seismogenic crust beneath the locked 1906 segment (compare with cross sec. *L–L′*, fig. 5.7). In contrast, the earthquakes at Tejon Pass cover the full depth range from 0 to 25 km. At the southeast end of the 1857 rupture zone at Cajon Pass, maximum focal depths increase with the seismicity level to a maximum of 20 km. In this section, there are no shallow (less than 5 km deep) events.

Note, in particular, that focal depths of more than 20 km are broadly associated with the convergent tectonics of the Transverse Ranges; they are not limited to the seismicity clusters in the vicinity of the bends in the San Andreas fault system as might be inferred from cross section *M–M′* (fig. 5.9*B*). Cross sections *N–N′* and *O–O′* (fig. 5.9*B*), for example, illustrate that the seismogenic crust reaches thicknesses of 20 to 25 km beneath the Santa Barbara Channel and the western Transverse Ranges, as well as beneath the Tehachapi Mountains to the east.

SOUTHERN SECTION OF THE SAN ANDREAS FAULT SYSTEM

Southeast of the 1857 rupture, the San Andreas fault splays into several branches associated with intense

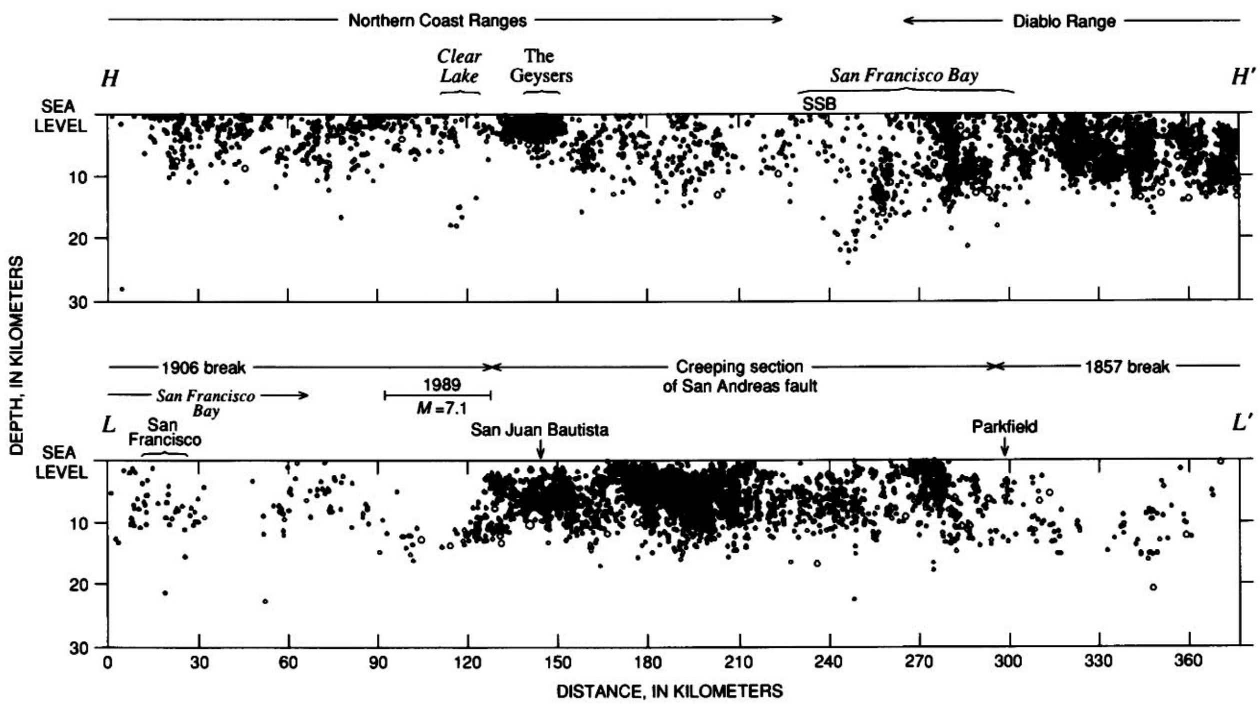


FIGURE 5.7.—Longitudinal depth sections along the San Andreas fault system in the northern and central Coast Ranges. Bar above section *L–L′* indicates rupture extent of the October 17, 1989, Loma Prieta M=7.1 earthquake (see chap. 6). SSB, Suisun Bay. See figure 5.6 for locations of sections and explanation of symbols, which are scaled with scale change of cross sections.

seismicity in the Banning-San Gorgonio area. Like the Tejon Pass bend in the 1857 rupture zone, the San Gorgonio bend spawns a major left-lateral fault (the Pinto Mountain fault) conjugate to the San Andreas system. Unlike the situation at Tejon Pass, however, the San Andreas fault at San Gorgonio splays into a complex pattern of branching and intersecting fault segments. South of San Gorgonio, the San Andreas fault reconverges into a single strand and bends again to the more southeasterly trend that characterizes the southern section of the fault system.

This section of the fault system south of the Transverse Ranges is transitional from oblique spreading along the axis of the Gulf of California to the obliquely convergent strike-slip displacement that dominates deformation along the continental section of the San Andreas transform boundary to the north. Several major strike-slip faults run west of and subparallel to the main strand of the San Andreas fault south of the Transverse Ranges. These faults, which are considered part of the San Andreas system and include the Imperial, San Jacinto, and Elsinore faults, accommodate a significant proportion of the plate-boundary motion. The Imperial and San Jacinto faults, in particular, have produced more moderate earthquakes than any other segment within the fault system (see chap. 6; Hanks and others, 1975).

SOUTHERN BRANCH OF THE SAN ANDREAS FAULT

The most intense seismicity along the main trace of the southern section of the San Andreas fault is associated with the San Gorgonio bend and is concentrated between the two principal branches of the San Andreas fault: (1) the Mission Creek fault, or northern branch of the San Andreas; and (2) the Banning fault, which runs nearly due west from the south end of the Mission Creek fault toward an ambiguous junction with the San Jacinto fault just south of San Bernardino (see fig. 5.3*A* and maps at front of book). Neither strand forms a continuous structure through the bend. This San Gorgonio seismicity cluster produced numerous M=5.0–6.5 earthquakes in the 1930's and 1940's, and in 1986 it produced the M_L=5.6 North Palm Springs earthquake, which involved dextral strike-slip displacement on the north-dipping Banning fault (Jones and others, 1986). The background seismicity in this area is the highest in southern California, but it is distributed throughout a volume and cannot be clearly associated with any fault. To the west, seismicity associated with the Banning cluster abuts the dense lineation of epicenters coincident with the northernmost segment of the San Jacinto fault. Nicholson and others (1986) suggested that much of the seismicity within the upper 10 km of the crust in this cluster involves left-lateral slip on a series of northeast-striking faults; however, Jones (1988) pointed out that the evidence for northeast-trending lineations of epicenters within the Banning cluster is less than clear.

Diffuse seismicity extends northward from the Banning cluster into the San Bernardino Mountains and eastward into the Pinto Mountains, with no clear lineations along the sinistral Pinto Mountain fault. Indeed, a diffuse, north-south-trending lineation of epicenters seems to cut directly across the Pinto Mountain fault from the west-central Pinto Mountains. Two M=5.2 earthquakes (see events 75, 76, fig. 5.11*A*) with right-lateral strike-slip planes parallel to this trend occurred at the north end of this zone in 1975 and 1979. Somewhat farther south, however, a broad, east-west-trending lineation appears to coincide with the Blue Cut fault. Even farther south, a second broad lineation extends eastward from near the junction of the Banning and Mission Creek branches, although this lineation does not coincide with a mapped fault.

The southernmost section of the San Andreas fault, the Indio segment, which extends from the junction of the Banning and Mission Creek branches southward to the end of the San Andreas at the Salton Sea, has been almost completely aseismic in historical time. At the north end of this segment, periodic swarms of small ($M \leq 4$) earthquakes a few kilometers east of the San Andreas appear to occur on small northeast-trending structures (for example, Norris and others, 1986; Jones, 1988). The sparse background seismicity is also offset a few kilometers to the east from the surface trace of the San Andreas. Although the possibility of systematic offsets related to P-wave-velocity contrasts across the fault has not been investigated in detail, the observed offset seems too large to be explained entirely by lateral velocity contrasts.

Although it has not ruptured with a major earthquake in historical time, the aseismic Indio segment of the San Andreas fault seems to have much in common with the 1857 and 1906 rupture zones. Sieh (1986) presented geologic evidence for at least four major ruptures along the Indio segment since A.D. 1000; the last occurred approximately 300 yr ago. Unlike the two major locked sections, however, the south end of the Indio segment adjacent to the Salton Sea shows minor aseismic creep (Louie and others, 1985) and has shown episodes of sympathetic slip accompanying $M \approx 6$ earthquakes on the Imperial fault and the southern section of the San Jacinto fault (Sieh, 1982). Not only is the Indio segment aseismic, but also the entire Coachella block extending from the San Andreas fault on the northeast to the crest of the San Jacinto Mountains on the southwest.

A cross section of hypocenters along the southern branch of the San Andreas fault (M–M', fig. 5.9*B*) shows that the earthquakes associated with the bend at San

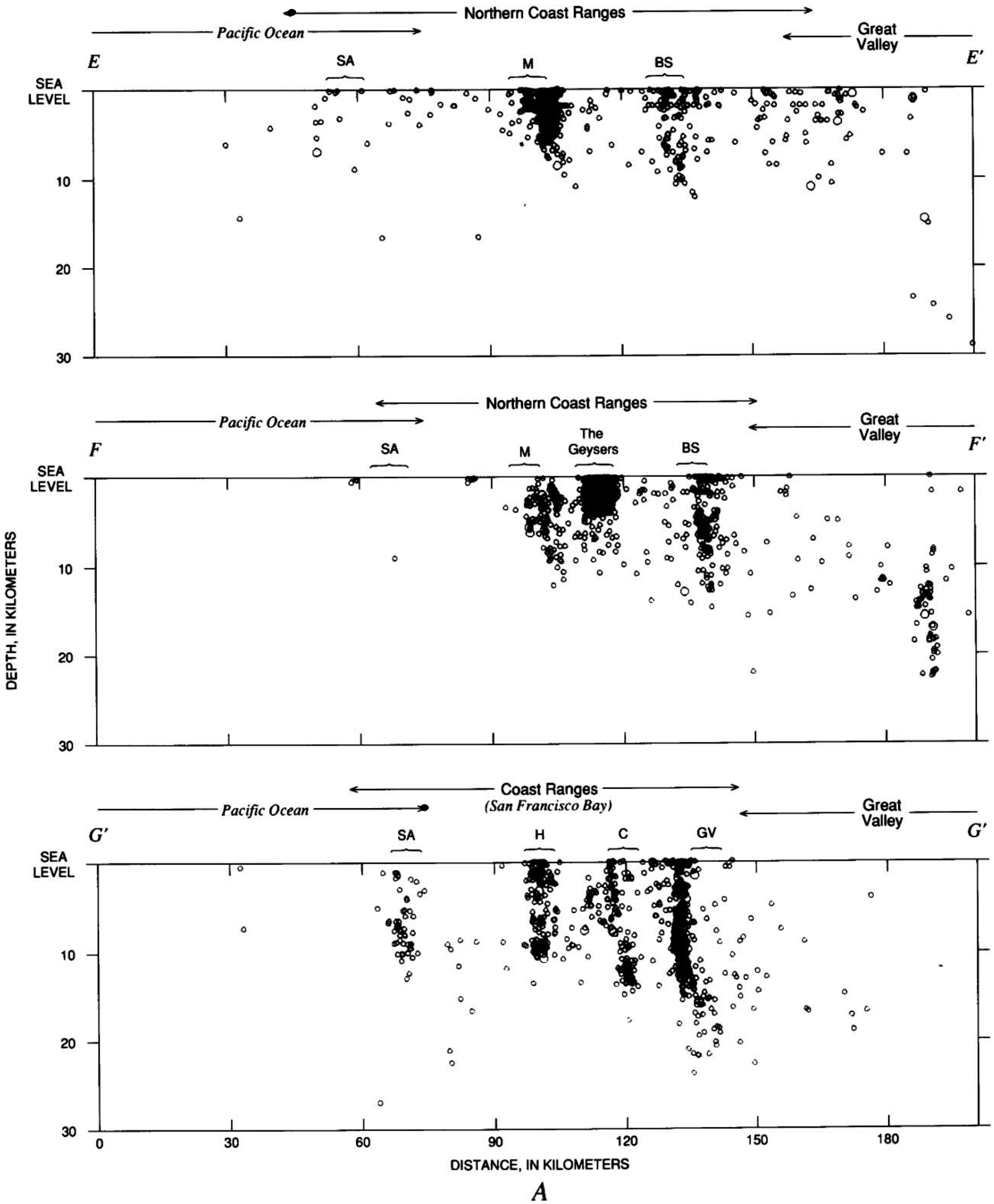
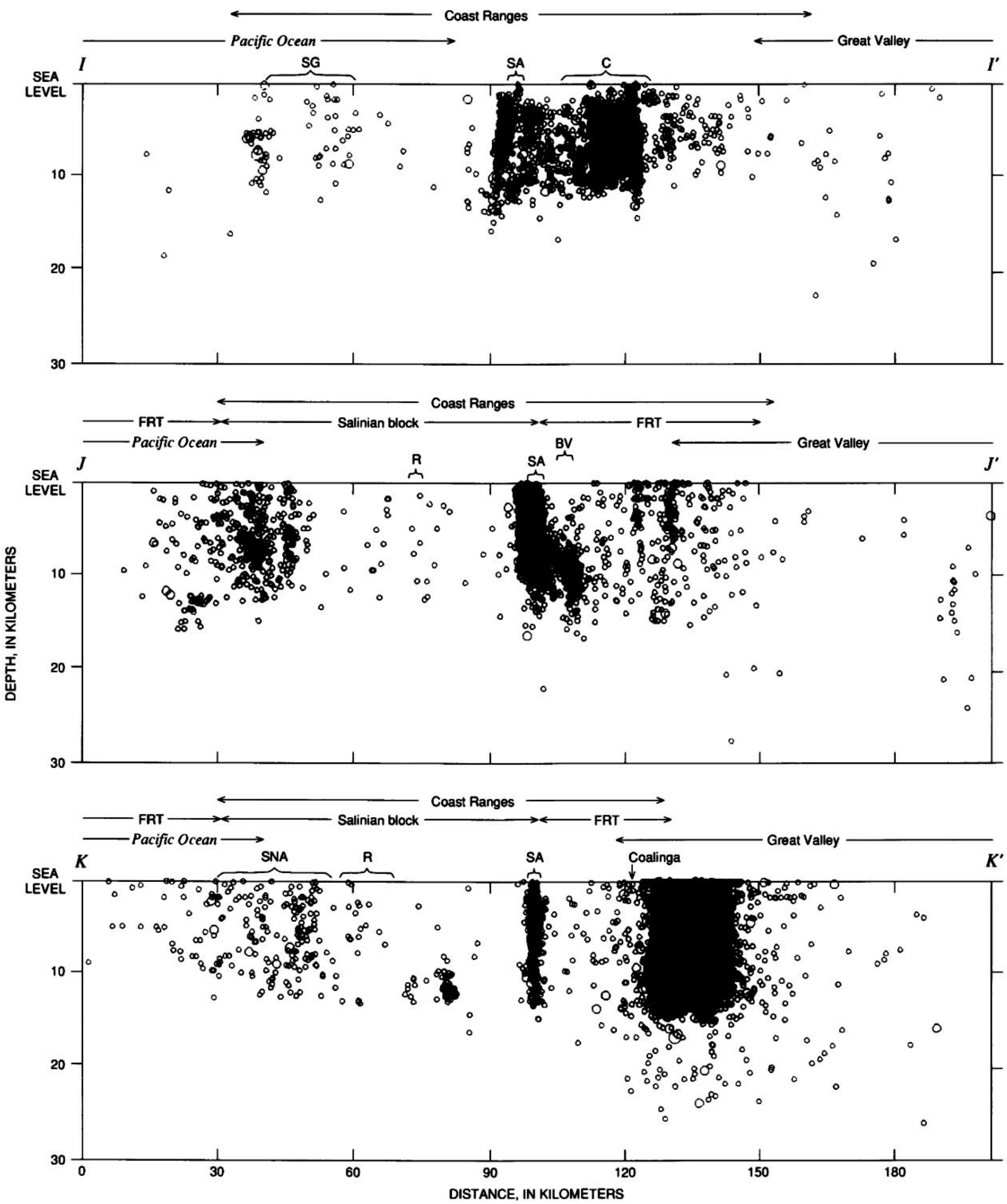


FIGURE 5.8.—Transverse depth sections across the San Andreas fault system in the northern (*A*) and central (*B*) Coast Ranges. See figure 5.6 for locations of sections and explanation of symbols, which are scaled with enlargement of cross sections. Faults: BS, Bartlett Springs; C, Calaveras; GV, Greenville; H, Hayward; M, Maacama; R, Rinconada; SA, San Andreas; SG, San Gregorio; SNA, Sur-Nacimiento. BV, Bear Valley on cross section *J–J′*. FRT, Franciscan terrane.



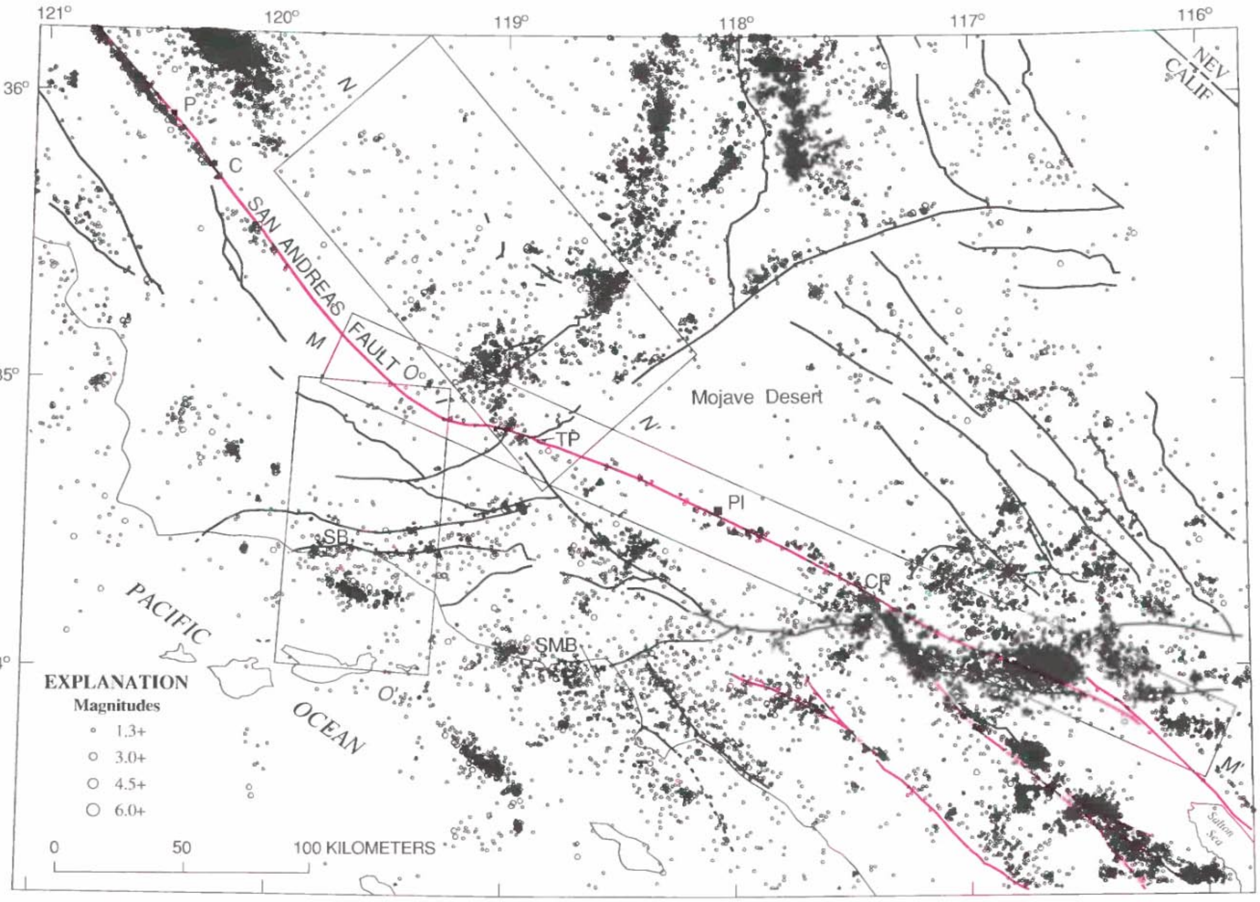
B

FIGURE 5.8.—Continued.

Gorgonio are among the deepest in southern California, with maximum focal depths approaching 25 km. The maximum focal depths deepen southward along the San Andreas fault from about 12 km beneath the Mojave segment to 25 km beneath the San Gorgonio fault. At the south end of the San Gorgonio area, however, maximum focal depths abruptly decrease to 10 km. This shallowing of seismicity is associated with a shift in the most concentrated seismicity from between the two segments (Mission Creek and Banning) of the San Andreas to east of the Mission Creek fault. The sparse seismicity of the Indio segment is limited to depths of 5 km or less.

ASSOCIATED FAULTS

Although the southernmost section of the San Andreas fault is almost completely aseismic, associated subparallel faults are extremely active. These faults are marked by the three bold north-south- to northwest-trending alignments of epicenters that dominate the seismicity pattern within the San Andreas fault system south of the Transverse Ranges (fig. 5.10*A*), from east to west: (1) the Brawley seismic zone (Johnson, 1979), defined by a dense, spindle-shaped cluster of epicenters connecting the north end of the Imperial fault and the south end of the Indio segment of the San Andreas fault; (2) the northwestward alignment of densely clustered epicenters along the San Jacinto fault zone, which appears to branch from the northern section of the Imperial fault; and (3) the northwestward alignment of more diffusely clustered epicenters along the Elsinore fault, which appears to branch from somewhere near the south end of the Imperial fault.



A

FIGURE 5.9.—Seismicity in the southern Coast Ranges and Transverse Ranges. *A*, Earthquake locations, showing major branches of the San Andreas fault system in red; faults dotted where concealed. Magnitude symbols shown in explanation are scaled with enlargement of cross sections. C, Cholame; CP, Cajon Pass; P, Parkfield; Pl, Palmdale; SB, Santa Barbara; SMB, Santa Monica Bay; TP, Tejon Pass. *B*, Depth sections outlined in figure 5.9*A*. Faults: B, Banning; G, Garlock; MC, Mission Creek; N.Br.SA, northern branch of the San Andreas; PM, Pinto Mountain; SA, San Andreas, SJ, San Jacinto; WW, White Wolf.

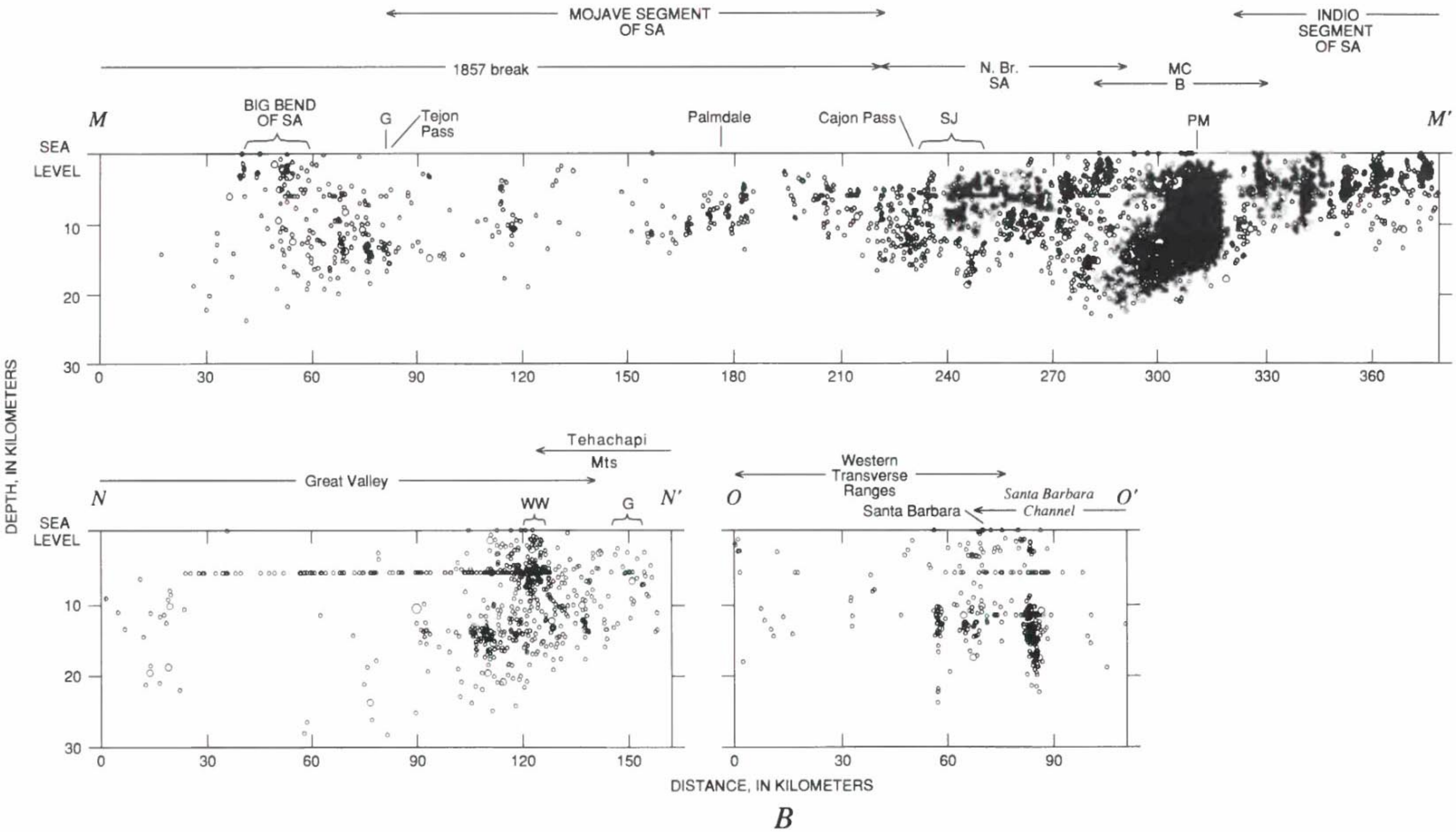


FIGURE 5.9.—Continued.

The Brawley seismic zone and the cluster of epicenters at the south end of the Imperial fault (coincident with the Cerro Prieto volcanic-geothermal field in Mexico) represent the two northernmost in the series of small spreading centers offset by right-lateral transform faults that characterize oblique spreading in the Gulf of California (Lomnitz and others, 1970; Johnson and Hill, 1982). The Imperial fault itself, which is marked by a scattered alignment of epicenters, serves as the transform fault between these two small spreading centers. The $M=7.1$ El Centro earthquake ruptured the entire length of the Imperial fault in 1940, and the $M=6.6$ Imperial Valley earthquake of 1979 ruptured the north two-thirds of the fault; intensity data suggest that moderate earthquakes ($5.5<M<6.3$) in 1906, 1915, 1917, and 1927 may also have been located on the Imperial fault (Johnson and Hill, 1982). Most of the aftershocks associated with the 1979 Imperial Valley earthquake were concentrated in the south half of the Brawley seismic zone, which was first recognized because of the many earthquake swarms it produced from 1973 through mid-1979 (Hill and others, 1975; Johnson 1979; Johnson and Hutton, 1982). Many of the individual swarm sequences, as well as individual clusters of events in the aftershock sequence, defined lineations transverse to the strike of the Imperial fault and the long axis of the Brawley seismic zone. Most earthquakes within the Brawley seismic zone have strike-slip focal mechanisms; thus, kinematically, these transverse lineations represent conjugate structures to the dominant north-northwestward trend of the Imperial-Brawley fault system.

Irregular clusters of epicenters mark the San Jacinto fault zone, which runs along the southwest base of the Santa Rosa and San Jacinto Mountains. These clusters tend to be concentrated near bends and junctions within the complex set of multiple fault strands that form the surface expression of this fault zone. In several places, particularly within the southern and northern sections of the fault zone, epicenters define linear concentrations that tend to be closely aligned with mapped fault traces. The San Jacinto fault zone has produced at least 10 earthquakes of $M=6.0$–6.6 since 1890, the most recent of which were the $M=6.2$ earthquake of 1954, the $M=6.6$ Borrego Mountain earthquake of 1968, and the $M=6.6$ Superstition Hills earthquake of 1987. Thatcher and others (1975) pointed out that this series of historical $M>6$ earthquakes along the San Jacinto fault zone has left two seismic gaps: one along the northern 40 km of the fault, and the other along a 20-km-long stretch of the central section of the fault zone (the Anza gap). The Anza gap shows up in figure 5.10*A* as a relatively quiescent stretch of the fault zone between two dense clusters, with a third cluster located off the fault zone some 20 km southwest of the gap (see Fletcher and others, 1987; Sanders and Kanamori, 1984).

The Elsinore fault zone is defined not so much by a coincident alignment of epicenters as by the loci of western end points for clusters of epicenters elongate northeastward between the Elsinore and San Jacinto fault zones. This pattern is most pronounced along the southeast half of the fault; the northwest half, which defines the northeast scarp of the Elsinore Mountains, is marked by scattered clusters of epicenters. As the Elsinore fault enters the Los Angeles Basin to the north, it splays into the Whittier and Chino faults. Historical seismicity levels are considerably lower along the Elsinore fault than either the San Jacinto fault zone or the Imperial fault/Brawley seismic zone. The largest historical earthquake on the Elsinore fault was an $M=6$ event in 1910 in the central section. The Whittier Narrows earthquake ($M_L=5.9$) of 1987, which caused over $300 million in damage, was located at the north end of the Elsinore-Whittier fault. Because its mechanism was thrust faulting on an east-west-striking plane with a shallow dip, however, it does not appear to be simply related to the Elsinore system.

Seismicity in the relatively quiescent southwestern corner of California between the Elsinore fault and the coast shows up in figure 5.10*A* as small, sparsely scattered clusters of epicenters. Activity picks up again, however, in the vicinity of the major northwest-striking faults along the coast (the Rose Canyon fault through San Diego and the Newport-Inglewood and Palos Verdes faults along the western margin of the Los Angeles Basin). Except for weak alignments along the Newport-Inglewood fault, which ruptured with an $M=6.3$ earthquake in 1933 (Richter, 1958), the seismicity patterns associated with these faults show little tendency to align along mapped fault traces.

The cross sections in figure 5.10*B* emphasize that, except in the immediate vicinity of the Salton Sea, maximum focal depths associated with earthquakes aligned along the principal branches of the southern section of the San Andreas fault system are systematically deeper than those aligned along its central and northern sections. Maximum focal depths, for example, decrease from 15 to 18 km beneath the central section of the Imperial fault near the United States-Mexican border to less than 10 km beneath the north end of the Brawley seismic zone at the southeast tip of the Salton Sea (cross sec. Q–Q', fig. 5.10*B*). The focal depths associated with earthquakes along the Coyote Creek, Superstition Hills, and Superstition Mountain faults forming the southwestern section of the San Jacinto fault zone adjacent to the Salton Sea are concentrated in the upper 10 km of the crust (cross sec. P–P', fig. 5.10*B*).

Those segments of the San Andreas fault system in southern California with maximum focal depths shallower than 12 to 15 km are also those that show evidence of aseismic creep (see Louie and others, 1985). Indeed, actively creeping segments of the San Andreas fault system throughout California seem to be confined to those along which microearthquakes are concentrated in the shallow crust (focal depths of less than 12–15 km).

Moving northwestward along the San Jacinto fault zone, the base of the seismogenic crust deepens systematically to a maximum of 20 km beneath the stretch adjacent to San Jacinto Mountain (which at 3,293 m, is the second highest point in southern California) midway along the fault zone (cross sec. *P–P′*, fig. 5.10*B*). The base of the seismogenic crust maintains this 20-km depth farther northwestward along the fault zone to its junction with the Banning fault just south of San Bernardino (fig. 5.10*A*), beyond which it begins to shallow again. Note, in particular, that earthquakes tend to be concentrated between 10- and 20-km depth beneath the San Jacinto fault zone, leaving the upper 10 km of the crust relatively quiescent along the middle stretch of the fault zone. The dense knot of hypocenters in the upper 5 km of the crust midway along cross section *P–P′* corresponds to the cluster of epicenters 15 km southwest of the fault zone near the Anza gap (fig. 5.10*A*). The Anza gap itself shows up between $\Delta=120$ and 140 km in cross section *P–P′* as a quiescent zone below and southeast of the shallow cluster of hypocenters (Fletcher and others, 1987; Sanders, 1987). The distribution of hypocenters beneath the Elsinore fault zone (cross sec. *R–R′*, fig. 5.10*B*) is in many ways similar to that beneath the San Jacinto fault zone. Maximum focal depths increase northwestward from 12–15 km at the southeast end of the fault near the United States-Mexican border to about 20 km midway along the fault zone (generally coincident with the highest topography in this section of the Peninsular Ranges) and then gradually decrease farther northwestward toward the Los Angeles Basin. Maximum focal depths show evidence of increasing again at the northwest end of the fault as it approaches the Transverse Ranges and branches into the Whittier and Chino faults. The hypocenters along the south half of the Elsinore fault also tend to concentrate in the lower 10 km of the seismogenic crust, although this pattern is not as well defined in the diffuse seismicity of the Elsinore fault zone as in the dense clustering along the San Jacinto fault zone.

FOCAL MECHANISMS AND TRANSFORM-BOUNDARY KINEMATICS

Focal mechanisms of selected earthquakes recorded in California from 1933 through 1988 are shown in figure 5.11*A*, and the corresponding source parameters are listed in tables 5.2 and 5.3. Primary considerations in the selection of these events were (1) size—larger events were chosen where available, because they represent large-scale processes along major boundaries; (2) date of occurrence—the quality of data for focal-mechanism determinations improved significantly during the mid-1970's; and (3) location—some larger events were omitted because they were redundant in terms of mechanism and location, and some smaller events were included because they occurred in regions of significant seismicity where no larger events were available. Most focal mechanisms were determined from first arrivals at stations in the northern and southern California seismic networks. The evolving capability of these networks for such studies is reflected in the number of stations in the networks, summarized in table 5.1. Fault-plane solutions for the few large earthquakes on the list before the mid-1970's were supported by observations from stations outside the California networks.

Since the mid-1970's, focal mechanisms have been determined for only a fraction of the events for which adequate local first-motion data were available. Therefore, in addition to the three considerations listed above, there was a fourth, the interests of the investigators who analyzed the data. These interests included topical studies of large earthquakes and aftershock sequences, analyses of regional traveltimes on the basis of $M\geq4$ earthquakes, and a special study of the focal mechanisms of earthquakes on or near the San Andreas fault in southern California (Jones, 1988).

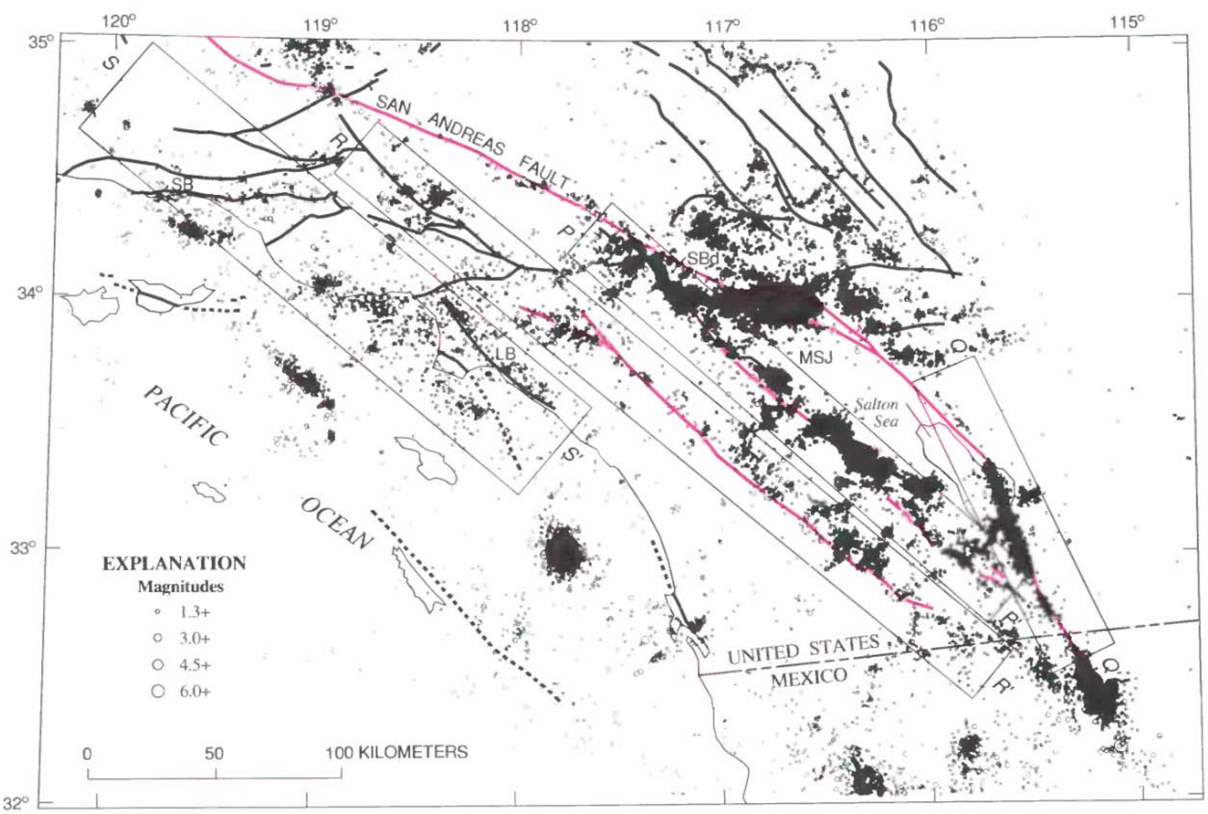
Focal mechanisms discussed in the first two subsections below are for earthquakes in the contiguous Coast Ranges-Transverse/Peninsular Ranges-Mojave Desert region associated with the principal seismic expression of the San Andreas fault system, where the seismic networks are best developed. Outside that region, except for the Cape Mendocino area and the vicinity of Long Valley caldera, the few well-determined focal mechanisms that are available provide only limited information on tectonic processes.

STRIKE-SLIP KINEMATICS OF THE SAN ANDREAS FAULT SYSTEM

Most moderate and large ($M\geq3$) earthquakes along the San Andreas fault and its major branches produce nearly pure right-lateral displacements along near-vertical planes that closely follow the surface traces of the respective fault segments. This relatively simple kinematic pattern holds for the great earthquakes that rupture "locked" sections of the fault every few hundred years (Sieh, 1981), as well as for nearly all the moderate earthquakes that rupture limited patches along persistently active segments of the fault system (Ellsworth and others, 1982; Jones, 1988). Displacements associated with these earthquakes dominate the kinematic pattern along the transform boundary in California. DeMets and others (1987) and Minster and Jordan (1987), for example, argued that the cumulative displacement from earthquakes along the faults in the San Andreas system, together with the contribution from aseismic slip along its creeping segments, accounts for 60 to 70 percent of the total displacement between the Pacific and North American plates.

The fault-parallel strike-slip displacements typical of San Andreas earthquakes are illustrated in figure 5.11*A* by focal mechanisms along the San Andreas fault and its major branches from the United States-Mexican border to north of Clear Lake. In central California, such mechanisms mark the San Andreas fault itself from San Francisco to Cholame (events 26, 36, 38, 45, 46), the Calaveras-Greenville fault (events 23, 28–34) and the Hayward fault (event 27). Farther north, such mechanisms occur along the Green Valley-Bartlett Springs fault (event 15) and the Rodgers Creek-Healdsburg-Maacama faults (events 16, 17, 19, 20). In southern California, such mechanisms mark the San Jacinto fault (events 78, 82–85) and the Imperial fault (event 89). Along the coast west of the San Andreas fault, similar focal mechanisms occur along the San Gregorio-Palo Colorado fault (events 39, 40) in northern California and along the Newport-Inglewood fault zone (events 62, 71), the Rose Canyon fault (event 73), and the San Clemente fault (event 70) in southern California.

Exceptions to this simple pattern for moderate ($M \geq 4$) events along the San Andreas fault and its major branches appear to be limited to regions of unusual complexity, such as the major bends in the San Andreas near Cajon Pass (event 69) and San Gorgonio Pass (event 80). Jones and others (1986) attributed the July 8, 1986, earthquake (event 80) to right-lateral slip on the Banning



A

FIGURE 5.10.—Seismicity along the southern section of the San Andreas fault system. *A*, Earthquake locations, showing major branches of the San Andreas fault system in red; faults dotted where concealed. Magnitude symbols shown in explanation are scaled with enlargement of cross sections. BZ, Brawley seismic zone; LB, Long Beach; MSJ, Mount San Jacinto; SB, Santa Barbara, SBd, San Bernardino. *B*, Depth sections outlined in 5.10*A*. Faults: CU, Cucamonga; NI, Newport-Inglewood; W, Whittier.

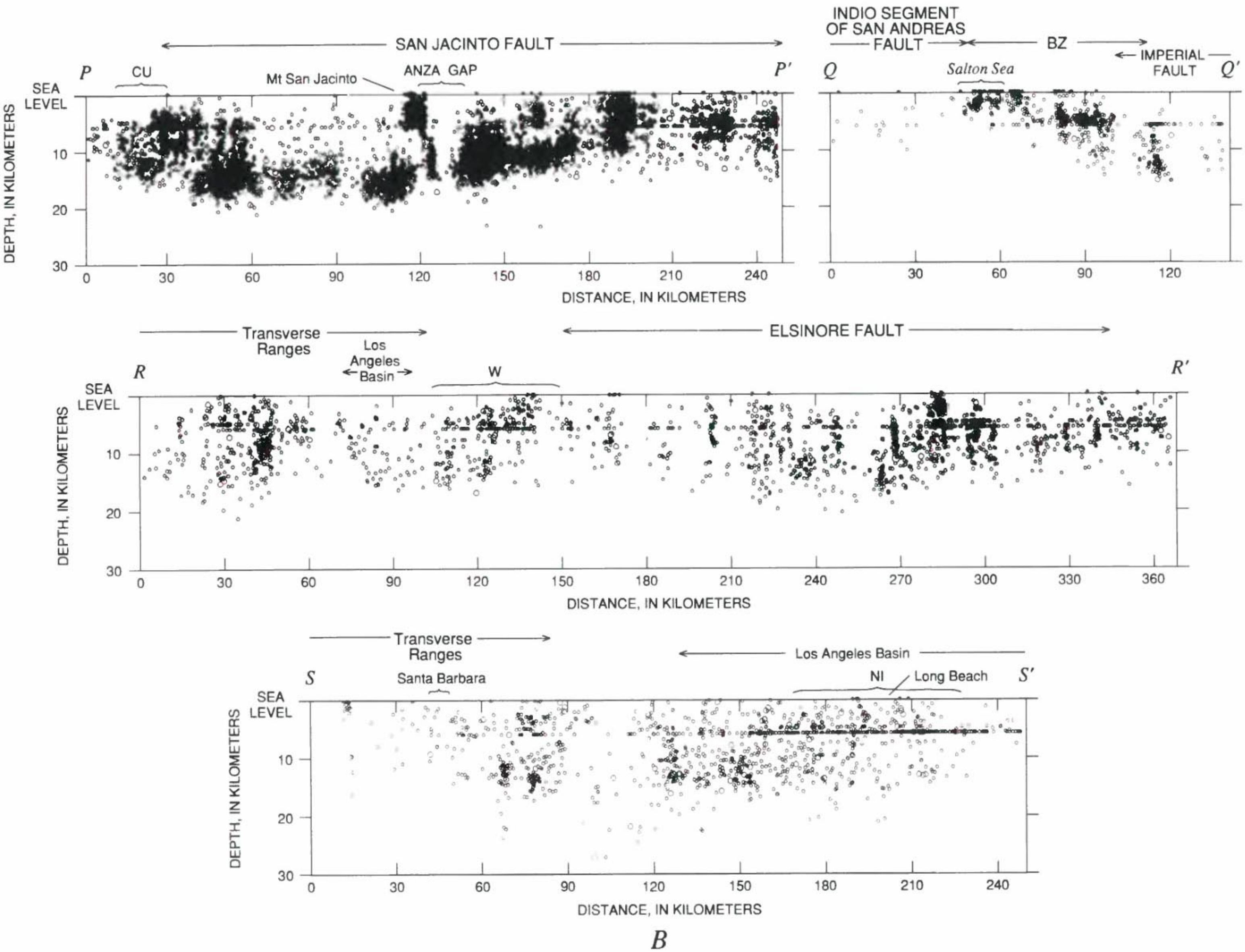


FIGURE 5.10.—Continued.

segment of the San Andreas fault where it dips 45° N. beneath the San Bernardino Mountains. The October 17, 1989, M=7.1 Loma Prieta earthquake involved nearly equal amounts of right and reverse slip along a section of the San Andreas fault that takes a slight westerly bend through the Santa Cruz Mountains and dips 70° SW. (see chap. 6). Smaller (M<4) events near, but probably not on, the fault show a great variety of focal mechanisms that reflect varying conditions along the fault; these mechanisms range from reverse or reverse-oblique slip

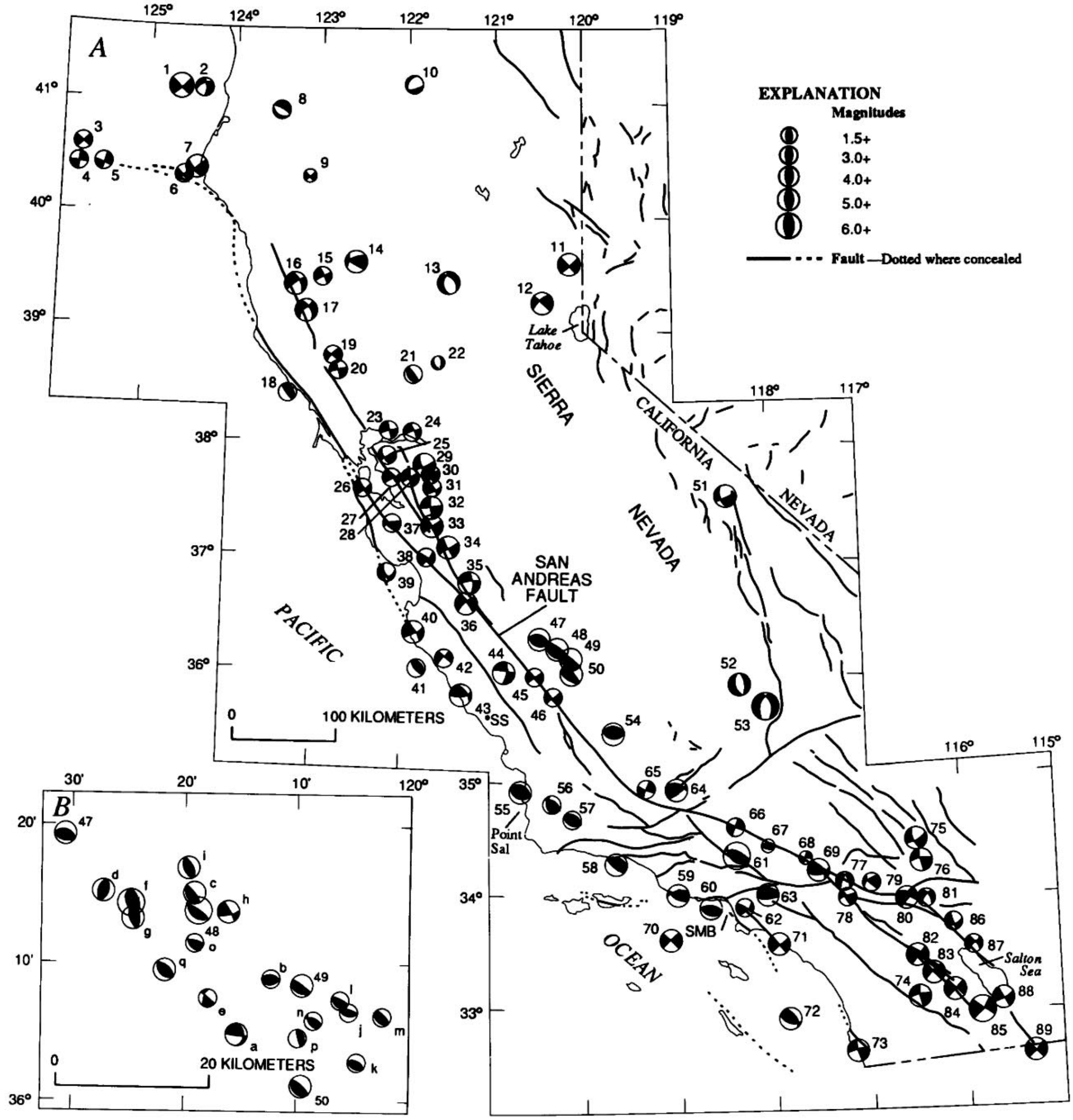


FIGURE 5.11.—Focal mechanisms for larger earthquakes. *A*, California. SMB, Santa Monica Bay; SS, San Simeon. Numbers refer to table 5.2. *B*, Coalinga-Kettleman Hills region (events 47–50, fig. 5.11*A*). Letters and numbers refer to table 5.3. Circle size increases with magnitude from 3.5 to 6.7.

TABLE 5.2.—*Locations and focal-mechanism parameters for selected earthquakes in California*

[M_L, estimated local magnitude. For M_L<3, estimate is based on coda magnitude (see Lee and Stewart, 1981); for M_L>3, estimate is based on peak amplitude and associated period (see Eaton and others, 1970). Focal-mechanism parameters: DA, dip angle; DD, dip azimuth]

Event	Date (yr/mo/d)	Time (G.m.t.)	Lat N.	Long W.	Depth (km)	M_L	Focal-mechanism parameters		
							DD (°)	DA (°)	Rake (°)
1	801108	1027:32.5	41°06.96′	124°39.87′	6.0	7	138	82	−8
2	801110	0624:07.3	41°06.79′	124°24.06′	7.5	4	337	52	−391
3	801109	0409:07.5	40°35.62′	125°46.45′	15	5.4	134	90	0
4	801108	1125:34.6	40°25.22′	125°48.83′	15	4	5	90	180
5	831220	1041:05.2	40°25.44′	125°31.35′	15	5.7	21	90	180
6	810916	1241:14.7	40°20.38′	124°35.64′	28.9	4.8	319	80	0
7	870731	2356:58.0	40°25.33′	124°26.61′	16.4	5.8	146	90	−20
8	870409	2034:09.0	40°56.32′	123°29.14′	26.2	4.1	27	68	−93
9	820912	0651:31.9	40°21.57′	123°08.52′	50.7	3	52	78	−170
10	820621	0643:37.6	41°10.66′	121°56.64′	7.3	4.3	168	64	−59
11	660912	1641:02.6	39°36.28′	120°09.61′	10	6	134	80	0
12	801128	1821:12.2	39°16.32′	120°27.74′	21.8	5.5	314	60	0
13	750801	2020:12.8	39°26.33′	121°31.71′	5.5	5.7	270	65	−70
14	820903	1858:24.1	39°36.92′	122°34.96′	14.6	4.2	214	74	127
15	781112	1307:57.0	39°29.46′	122°57.09′	10.2	4.3	60	80	180
16	771122	2115:52.2	39°25.10′	123°16.19′	6.6	5.1	65	44	−166
17	780326	0027:03.8	39°11.82′	123°08.49′	6.0	4.7	55	54	−169
18	780331	0103:26.8	38°28.92′	123°20.04′	6.4	3.6	56	20	90
19	820529	1302:23.9	38°47.87′	122°49.35′	4.8	4.3	39	90	−167
20	770911	2346:11.5	38°39.96′	122°45.61′	7.0	3.7	76	90	−167
21	780908	1659:47.6	38°37.86′	121°54.59′	8.1	4.3	239	20	90
22	870103	1354:18.0	38°44.89′	121°37.90′	11.4	1.8	90	56	−68
23	770905	1745:28.0	38°09.68′	122°10.44′	7.5	3.7	76	90	180
24	770604	2057:07.8	38°09.42′	121°54.51′	18.3	3.6	70	80	180
25	770108	0938:07.0	37°54.94′	122°11.58′	10.4	4.5	240	66	180
26	790428	0044:44.7	37°37.32′	122°27.68′	11.6	4.2	49	70	169
27	840327	0336:35.3	37°43.48′	122°08.41′	3.3	4.5	55	56	173
28	770814	1425:34.4	37°43.42′	121°56.40′	6.5	3.5	60	84	180
29	800124	1900:09.1	37°50.20′	121°46.88′	11.9	5.9	247	75	−170
30	800127	0233:35.8	37°45.12′	121°42.54′	12.4	5.3	232	78	180
31	770621	0243:06.7	37°37.83′	121°40.55′	10.3	4.6	59	80	157
32	860331	1155:39.9	37°28.05′	121°41.63′	8.3	5.8	262	80	180
33	840424	2115:18.8	37°18.56′	121°40.68′	8.4	6.2	236	82	180
34	790806	1705:22.3	37°06.70′	121°30.03′	9.6	5.9	240	84	180
35	860126	1920:51.2	36°48.53′	121°16.10′	4.8	5.8	87	70	−170
36	820811	0746:43.0	36°37.60′	121°18.02′	9.2	4.5	53	85	−166
37	770727	2151:17.2	37°19.06′	122°07.24′	6.8	3.5	212	48	124
38	820818	0843:49.5	37°01.34′	121°44.66′	11.8	4.3	38	80	166
39	780702	1157:56.7	36°53.40′	122°10.86′	6.2	4	249	78	−147
40	840123	0540:19.9	36°22.13′	121°52.74′	7.7	5.2	60	78	173
41	860708	0040:23.0	36°03.81′	121°50.17′	11.9	4.4	60	34	90
42	830721	0123:33.0	36°09.17′	121°32.64′	5.2	3.9	41	90	−175
43	830829	1010:30.9	35°50.17′	121°20.70′	6.6	5.4	51	55	139
44	851124	1921:38.6	36°01.16′	120°53.12′	11.3	4.4	102	70	−170
54	820625	0358:23.0	35°57.43′	120°33.11′	9.1	4.2	51	80	180
46	660702	1216:15	35°47.3–′	120°20.6–′	9.1	3.5	231	78	180
47	821025	2226:03.7	36°19.31′	120°30.44′	11.0	5.5	198	28	90
48	830502	2342:38.1	36°13.96′	120°18.57′	10.0	6.7	217	23	90
49	850804	1201:55.8	36°08.59′	120°09.44′	11.4	5.7	217	14	90
50	850807	0016:03.41	36°01.13′	120°09.46′	14.9	4.6	216	20	82
51	860721	1442:26.1	37°31.91′	118°26.67′	9.1	6.5	245	58	180
52	831021	2244:00	35°54.9–′	118°19.9–′	4.4	4.5	83	46	−85
53	460315	1349:35.9	35°43.50′	118°03.27′	22	6.3	76	45	−117
54	880222	0743:12.8	35°29.84′	119°42.13′	19.1	4.2	182	44	90
55	800529	0338:47.5	34°58.65′	120°42.37′	9.2	5.1	28	34	98
56	820923	2042:50.6	34°52.19′	120°21.76′	4.8	4	36	56	63
57	841025	1036:02.4	34°44.21′	120°08.85′	6	4.5	211	43	90
58	780813	2254:53.4	34°20.82′	119°41.75′	12.1	5.1	10	26	57
59	730221	1445:57.3	34°03.89′	119°02.10′	8	5.9	350	36	55
60	790101	2314:38.9	33°56.65′	118°40.88′	11.1	5	10	60	85
61	710209	1400:41.8	34°24.67′	118°24.03′	8.1	6.4	20	54	76

TABLE 5.2.—*Locations and focal-mechanism parameters for selected earthquakes in California*—Continued

Event	Date (yr/mo/d)	Time (G.m.t.)	Lat N.	Long W.	Depth (km)	M_L	Focal-mechanism parameters		
							DD (°)	DA (°)	Rake (°)
62	790227	1540:58.9	33°56.7–′	118°19.5–′	9.7	3	135	60	20
63	871001	1442:19.8	34°03.11′	118°04.56′	14.7	6.1	175	65	90
64	520721	1152:14	35°00.—′	119°01.—′	0	7.7	140	63	49
65	820421	2119:30.2	35°00.48′	119°20.94′	15.0	3.2	201	76	170
66	781107	0028:45.6	34°39.93′	118°24.27′	13.4	2.6	200	85	176
67	840414	0227:02.6	34°29.51′	118°04.01′	11.9	2.9	357	56	80
68	850719	1617:01.7	34°23.20′	117°39.79′	8.1	2.8	196	80	169
69	700912	1430:53.0	34°16.18′	117°32.40′	8	5.4	55	60	140
70	810904	1550:50.3	33°40.26′	119°06.67′	5	5.3	315	80	0
71	330311	0154:07.8	33°36.99′	117°58.00′	0	6.3	320	90	0
72	860713	1347:08.2	32°58.24′	117°52.19′	6	5.3	50	50	110
73	850618	0428:14.8	32°40.22′	117°10.33′	12.1	4	255	85	175
74	841010	2122:58.9	33°08.26′	116°30.06′	11.6	4.5	260	80	191
75	750601	0138:49.2	34°30.94′	116°29.72′	4.1	5.2	247	70	–165
76	790315	2107:16.5	34°19.63′	116°26.68′	2.1	5.2	258	81	167
77	810912	2123:07.3	34°09.90′	117°15.93′	4.2	3.8	294	63	–52
78	851002	2344:12.4	34°01.40′	117°14.71′	15.2	4.8	242	75	165
79	781120	0655:09.1	34°09.07′	116°58.52′	12.9	4.3	227	75	145
80	860708	0920:44.5	33°59.91′	116°36.38′	11.1	5.6	30	45	170
81	850119	0030:13.0	33°59.64′	116°23.83′	2.9	3.9	310	63	–40
82	800225	1047:38.5	33°30.05′	116°30.79′	13.9	5.5	38	68	191
83	690428	2320:42.9	33°20.60′	116°20.78′	20	5.8	230	80	191
84	680409	0228:59.1	33°11.39′	116°07.72′	11	6.4	42	90	180
85	871124	1315:56.4	33°00.69′	115°51.31′	1.7	6.2	125	80	0
86	831227	2134:37.7	33°46.79′	116°07.32′	2.7	3.1	251	82	–148
87	791204	0828:17.6	33°34.55′	115°54.75′	5.1	2.7	51	71	–165
88	810426	1209:28.4	33°05.90′	115°37.90′	3.0	5.7	150	80	0
89	791015	2316:53.4	32°36.81′	115°19.09′	12.1	6.6	42	90	180

on easterly-striking planes (events 37, 67), through right-lateral strike slip on planes parallel to the San Andreas fault (events 65, 66, 68, 87), to normal or normal-oblique slip on northerly-striking planes (events 77, 81).

Moderate earthquakes with strike-slip focal-mechanisms that are not located on major faults of the San Andreas system but yet are broadly associated with it commonly have right-slip planes, with strikes ranging from northwestward (event 42) to north-southward (events 35, 44, 74, 75, 76, 86). In most cases, these right-slip planes agree in strike with local mapped faults or with alignments of epicenters that strongly suggest active faults (events 75, 76).

CRUSTAL CONVERGENCE ADJACENT TO THE SAN ANDREAS FAULT SYSTEM

One of the more important results to emerge from high-resolution focal-mechanism studies in recent years is that earthquakes occurring even a short distance off faults of the San Andreas system can involve displacements that diverge sharply from local San Andreas strike-slip displacements. This pattern is particularly pronounced in the strong component of reverse slip at large angles (more than 60°) to the local strike of the San Andreas fault on both sides of the San Andreas fault system in both the Transverse and Coast Ranges.

North-south convergence within the Transverse Ranges is dominated by reverse slip on easterly-striking planes. The M=7.7 Kern County earthquake of 1952 (event 64), which occurred on the south-dipping White Wolf fault along the north flank of the Transverse Ranges about 25 km north of the junction of the San Andreas and Garlock faults, and the M=6.6 San Fernando earthquake of 1971 (event 71), which ruptured a 20-km-long stretch of the northeast-dipping San Gabriel-San Fernando thrust faults (Whitcomb, 1971; Heaton, 1982), are two striking examples of this deformation. So, also, is the alignment of M=5–6 reverse-slip earthquakes (events 59, 60, 63) along the southern margin of the Transverse Ranges. The reverse slip on east-west-striking planes associated with these earthquakes suggests that the north-dipping Santa Monica-Cucamonga fault serves as an important convergent boundary between the Peninsular and Transverse Ranges.

Figure 5.11*A* also shows that the east-west-trending zone of convergence associated with these earthquakes

TABLE 5.3.—*Locations and focal-mechanism parameters for earthquakes in the Coalinga-Kettleman Hills region*

[Same symbols as in table 5.2]

Event	Date (yr/mo/d)	Time (G.m.t.)	Lat N.	Long W.	Depth (km)	M_L	Focal-mechanism parameters		
							DD (°)	DA (°)	Rake (°)
a	760114	2143:59.5	36°04.88′	120°15.09′	9.0	4.7	85	42	168
47	821025	2226:03.7	36°19.31′	120°30.44′	10.9	5.5	198	28	90
48	830502	2342:38.1	36°13.96′	120°18.57′	10.0	6.7	217	23	90
b	830522	0839:21.7	36°09.03′	120°12.09′	10.5	4.2	164	40	73
c	830524	0902:17.7	36°15.24′	120°19.00′	8.9	4.7	256	18	111
d	830611	0309:52.2	36°15.33′	120°27.01′	2.4	5.2	107	50	90
e	830612	0131:27.5	36°07.55′	120°17.71′	14.5	4.0	296	44	168
f	830722	0239:54.1	36°14.44′	120°24.53′	7.3	6.0	85	38	102
g	830722	0343:01.0	36°13.31′	120°24.37′	7.9	5.0	72	30	85
h	830909	0916:13.5	36°13.91′	120°15.90′	6.7	5.3	64	75	161
i	840219	0943:09.4	36°17.10′	120°19.47′	10.7	4.5	66	52	90
49	850804	1201:55.8	36°08.59′	120°09.44′	11.4	5.7	217	14	90
j	850804	1208:41.3	36°06.67′	120°05.23′	10.9	4.3	188	44	85
k	850804	1515:39.3	36°02.85′	120°04.57′	11.1	4.4	203	26	90
l	850805	1445:37.8	36°07.48′	120°05.99′	7.5	4.4	229	20	105
50	850807	0016:03.4	36°01.13′	120°09.46′	14.9	4.6	216	20	82
m	850809	0847:09.7	36°06.36′	120°02.32′	9.9	3.6	218	30	82
n	850809	1242:18.8	36°05.94′	120°08.39′	6.1	3.8	233	38	113
o	850914	0302:44.6	36°11.57′	120°18.89′	9.4	3.6	225	44	112
p	850915	0909:46.8	36°04.72′	120°09.68′	13.1	3.5	77	16	90
q	870214	0726:50.3	36°09.56′	120°21.53′	14.6	5.2	238	48	98

curves northward near Santa Monica Bay and continues northwestward along the coast at least as far as Point Sal and probably as far as San Simeon. Focal mechanisms of earthquakes along this zone from Point Sal to Whittier (events 55–60, 63) are predominantly reverse slip, with slip directions nearly normal to the local trend of the zone. The focal mechanism of event 43 near San Simeon, which indicates right-oblique reverse slip on a northeast-dipping plane parallel to the coast, is intermediate between those of event 40 at Point Sur and event 55 at Point Sal.

Reverse-slip focal mechanisms for offshore events 18 and 41 in central California and for event 72 in southern California suggest that the offshore crust is undergoing compression normal to the coastline throughout the length of the San Andreas fault system. The Coalinga-Kettleman Hills earthquake sequence of 1982–85 (events 47–50, fig. 5.11*A*) emphasizes the important role of crustal convergence along the southern Coast Ranges-Great Valley boundary in central California. The principal events in this sequence (event 48, Coalinga, and event 49, Kettleman Hills, fig. 5.11*A*) involved reverse slip on subparallel planes at depths of 10 to 12 km that dip gently (approx 20°) southwest. Much of the aftershock activity, however, occurred at shallower depths and involved high-angle reverse slip on planes dipping steeply (45°–70°) northeast (events f, g, i, o, q, fig. 5.11*B*). Displacements associated with these earthquakes, which are nearly perpendicular to the San Andreas fault, represent a convergent process in which Franciscan melange on the west is being wedged between crystalline basement and the overlying Great Valley sedimentary sequence on the east (Wentworth and others, 1983; Eaton, 1990).

The boundary between the Coast Ranges and Great Valley is marked by reverse-slip earthquakes throughout much of its length: event 54 southeast of the Kettleman Hills, the Coalinga-Kettleman Hills sequence, event 21 near Winters east of Lake Berryessa, and event 14 west of Oroville. The similarity in focal mechanism of event 21 near Winters to the Coalinga and Kettleman Hills main shocks suggests that the convergent process acting in the southern Coast Ranges is common to the entire eastern margin of the Coast Ranges. Indeed, the strong earthquakes that shook the Winters-Vacaville-Dixon area in 1892, just south of event 21, resemble the Coalinga-Kettleman Hills sequence in both setting and intensity distribution. Focal mechanisms of smaller earthquakes along the Coast Ranges-Great Valley boundary in central California studied by Wong and others (1988) also suggest convergence across that boundary.

Convergence normal to the strike of the San Andreas fault is not limited to the coast and the Coast Ranges-Great Valley boundary described above. In a detailed examination of the focal mechanisms of aftershocks of the 1984 Morgan Hill earthquake, Oppenheimer and others (1988) concluded that the direction of maximum compression immediately adjacent to the Calaveras branch of the San Andreas fault is at an angle of about 80° to the N. 10°

W. strike of the fault. Along the entire stretch of the San Andreas fault from Parkfield to the Salton Sea, Jones (1988) found a constant angle of 65° between the strike of the fault and the maximum-principal-stress direction for earthquakes occurring off the fault.

This evidence from earthquake focal mechanisms and other stress indicators (such as borehole breakouts and fold axes) that the maximum principal compressive stress may be oriented at a high angle to the local strike of the San Andreas fault seems to contradict long-accepted ideas for brittle failure in the crust based on laboratory experiments in rock mechanics. Zoback and others (1987) and Oppenheimer and others (1988) suggested that these relations can be explained by an exceptionally low average shear strength for the San Andreas fault system. As pointed out by Lachenbruch and McGarr in chapter 10, however, the strength and state of stress along the San Andreas fault are still matters for discussion.

EAST-WEST EXTENSION IN THE SIERRA NEVADA

The three moderate-earthquake focal mechanisms for the Sierra Nevada and its western foothills shown in figure 5.11*A* all indicate normal faulting on northerly-striking planes and suggest pervasive east-west extension throughout the Sierra Nevada. Event 52 is in a dense north-south-trending band of epicenters about 15 km east of the Kern River canyon, and event 53 is in a north-south-trending band of earthquakes about 10 km west of the Sierra frontal fault near Walker Pass. These relations suggest that the east-west spreading and associated normal faulting on northerly-striking faults of the Great Basin are encroaching into the southeast corner of the Sierra Nevada block (Jones and Dollar, 1986).

Event 13 is the main shock (M=5.7) of an earthquake sequence on a north-south-striking, west-dipping normal fault near the Oroville Dam that occurred in 1975. The uplift of the Sierra Nevada relative to the Great Valley to the west indicated by the focal mechanism of this event is also visible in the Chico monocline, which marks the Sierra Nevada-Great Valley boundary northwest of Oroville.

CONJUGATE FAULTING IN THE SIERRA NEVADA-GREAT BASIN BOUNDARY ZONE

The Sierra Nevada-Great Basin boundary zone is represented in figure 5.11*A* by three focal mechanisms. Events 11 and 12 lie northwest of Lake Tahoe along the edge of a minor gap in the band of seismicity along the east edge of the Sierra Nevada. Both events appear to have resulted from left-lateral slip along steeply dipping, northeast-striking faults; both events had aftershock regions that were elongate northeast-southwest. About 250 km southeast, the M=6.4 July 21, 1986, Chalfant Valley earthquake (event 51) resulted from right-lateral strike-slip displacement on a north-northwest-striking surface dipping 60° SW. An M=5.7 foreshock on July 20 resulted from left-lateral strike slip on a northeast-striking, northwest-dipping surface. These two conjugate slip surfaces merge at their north ends (Cockerham and Corbett, 1987; Smith and Priestly, 1988).

The zone of intense seismicity in the vicinity of Long Valley caldera and the Sierra Nevada block to the south produced 11 $M \geq 5.5$ earthquakes from 1978 through 1984 (Savage and Cockerham, 1987), as well as many thousands of smaller events and numerous earthquake swarms. Most of the larger events occurred in the Sierra Nevada block south of Long Valley caldera, involving left-lateral slip along near-vertical, north-south- to north-northeast-striking faults. One of four $M \approx 6$ events that occurred on May 25–27, 1980, however, was located within the south moat of the caldera along the west-northwest-striking fault zone that produced most of the earthquake swarms (see Hill and others, 1985a, b).

FRAGMENTATION OF THE SOUTHEAST CORNER OF THE GORDA PLATE

The 1980 Eureka M=7.2 earthquake occurred along a fault break that extended from the continental slope 40 km west of the coastline at lat 41° N. for a distance of 140 km southwestward to the MFZ, virtually cutting off the southeast corner of the Gorda plate. Focal mechanisms of the main shock and largest aftershock (events 1, 3, fig. 5.11*A*) both indicate left-lateral strike-slip displacement along a vertical fault that coincides with the line of aftershocks. Some early aftershocks, including event 4 and other moderate events farther east along the MFZ, have focal mechanisms that indicate right-lateral slip along the MFZ. Although the main shock occurred beneath the Continental Shelf, it seems clear that the 1980 earthquake primarily involved the Gorda plate because the fault broke well beyond the base of the continental slope and the edge of the North American plate. Moreover, left-lateral slip along the 1980 break stimulated right-lateral slip along the adjacent part of the MFZ. Ongoing right-lateral displacement along the MFZ is also indicated by event 5 (Dec. 1983).

Two moderate earthquakes near Cape Mendocino in 1981 and 1987 (events 6 and 7, respectively) had focal mechanisms similar to that of the 1980 Eureka earthquake, indicating left-lateral strike-slip displacement on steeply dipping, northeast-striking planes. Aftershocks of the 1987 M=5.8 event outlined a narrow, steeply dipping, northeast-trending, 20-km-long zone between about 15- and 25-km depth that extended southwestward from the shoreline just north of Cape Mendocino to the